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Full Length Research Paper

Determinants of technical inefficiency and constraints to small scale maize production in the Federal Capital Territory (FCT) Abuja, Nigeria

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ABSTRACT: The research deals with the challenges face in maize farming and factors that should practice to improve maize farming in Abuja. Determinants of technical inefficiency plays central role in farmers' decisions making process. The study identified the determinants of technical inefficiency among maize farmers in Abuja, Nigeria. Multistage sampling technique was used for the selection of 154 respondents for the study. Data were analyzed using descriptive statistics, and stochastic frontier function. The results show that 81% of households are males and married. With 82% of the farmers aged above 40 and had average age of 49 years. Also 85.6% of the respondents were literate with at least primary education. Majority (71.7%) of the farmers' household size was between 6 and 10 peoples with average of 9 persons and majority of them had farming experience of 20 years and above. Farm size significantly influenced their production at 1% level while agrochemicals influenced maize farming at 10% level. Farming experience was found to be significant at 1% probability level and household size was major determinants of technical inefficiency. The major constraints faced by the respondents include; pests and diseases, inadequate credit facility, soil infertility and high cost of inputs. Efforts should be made to increase farm size and improve the farmers' skill through regular training on application of best farming practices. Credit facility should be provided to enhance maize production.

Keywords: Determinants, technical inefficiency, small scale, maize, farmers

INTRODUCTION

Maize popularly known and called "corn" (*Zea mays*), came into Africa from Europe, (Portugal) in the 16th century and spread through the African nation. Maize belongs to the grass family (*Poaceae*) and the third most grown cereal crop after Sorghum and Millet, (Kashim *et al.,* 2014). Maize is widely and popularly consumed by majority in the world. It is an important cereal crop and constitutes staple food for 1.2 billion people in West Africa with Nigeria accounting for about 48% of the total production in west and central of the sub-Saharan Africa, (Kashim *et al.,* 2014). Maize is seen growing more in the Northern part of Nigeria with two major types (white and yellow) grown (FAO STAT, 2017). The major producing areas in Nigeria are: Niger, Kaduna, Taraba, Adamawa, Plateau, Katsina. Others include; Bauchi, Borno, Yobe, Jigawa, Gombe, Sokoto, Nasarawa, Zamfara and FCT (FAOSTAT, 2017; ATA, 2012). Despite this, Maize production in Nigeria is low with 3.0 tonnes of maize per hectare when compared with the worlds' global average of 5.1 metric tonnes per hectare (FAO, 2017; IITA Report, 2018). It is disturbing to note that quantity of maize produced is far below the nations' requirement resulting in very high prices (Akanni and Okeowo, 2011). When compared with other crops grown in Nigeria, maize is among the most important cereal crops and considering its numerous uses and the fact that 90% of its production is in the hands of small scale holders with traditional and underdeveloped farming system, meeting the demand of the people comes difficult, Iken and Amusa (2004). Maize is used in the agro industries as beverage, soap and pharmaceutical purposes and this has also lead to increase in cultivation from subsistent to commercial, Aye and Mungatara (2012). Close to 80% of maize produced is consumed by both human and animals, while the remaining 20% goes into different other uses such as the agro-based industries where materials like starch, corn sweetener, ethanol, cereal, alkaline, etc are produced (Onuk *et al.,* 2010).

The first major effort of promoting maize production in Nigeria was in 1974. This was when the Nigerian Government launched the early stage of the National Accelerated Food Production Programme (NAFPP) (Edache, 1999). The impressive growth in maize production which the nation achieved in the past decade (1980s) is attributed to a number of factors, especially: restriction on the importation of maize and later, wheat, rice and malted barley, which gave rise to high demand for locally produced maize as a result of its use as a substitute for some inputs in the brewery, pharmaceutical and bakery industries; good weather conditions for crop production; and, high demand for Nigerian grains in the neighboring Saharan countries (Edache, 1999).

