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Determinants of maize farmers' performance in Benin, West Africa

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ABSTRACT

Increased agricultural productivity is the primary aim of all agricultural policies undertaken in developing countries. Increased agricultural productivity involves not only the analysis of factors limiting productivity but also efficiency because improved efficiency leads to productivity improvement. This paper investigated the factors limiting maize productivity in Benin based on a survey of 354 maize farmers. The mean maize yield was 1,347 kg/ha. The low level of maize yield in Benin is due to the lack of access to inputs, capital, and the weak institutional environment in which farmers operate. Furthermore, the efficiency model revealed that an increase in maize output of about 25 percent can be achieved in the short run by adopting the best farming practices and by addressing socio-economic and structural constraints. Policy should be encouraged that would facilitate access to inputs, capital, and training, and promote the development of infrastructure in farming areas.

Introduction

Food insecurity and poverty are important matter for farmers in Benin. Most of those reported as food insecure and susceptible to risk of food insecurity in Benin have agriculture as their main income-generating activity (World Food Programme [WFP], 2014). Most farmers in Benin live in rural areas that are characterized by a high poverty level compared to urban areas (Institut National de la Statistique et de l'Analyse Economique [INSAE], 2012). Poverty reduction in Benin as in most developing countries requires necessarily the transformation of the agricultural sector and the improvement of farmers' conditions and performance. From food security and food self-sufficiency standpoints, maize is a crucial crop and one of the six strategic crops that the government of Benin has chosen to develop intensively (Ministère de l'Agriculture, de l'Elevage et de la Pêche [MAEP], 2017), with the introduction of technological innovations and institutional support being the options chosen by the government to achieve this objective (Adjimoti, Kwadzo, Sarpong, & Onumah, 2017; MAEP, 2017). However, little research has been conducted on the appropriateness of these options and more importantly on the current level of efficient use of existing technological innovations in Benin.

Maize is the major staple food and the most cultivated crop in the country. Most farmers (85%) in Benin grow maize (WFP, 2014) and about one-third of the agricultural area harvested in Benin is devoted to maize production (INSAE, 2013). The Government of Benin identified maize as one of the strategic crops to be intensively developed and considerable resources, financial and technical assistance, the introduction of new technologies, and supply of inputs,

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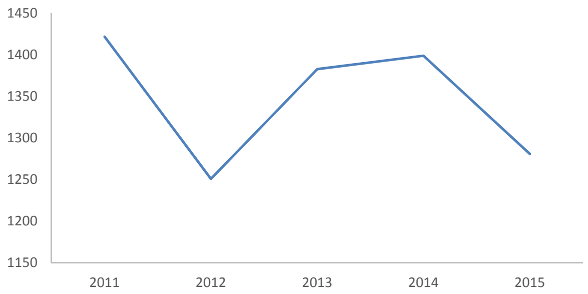

Figure 1 Maize yield in Benin between 2011 and 2015

have been invested in this sector. Despite these efforts, the maize yield has decreased in Benin (Figure 1) from 1,422 kg/ha in 2011 to 1,281 kg/ha in 2015 (MAEP, 2017). Furthermore, the current mean maize yield is far lower than the potential achievable yields (between 3 and 5 t/ha) (Azontondé, Igué, & Dagbénonbakin, 2010). This low performance has been proposed for the country's failure to achieve the production target of 1,900,000 t of maize by 2015. In 2015, the production deficit was 613,940 t of maize (MAEP, 2017). However, maize consumption is increasing. Between 1996 and 2016, The United States Department of Agriculture (USDA) (2017) estimated that mean maize consumption increased by 5 percent annually in Benin.

The improvement of the performance of agriculture in Benin has become an emergency due to the rapid increase in population and thereby the food demand. The population of Benin is expected to double every 20 years if the current trend continues (INSAE, 2013). It is clear that feeding such an increasing population will require an increase in food production to minimize food insecurity. To ensure a rapid increase in food production with the aim of meeting future food demand, it is important to have a clear picture of the state and prospects of Beninese agricultural production and to identify possible challenges which could impede the reliably of supplying increasing quantities of important food commodities. The identification of agricultural inputs with the highest efficiency can help to achieve the goal of a rapid increase in food supply. Rightly, Farrell (1957) suggested that efficient management of existing technologies leads to productivity improvement. Further, efficiency can help to close the gap between actual and potential outputs (Audibert, 1997).

