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COMPARATIVE ANALYSIS OF RESOURCE USE EFFICIENCY IN MAIZE PRODUCTION INVOLVING LOCAL AND IMPROVED VARIETIES IN ZAMFARA STATE, NIGERIA

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ABSTRACT

The study examined the comparative analysis of resources-use efficiency in maize production using local and improved varieties in Zamfara State. Seven Local Government Areas were purposively selected for the study. Two Districts were randomly selected from each of the seven Local Government Areas. Two Villages were also randomly selected from each of the two districts in a Local Government Area. Through the use of simple random sampling ten farmers (five each for local and improved maize varieties) were selected from each of the villages and this gave a total of 280 farmers as the sample size. Data collected by the use of structured questionnaire were analyzed using regression. The results showed a positive and significant ($P<0.05$) relationship between plot size, quantity of fertilizer applied and yield of improved maize. Increase in the quantity of seed (0.425) and fertilizer (0.374) led to significant increase in yield at 5% and 1% levels respectively for local maize production. The ratio of marginal value product (MVP) of farm size to the marginal factor cost (MFC) was less than unity for local maize varieties. The quantity of seed and quantity of fertilizer had ratio greater than unity in the local maize varieties' production. The ratio of marginal value product (MVP) of plot size, quantity of seeds and quantity of fertilizer to the marginal factor cost (MFC) were greater than unity.

Keywords: Resource use efficiency; Maize production; Maize varieties

INTRODUCTION

Maize (*Zea mays*) is one of the oldest and widely cultivated cereals worldwide. It has a big impact on the economies of developed as well as developing countries. Improved Open Pollinated Varieties (OPVs) and hybrid maize varieties are termed as modern varieties (MVs) developed by formal plant-breeding programme. Local varieties refer to the farmers' traditional varieties (also known as land races) that have never been worked on by a formal breeding programme, as well as older improved OPVs and hybrids (Morris *et al.*, 1999).

Efficiency in agricultural production is defined as the index of the ratio of the value of total farm output to the value of the total input used in farm production (Olayide and Heady. 1982). For optimum level of production to be achieved, resources must be available and these resources must be used efficiently.

Even though a lot of researches in resource-use efficiency in maize production in other areas were carried out, a lot more research is needed on the resource-use efficiency of improved and local maize production particularly in the proposed area of study. This is because some farmers still hold on to maize production using local varieties in the area. The study was to compare resource-use efficiency in maize production using local and improved varieties, to determine if both varieties are efficiently utilized. The finding could be used by farmers to make adjustment in the use of farm resources to enhance increased maize production. Thus, it was hypothesized that there is no relationship between input and output in the production of local and improved maize varieties.

MATERIALS AND METHODS

The Study Area

The study was carried out in Zamfara State in the North western part of Nigeria. Zamfara State is geographically located between latitudes l0°50'N and 13^{0}38'N and longitudes 4^{0}16'E. The state covers a land area of 38,418sq. km. Climate is characterized by a long hot dry season usually lasting from September to May and a short warm, wet (rainy) season that usually starts in mid- May and ends in September. The mean annual rainfall is about 900mm. Mean annual temperature is about 30°C with a maximum of 42°C in April-May. Average relative humidity is 50% and annual mean evaporation of 6%. Harmattan lasts from November-March (ZARDA, 2005; as cited in Rabi'u *et al.*, 2006). The state is blessed with a vast area of land that is suitable for production of crops. Maize in Zamfara state is gradually replacing Guinea corn that used to be the most common staple food in the state. Maize is widely cultivated, marketed and consumed by the people in the state. Maize grain is consumed by human and the maize stalk consumed by livestock. The improved maize varieties cultivated by farmers in the area included Quality Protein Maize (QPM), Extra Early White, Extra Early Yellow, Oba super I, Oba super II and Oba 98. The local maize varieties cultivated in the area included 'Yargara White and Yellow. Other food crops grown in the area are Millet, Maize, Rice, Guinea corn. Cassava. Groundnut, sweet potatoes and cowpea. The area has abundant grasses for animal grazing and characterized by scattered trees, mainly Baobao, Bean seed, Mango and Neem trees. The inhabitants of the area also engage in trading, rearing and fishing (ZSG, 2006).