As a very important crop, maize is planted both in small and large scale farm, under rain-fed or by irrigation and widely consumed by both humans and animals as a staple. It supplies a good amount of nutrients needed in the body such as vitamins, energy and some insignificant amount of protein (Benjamin and Kimhi, 2005). Owing to its use as raw material by agro based industries such as Livestock feeds, beverage, soap and pharmaceuticals, its production increased from subsistence level to commercial (Aye and Mungatana, 2012). According to Ohajianya *et al.* (2010) the vegetable parts are also used in making silage for ruminants while the crop residue provides useful source of feed for cattle during dry season, even as the grain is a major component of poultry and pig ration (Opaluwa *et al.,* 2014). According to Iken and Amusa (2004), demand for maize due to its numerous needs (domestic and industrial) cannot be met with 90% of its production coming from small scale farmers who rely on traditional and underdeveloped farming systems.

According to (Thirtle *et al.,* 2003) as cited by (Shamsudeen *et al.,* 2017) most rural poor Africa's population to an extent depends largely on farming based on this, the growth of agriculture should be a major component of any development strategy that aims at reducing poverty and hunger in the country. Technical inefficiency analysis is of paramount important to increase maize productivity and contribute to the attainment of food security and income generation. Therefore, the present study identifies the determinants of technical inefficiency in maize farming in the study area. The results from this study will help close knowledge gap in previous literatures. Thus, this present study is expected to answer the research questions below:

(i) What are the socioeconomic features of the respondents in the study area?
(ii) What are the determinants of technical inefficiency in maize production?
(iii) What are the constraints to maize production in the study area?

The objectives of the study

(i) Describe the socioeconomic characteristics of the farmers;
(ii) Identify the determinants of technical inefficiency in maize production; and
(iii) Identify constraints to maize production in the study area.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Abuja, Nigeria. It is located between longitude 6.20°E and 7.33°E of the Greenwich meridian and latitudes 8.30°N and 9.20°N of the equator. It occupies a land area of about 8,000 square kilometers, (FCDA, 2018). Coal, Columbite, Tantalite, Granite, Precious Stone, Gem Stones are some of the natural resources seen in the area. Abuja is the capital of Nigeria. It is surrounded by Kaduna and Kogi States on the North and South, while bordered by Nasarawa and Niger States on the East and west. It has a population of 776,298 persons (NPC, 2006). The study area is currently made up of 6 area councils namely: Abuja Municipal, Abaji, Bwari, Gwagwalada, Kuje and Kwali. The indigenous people of Abuja are the Gbagyis and are found mostly in the Bassa, Gwandara, Gade, Ganagana, Koro areas. Their major language is Gwari. Like most other parts of the country, Abuja experiences two major weather conditions. The rainy season which runs from March to October with a day light temperature of 28°C (82.4°F) to 30°C (86.0°F) and a night time temperature of about 22°C (71.6°F) to 23°C (73.4°F). Dry season normally begins in October and ends in March with day time temperature as high as 40°C (104.0°F) and nighttime temperature of about 12°C (53.6°F). Abuja is mostly occupied by Civil servants from all parts of the country of which some still seek extra income from farming. Though vast of the indigenous people are predominantly farmers of different agricultural products especially crops. You can also see other agricultural activities like cattle rearing, fish farming; poultry farming etc. it has about 70% literacy level.

Sampling and sample size

The study aimed at a population of 1000 registered farmers involved in maize production in the study area. A multistage sampling technique was used in determining the sample size. Three Area Councils were purposively selected from the 6 area councils in the study area. Majorly because of the fact that some of these areas fall within the agricultural designated areas of Abuja. The second stage was also done by a purposive selection of 5 villages each from the 3 councils earlier selected. It is also in line with the government designated agricultural areas in the FCT as provided for in the Abuja master plan and also for the fact that, majority of those who practice farming leaves close to their farm lands. The third stage involved a random proportionate (15%) selection of respondents using the balloting method, that is, in each village, 15% of the number of maize farmers was selected to give a sample size of 154 maize farmers for the study.

Method of data collection

The data for the study were collected through the use of structured questionnaire and on the spot interviews. The data collected was for 2018 cropping season on variables such as: household size, educational level of household head/farmer, types of inputs (seed, fertilizer, and herbicides), output of maize, area planted/harvested, engagement of extension agents, pest and farm location.