Sampling Procedure and Sample Size

The survey was carried out in seven (7) purposively selected Local Government Areas of Zamfara State out of the fourteen (14) existing ones. These are Talata Mafara, Bungudu, Maru, Bukkuyum, Tsafe, Gusau and Anka Local Government Areas. This was done for reason of abundance of maize production in the areas. Two (2) districts were randomly selected from each of the already chosen seven Local Government Areas. This gave a total of fourteen (14) districts. Two (2) villages in each of the 14 districts were randomly selected. This gave a total of twenty eight (28) villages required for the research. Names of farmers using improved maize varieties were obtained from Zamfara Comprehensive Agricultural Revolution Programme (ZACAREP) while farmers using local maize varieties were identified by local leaders in order to serve as sampling frame. Five (5) farmers who grew improved maize variety and 5 farmers who grew local maize variety from each of 28 villages were randomly selected. This gave a total of 280 maize farmers as sample size for the research.

Data Collection

Data were collected from the farmers through the use of a structured questionnaire. The farmers were visited twice during the period. Questions were asked by the researchers and responses of the farmers were recorded. The data were collected once for the 2007 cropping season only. Input-output data were collected from the farmers. The output data included yield of maize in kg. The input data included quantity and cost of labour, quantity and cost of fertilizer, quantity and cost of seeds, maize plot size, quantity and cost of manure and hours of animal traction.

Data Analysis

The data obtained from the field survey for the production of improved and local maize varieties in the study area were analyzed by the use of regression analysis.

Resource-Use Efficiency Production Function Models

In order to determine the efficiency of input utilization in improved and local maize production in the study area, production function models were used. The production function stipulates the technical relationship existing between input and output in the production process (Adesimi, 1982). The functional forms of the model that were used in the analysis included linear and Cobb-Douglas production functions. The Cobb Douglas production function was chosen and reported because it gave the best fit based on magnitude, sign on the regression coefficient and level of significance of the parameter estimates of the independent variables. Several inputs were utilized in crop production system. In this survey, the yield realized by farmers was used as the dependent variable while the independent variables were the inputs used. The following multiple regression equations were run for both improved and local maize varieties.

i. The Linear Production Function Model.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7x_7 + u \quad (1)$$

ii. The Cobb - Douglas Production Function Model

$$Y = ax_1^{b_1}x_2^{b_2}x_3^{b_3}x_4^{b_4}x_5^{b_5}x_6^{b_5}x_6^{b_6}x_7^{b_7}u \quad (2)$$

Transformation of The Cobb - Douglas production function model into Logarithmic form gave.

$$\text{Log } Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + b_7 \log X_7 + u. \quad (3)$$

Where

Y = The total quantity of maize produced (kg) as the dependent variable.
X_1 = Maize plot size (ha).
X_2 = Family labour (man-days).
X_3 = Hired labour (man-days).
X_4 = Quantity of maize seeds used (kg).
X_5 = Quantity of fertilizers used (kg).
X_6 = Quantity of manure applied (kg).
X_7 = Animal traction (hour).
a = Constant term.
u = Error term.
b_1 b_2, b_3 b_4, b_5, b_6 and b_7 are the coefficients.
X_1, X_2, X_3, X_4, X_5, X_6 and X_7, are the independent variables.

To determine resource use efficiency, the marginal value product (MVP) of each input was calculated by using the regression coefficient of each input, and the geometric mean values of farm revenues and farm inputs. The MVP_{xi} of Cobb Douglas function is the product of the production elasticity coefficient of the input and the average physical product multiplied by the price of the dependent variable (b_iY/X_i) PY (Alimi, 2000). The MVP of linear function is b_iP_y. Where Y is the dependent variable, P_Y is the price of the dependent variable, b_i is the elasticity coefficient and X_i is the independent variable (Sada, 2006). The marginal factor cost (MFC) of an input was taken to be the market price because the inputs were purchased from competitive input market. When the input is purchased in a perfectly competitive market, the price of successive unit of input remains the same. In this case MFC = PXi where PXi is the price paid for the unit of an input X_i (Olukosi and Ogunbile, 2005). The ratio of MVP to MFC of each input was computed to measure the resource use efficiency. Resource was determined whether it was used efficiently or not as follows: If MVP is greater than MFC, that is, the ratio of MVP to MFC is greater than one (1) the resource is under utilized. If MFC becomes greater than MVP, that is, the ratio of MVP to MFC is less than one (1) the resource is over-utilized. If MVP equal to MFC, that is, the ratio 'of MVP to MFC is equal to one (1) the resource is said to be efficiently utilized (Olukosi and Ogunbile, 2005).

RESULTS AND DISCUSSION

Results of the Production Function Analysis

The production function estimates for the production of local and improved maize varieties were estimated using the linear and Cobb-Douglas production function models. For the two models run, Cobb-Douglas was chosen and reported because it gave the best fit based on magnitude, signs on the regression coefficients, and level of significance of the parameter estimates. Tables 1 and 2 showed regression results of Cobb-Douglas Production Function for the production of Improved and local maize.