Model specification

Just and Pope, (1978) proposed a model which captures production risk in stochastic production function framework. This model paved way to understand production risk in input through estimating input-dependent heteroscedasticity regression incorporated with additive specification. Based on this, the Just and Pope model is implicitly specified as:

$$y = f(\chi) + g(\chi)v \quad (1)$$

Where y =yield

χ =input

$f(\chi)$ =average output function

g (χ) =production risk function for inputs that enables heteroskadasticity in random error in v as

$$\sigma^2_v = g(\chi) \quad (2)$$

Where

v = independently and identically distributed random error iid ~ N $(0, \sigma^2_v)$

According to Ogundari and Akinbogun (2010), the coefficient of g (χ) in the model shows marginal production risk with reverence to variable input x, which is either positive or negative. Just and Pope, (1978) and Battese *et al.* (1997) addictively combined the structure of the conventional stochastic frontier production model postulated by Aigner *et al.* (1977) and Meeunsen *and* Broeck, (1977) to give an Stochastic Frontier Production function with flexible risk specification as represented below;

$$Y_i = f(\chi_i : \beta) + g(\chi_i : y)v - u(z:0) \quad (3)$$

Where $f(\chi_i : \beta)$ is the output function, $g(\chi_i : y)$ is the risk function and v and u denotes the random noise and technical inefficiency effects respectively. y, χ, $f(\chi)$, g(χ) are as explained in equation 1 while u is the error term for inefficiency. According to Ogundari and Akinbogun (2010), 'u' added in equation 3 differentiate it from the conventional SFP model of equation 1 thereby imposing the same variable inputs and functional form on the heteroskadacity in v and u. Similarly, Battese *et al.* (1997) model was broadened by Kumbhakar (2002) to allow for generalized form of the SFP function using flexible risk specification. This extension enabled effects of the variables inputs and the functional forms to differ on the heteroskadasticity of u and v. The generalized form is specified below:

$$Y_i = f(\chi_i : \beta) + g(\chi_i \psi)v - \rho(z : \delta)u_i, \quad (4)$$

Where $f(\chi_i : \beta)$ is the output function, $g(\chi_i\ \psi)$ is the risk function, ψ is the parameter to be estimated for production risk, ρ(z : δ) is the Technical Inefficiency model and δ is the parameter for Technical Inefficiency model. y, χ, $f(\chi)$, g(χ), u and v are as explained in equations 1and 3 above. ρ(z : δ) captures inputs and effects of socio-economic variables of farmers on inefficiency effects that allows heteroskadasticity in inefficiency error term u, to avoid yielding productions that will not support increase or decrease of output risk in input. A flexible Cobb-Douglas functional form was employed to specify $f(\chi)$ to allow for consistency on the parameters of the risk function valued based on Just and Pope framework.

The Cobb Douglas functional form according to Boahen *et al*. (2016) is transformed as below:

$$Lny_i=\beta o+\sum_{j=1}\beta_j Lnx_{ji}+\varepsilon_i \quad 5$$

Where y = output of maize by ith farmer and ε is the error term expressed thus;

$\varepsilon = g(x_i : \Psi)v_i - q(z_i : \delta)u_i$

X = vector of j explanatory variables of inputs of ith farmer

X_1 = Land (Ha)

X_2 = Fertilizer (kg)

X_3 = Herbicides/Pesticides (Ltrs)

X_4 = Seed (kg)

X_5 = Labour (M/day)

Following the Cobb-Douglas functional form used previously, we employ Kumbhakar (2002); Jaenicke *et al.* (2003); Kumbhakar and Tveterås (2003); Bokusheva and Hockmann, (2006); and to modify equation 2 and specify the variance function as:

$$\sigma^2 v=g(\Psi_0\sum^n_{j=1}\Psi_j X_j) \quad 6$$

From the above equation, (χ) is assumed to describe production risk in inputs used. To achieve optimization in both u and v, heterogeneity was allowed in mean of inefficiency term, u (Jaenickle *et al.,* 2003) model as specified under:

$$U_j=\rho(\xi_0+\sum^n_{j=1}\xi_j X_j+\sum^n_{j=1}\varphi_j Z_j) \quad 7$$

Where Z = vector of socioeconomic variables/characteristics of the household

Z_1 = Level of Education (years)

Z_2 = Farm Experience (yrs)

Z_3 = Age of Respondent (yrs)

Z_4 = household size (Number)

Z_5 = Contact with Extension Agent (frequency/yr)

Z_6 = membership of cooperative (yrs)

Ui= mean inefficiency effect

Ψ, ξ and β =parameters to be estimated in relation to socioeconomic variables of farmers, elasticity of input, marginal input risk and inefficiency effects of inputs.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The results of the socioeconomic characteristics of the respondents are presented in (Table 1). The result shows that majority (81%) of the respondents were males while the remaining 19% were females. This could be related to family or cultural belief where women are expected to be full time house wives while the men labour for the family, (Salau, 2013). Majority, (82%) of the farmers were aged above 40 years with mean age of 49years. This implies that the farmers in the study area were ageing and this could affect their productivity as well as efficiency. Education enable farmers take informed decision and understand technicalities involved in new farm ideas and innovations (Salau, 2013). The result shows that the respondents were literate as more than 50% of them have acquired both primary and secondary school education. Furthermore, majority of the respondents (81.6%) were married and majority (71.7%) of household sizes range between 6 and 10 persons, with a mean household size of 8 persons. A large household size serves as a good source of labour for farming activities. This is based on the fact that each household is a potential source of labour especially during peak of farming when labour is a constraint. This is expected to reduce constraints due to lack of labour. In terms of farming experience, majority of the respondents had farming experience of above 20 years with a mean of 27 years. As farmers get older in farming, they tend to be more experienced and knowledgeable in determining what constitutes inefficiency and poor productivity and were able to manage their resources for efficient productivity. A little above 50% of the farmers did not belong to any farm association and the average year of membership is about 4 years. This is an indication that farmers in the area do not participate actively in cooperatives. Agricultural cooperatives are one of the major sources of farm inputs. Inputs and other farm materials are made available through cooperatives at the right planting period and at reduced cost (Salau, 2013). This helps to reduce the problem of poor productivity due to lack and inadequate inputs. Conversely, majority of the farmers (55%) used local variety seed while about 67% bought their seeds from the market. The high percentage of respondents who use local varieties and those who buy from the market were also indications that farmers shun associations where they could get incentives and credit facility like seed inputs free or at reduced rate. Access to extension services was also seen to be relatively on the average (52.0%). Extension services are sources of information and training. Farmers who engage in extension services are better informed of innovations and changes through trainings visits. It makes farmers aware of new technologies that are likely to improve productivity and reduce ignorance. On the other hand, about 98% of the contacted farmers had farm size ranging between 1-2 hectares with mean of 1.38. This was an indication that farmers in the area were small scaled and could affect the high productivity in the area if more land is not made available for farming.

Determinants of technical inefficiency among farmers

The result of the determinants of the inefficiency effects

Table 1. Socioeconomic characteristics of the respondents

Socio-economic variable	Mean	Frequency	Percentage
Sex			
Male		123	80.9
Female		29	19.1
Age (years)	49.28		
Above 40		125	82.2
21-40		27	17.8
Level of education			
Secondary education		60	39.5
Primary education		39	25.7
Tertiary education		31	20.4
Non-formal education		22	14.5
Marital status			
Married		124	81.6
Widowed		21	13.8
Single		6	3.9
Divorced		1	0.7
Household size (number)	8.83		
6-10		109	71.7
11-15		35	23.0
1-5		8	5.3
Farm experience (years)	27.15		
1-10		14	9.2
11-20		38	25.0
21-30		51	33.6
Above 30		49	32.2
Maize farm size (hectares)	1.38		
1-2		150	98.6
3-4		1	0.7
Above 4		1	0.7
Source of seed			
Market		103	67.8
Association		33	21.7
Old seed		16	10.5
Maize type			
Local variety		85	55.9
Improved variety		39	25.7
Both local and improved variety		20	18.4
Membership of association			
No		83	54.6
yes		69	45.4
Years of membership of association (years)	3.66		
1-5		27	17.8
6-10		28	18.4
Above 10		14	9.2
Access to extension workers			
No		79	52.0
Yes		73	48.0
Number of extension contact (times)	2.24		
1-2		30	19.7
3-4		21	13.9
Above 4		21	13.9
Total		152	100

Source: Field survey, 2018

are presented in (Table 2). The result shows that household size and farm experience were the major determinants of inefficiency in maize farmers in the area. The coefficients of household size and farm experience were positive and statistically significance at ($p<0.01$) respectively. This shows that household and farm sizes

Table 2. Maximum likelihood estimates of inefficiency effects.