The results in Tables 1 and 2 revealed that, the coefficients of determination R^2 for the estimated Cobb-Douglass production function were 0.685 (68.5%) and 0.530 (53%) for improved and local maize varieties, respectively. This implied that 53 and 68.5 per cent of the variation in total yield of local and improved maize varieties respectively are explained by the independent variables included in the models.

Table 1: Results of Cobb-Douglas production function analysis for improved maize varieties in some selected Local Government Areas of Zamfara State

Variable	Regression Coefficient	Std. Error	T-Value	Sig.	F	R^2
X_1 (plot size)	0.286	0.132	2.166	0.034*	19.6**	0.685
X_2 (family labour)	2.859E-03	0.045	0.063	0.950^{ns}		
X_3 (hired labour)	3.194E-02	0.060	0.533	0.596^{ns}		
X_4 (quantity of seed)	6.938E-02	0.079	0.876	0.384^{ns}		
X_5 (quantity of fertilizer	0.239	0.094	2.531	0.014*		
X_6 (quantity of manure)	-0.148	0.099	-1.488	0.142^{ns}		
X_7 (animal traction)	0.126	0.106	1.192	0.238^{ns}		
Constant	7.036	0.964	7.296	0.000**		

Field Survey, 2007; ** = Significant at 1%; * = Significant 5%; ns = Not significant

Table 2: Result of Cobb-Douglas production function analysis for local maize varieties in some selected Local Government Areas of Zamfara State.

Variable	Regression Coefficient	Std. Error	T-Value	Sig.	F	R^2
X_1 (plot size)	9.930E-06	0.066	0.537	0.593^{ns}	12.4**	0.53
X_2 (family labour)	0.142	0.097	1.457	0.150^{ns}		
X_3 (hired labour)	1.804E-02	0.111	0.163	0.871^{ns}		
X_4 (quantity of seed)	0.425	0.162	2.624	0.011*		
X_5 (quantity of fertilizer)	0.374	0.131	2.859	0.006**		
X_6 (quantity of manure)	9.830E-02	0.151	0.650	0.518^{ns}		
X_7 (animal traction)	-3.024E-02	0.121	-0.249	0.804^{ns}		
Constant	3.043	1.251	2.432	0.018*		

Field Survey, 2007; ** = Significant at 1%; * = Significant 5%; ns = Not significant

The F-ratios of local and improved maize varieties are significant at 1% level: this also confirmed the explanatory power of the independent variables. The regression coefficients of the respective independent variables showed the extent to which each variable explained variation in the dependent variable.

Table 1 show that, the regression coefficient with respect to plot size was positive and significant at 5% level for improved maize varieties. For the improved maize variety (Table 1) for every one percent increase in plot size (xi) holding all other inputs constant, there was increase in yield by 0.286% and this was significant at 5% level. For the local maize varieties the regression coefficient was 9.930E-06. This showed positive relationship between plot size and yield obtained, but the contribution was not significant even at 10% level. This was because the major source of farm land was through inheritance and this subsequently led to small-sized farm land that did not make significant increase in yield in local maize production. Falusi (1989) also reported that land coefficient had significant relationship with the dependent variable in the estimated regression equation for improved varieties of maize. In a related study in Uganda, Nkonya *et al.* (2003) reported that there was significant relationship between maize yield and plots planted with improved maize variety.

The regression coefficient associated with quantity of seeds is 0.425 for local maize varieties. This showed a positive relationship between the quantity of seeds used and the yield obtained. This means that for every one unit increase in the quantity of seeds, holding all other inputs constant, there was increase in yield by 0.425%, and this increment was statistically significant at 5% level. For the improved maize varieties the regression coefficient was 6.938E-02. This showed positive relationship between quantity of seeds and yield obtained, but the contribution was not significant even at 10% level. This was because the farmers had no enough access to improved seeds that could lead to a significant increase in yield.

The results in Tables 1 and 2 also indicated that the coefficient of the fertilizer used in the regression model revealed that fertilizer had 0.239 and 0.374 for improved and local maize varieties, respectively. This showed a positive relationship between the quantity of fertilizer used and yield obtained. This means that for every one percent increase in fertilizer, holding all other inputs constant, there were increases in yield by 0.374% and 0.239% for local and improved maize varieties and statistically significant at 1% and 5% level for local and improved maize varieties, respectively. This was evident for the access the farmers had to fertilizer from the Zamfara Comprehensive Agricultural Revolution Pogramme in the State that led to significant increase in yield from maize production. The hypothesis that there is no relationship between inputs and output in the production of improved and local maize varieties is rejected. In a related finding, it was reported that farm size, fertilizer and purchased inputs such as seeds were significant inputs that accounted for variation in the output of food crop farmers (Babatunde and Boluwade, 2004). In another related research, it was reported that an average settler could improve profit substantially by increasing the amounts of seeds, fertilizer, hired farm machinery and spray chemicals used per hectare for maize production (Adesimi, 1982). It was also earlier shown that maize yield was significantly higher on plots planted with improved seeds and on those where inorganic fertilizer, mulching and crop rotation are used (Nkonya *et al.,* 2003).

Marginal Analysis and Resource-Use Efficiency in Production of the Maize Varieties

Marginal analysis was used to determine the efficiency with which each input was used. The Marginal Product (MP) of each variable inputs of the Cobb-Douglass production function was given by the formular b_iY/x_I, while the marginal value product is given by the formular $(b_iY/X_i)\ P_y$. Where b_i represents the-regression coefficient for the variable input, and X and Y represent value of the variable input and dependent variable respectively and P_y represents the price of output per unit of the product (yield) (Alimi, 2000). Marginal analysis of variable inputs is presented in Table 3.

In resources-use efficiency analysis, an input is said to be efficiently utilized when the ratio of marginal value product (MVP) of an input is equal to its marginal factor cost (MFC). Where the MVP/MFC ratio is greater than unity, under utilization of input occurs, and increasing the quantity of the input will increase the profit level of the firm. Similarly, if the MVP/MFC ratio is less than unity, over utilization of resource occurs and profit could be increased by decreasing the quantity of the input used (Alimi, 2000).

Table 3: Resources-use efficiency for local and improved maize varieties production in the study area. ₦/ha.

Variable	MVP		MFC		MVP/MFC Ratio	
	Loc. Var	Imp. Var	Loc. Var	Imp. Var	Loc. Var	Imp. Var
Farm Size (X_1)	0.48	20,827.8	10,000	10,000	0.00005	2.08
Quantity of seed (X_4)	4135.2	1140	60	320	68.92	3.56
Quantity of fertilizer (X_5)	156	103.98	79	79	1.98	1.32

Field Survey, 2007.

The ratios of marginal value product (MVP) of plot size (X_i) to marginal factor cost (MFC) for local maize varieties were less than unity, implying that these inputs were over-utilized in the production of local maize varieties. Reducing the quantity of these inputs, holding other variable inputs constant will increase the profit level of the farmers in the study area. The result also indicated that, quantity of seed (X_4) and quantity of fertilizer (X_5) had MVP/MFC ratios greater than unity for production of local maize varieties, implying that these inputs were under-utilized in the production. Thus, increasing the quantity of these inputs individually, holding other variable inputs constant would increase the profit level in the local maize varieties.

The results also showed that, plot size (X_1), quantity of seeds (X_4) and quantity of fertilizer (X_5) in improved maize variety had MVP/MFC ratios greater than unity, implying that these inputs were under-utilized in improved maize variety production; increasing the inputs individually holding other variable inputs constant will increase the profit level of farmer in the study area. In a related research on resource-use efficiency in food crop production in Ekiti State Nigeria, it was reported that farmland and purchased inputs such as seeds were under-utilized, implying that increasing the farm size and purchased inputs such as seeds and fertilizer used would increase food crop production (Babatunde and Boluwade, 2004). The finding of the study also agreed with the findings of Alimi (2000) in a research on resource-use efficiency on food crop (such as maize, cassava, yam, coco yam, and rice) in order of importance in Oyo State Nigeria, that farmland and inputs such as fertilizer and seeds were under-utilized, and that increasing the farmland and capital used holding other production inputs constant would increase profit in food crop production.

The results in Table 3 on resource-use efficiency for production of local and improved maize varieties among the respondents in the study area showed that, none of the resource inputs were efficiently utilized as far as local and improved maize varieties are concerned in the study area; the sinputs were under-utilized. This tallied with Ogunniyi's (2005) finding on resource-use efficiency in maize production in Oyo State Nigeria that the ratio of the MVP of the various resources to the value of their cost indicated that the resources were yet to be efficiently utilized in the study area.

CONCLUSION

It was concluded that none of the inputs used was efficiently utilized in improved and local maize varieties, i.e. inputs were underutilized. It is therefore recommended that farmers should increase the use of the underutilized inputs like plot size, fertilizes and seeds.

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