Variables	Parameter	Coefficient	Std. error	z-ratio
Education (Z_1)	β_1	0.503	0.689	0.729
Farm Exp (Z_2)	β_2	4.502***	1.370	3.288
Age (Z_3)	β_3	-0.051	1.340	-0.038
HH size (Z_4)	β_4	2.974***	1.080	2.752
Ext.Cont. (Z_5)	β_5	0.232	0.581	0.400
Mem. Cop (Z_6)	β_6	-0.020	0.469	-0.410
Constant	β_0	-0.030	1.434	-0.023
Mean efficiency		0.729		

Source: Field survey, 2018, ***represents 1% significant level

Table 3. Constraints to maize farming in the study area

Constraint	Frequency	Percentage	Ranking
Pest and diseases	106	70	1
Inadequate credit facilities	85	56	2
Soil fertility problems	78	51	3
High cost of input	74	49	4
High cost of credit facilities	73	48	5
Lack of security in farm	61	40	6
Poor storage	59	39	7
Inadequate inputs (seed)	58	38	8
Poor prices of maize	55	36	9
High cost of transport	48	32	10

Source: Field survey, 2018, multiple responses allowed

have the tendency of increasing technical inefficiency of maize farmers in the FCT. This finding is in conformity with that of Salau (2013) who observed that household size influenced technical inefficiency of farmers positively in Southern Guinea Savannah of Nigeria. However, according to Kashim *et al.* (2014) household size reduced inefficiency of farmers. The coefficients of age and membership of cooperative though carrying the right signs (negative signs) were not statistically significant at P = 0.10. However, Umar *et al.* (2017) observed that education and years of farming were statistically significant on the production of maize in the area. This implied that they had the tendency of determining farmers' technical efficiency in maize farming in the area. They also found out that household size and extension agents were positive but were not statistically significant on the farmers' efficiency.

Constraints faced by maize farmers in the study area

Major constraints faced by the maize farmers in the study area are presented in (Table 3). Pests and diseases ranked first among the constraints. They complain of birds' invasion on the crops especially when late or delayed planting is done. Pest and diseases also attack farm crops both in the farm and after harvest especially due to poor storage. When the seeds are infested by pest, they reduce the quality and subsequently the market values. Credit facilities were seen to rank second among the constraints affecting maize farmers. There were serious complaints on lack, inadequate and high costs of credit facility such as seed and fertilizers. Most times farm inputs do not reach the FCT Agricultural Development Programme office (ADP, 2018) on time and farmers buy from the open markets which are most times expensive or not adequate. This also results to underutilization of input compared to required quantity per hectare due to lack of or complete absence of the needed inputs. This can result to inefficiency of farmers in the area as a result of poor combination of available inputs which may not meet the required or expected output by the individual farmers. High cost of transportation was also reported by the farmers in the area and contributed to poor prices of maize. Farmers who find it difficult to transport their products to their destinations or markets where they can sell at competing or high prices are forced to sell off at prices available to them. Onyewueke, (2014) also found high cost of transportation, inadequate credit facility, non-availability of credit as some of the major constraints farmers faced.

Conclusion

Among the various inefficiency parameters (Education, age, farming experience, households' size, extension contacts, membership of cooperatives), only farming experience and household size were found to be the major determinants of technical inefficiency. It is recommended that; there is need to employ and train more extension workers to increase farmers' access to extension agents as well as educate farmers since farm experience was unexpectedly seen as a determinant of inefficiency in the area. This will also help bring closer information about agriculture and new technologies to the farmers for efficiency and positive impact. To address the problem of poor soil fertility, maize farmers should be regularly mobilize and sensitize on the need to adhere to the associated protocols requires of maize farming as may be developed and release from time to time by the concern institutions. This will help in ensuring the application of best practices and thereby leading to improved soil management, and the problem of pest and diseases are re-occurring issues in crop production, both at the field level and during storage. In order to minimize the menace, farmers should periodically be trained on the whole maize value chain (from land preparation to cultivation, harvesting, right bagging, storage, processing, etc). This training should be through farmer field school (FFS) which will teach and educate the farmers to under study the entire cycle, thereby helping in identifying common pest and disease and various methods of controlling and eventual elimination.

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