Few studies have attempted to analyze the factors that determine farmers' performance in general and maize farmers' performance in particular in Benin. For instance, Degla (2015) analyzed the technical efficiency of cashew nuts in Benin and found that the mean efficiency score was 63 percent while Kpenavoun Chogou, Gandonou, and Fiogbe (2017) reported 67 percent for the mean technical efficiency of pineapple farmers in Southern Benin. Only the study conducted by Toléba Séidou, Biaou, Zannou, and Saïdou (2016) was related to maize. The authors suggested that the mean technical efficiency was around 80 percent and the main efficiency determinants are sex, formal education, access to extension services, use of agrochemical, access to credit, use of animals and mechanical traction. However, that study did not analyze the determinants of productivity. Houssa, Reding, and Sotirova (2017) analyzed vegetables and rice farmers' productivity in two regions of Benin (Mono and Couffo) and found that capital, labor, education, and soil type significantly affected farmers' productivity. Those authors also observed an inverse relationship between farm size and productivity and a difference in productivity between female and male producers.

This article provides additional empirical evidence on the performance of farmers in Benin (West Africa) by examining the following question: What are the determinants of maize farmers' performance in Benin? To answer this question, we estimated the farmers' productivity function and the technical efficiency function.

Methods

Productivity Model

Generally, agricultural productivity depends on four factors: inputs (seeds, fertilizer, labor, capital, etc.), farm land' characteristics (for example, quality of the soil), weather conditions and farmers' characteristics (gender, education, experience, etc.) (Houssa et al., 2017). In the literature, different production functions such as constant elasticity of substitution, translog functions, and Cobb–Douglas functions have been used (Houssa et al., 2017). In this study, we used a production function that theoretically shows the interdependence of the four factors and that can also incorporate the observable and unobservable characteristics that matter for productivity. The Cobb–Douglas production function was adopted in spite of the assumption that the input partial elasticities of substitution equal one in the defined input space. The Cobb–Douglas function in this case can be specified as shown in Equation (1):

$$F(K,L,T,X) = AK^{\delta}L^{\beta}T^{\gamma}X^{\alpha} \quad (1)$$

where K is the capital used in production, L is the labor used in production, $T$is the size of the farm, X represents other inputs including farmers individual characteristics, and A is the technology of production. The power related to every factor of production $(\delta,\beta,\gamma,\alpha)$ is a number between zero and one. The specification of the Cobb–Douglas production function which we chose for the econometric estimations with the data has the form shown in Equation (2):

$$\ln(Y_i) = \alpha_0 + \delta ln(K_i) + \beta ln(L_i) + \gamma(T_i) + \sum_k \alpha_k X_{ik} + \varepsilon_i \quad (2)$$

where Y_i is the productivity of producer i, K_i is the stock of capital used by producer i, L_i is the quantity of labor used by producer i, T_i is land size used by producer I, X_i represents other explanatory variables, and α_0, the constant in the estimation, can be interpreted as total factor productivity. The log–log form of the econometric specification was adopted in order to interpret the estimates from the regression as elasticities of productivity with respect to the given factor of production.

Table 1
Description of variables

Variable	Description
Ferti	Amount of inorganic sources of plant nutrient used in maize cultivation (kg/ha)
Capi	Total monetary expenses incurred for all operations related to maize cultivation (USD/ha)
Lab	Total family and hired labor used for all operations related to maize cultivation (labor days/ha)
Weedi	Amount of active ingredient of plant protection chemicals used in maize cultivation plot (L/ha)
Land	Size of the land devoted to maize production (ha)
Seed	Amount of maize seed used in cultivation plot (kg/ha)
Credit	Whether has access to formal institutional credit; 1 = yes, 0 = otherwise
Market	Whether has access to formal institutional and physical market; 1 = yes, 0 = otherwise
Sex	Male = 1 and Female = 0
Exten	Whether has access to formal institutional extension services; 1 = yes, 0 = otherwise
Expe	Number of years the farmer is engaged in maize cultivation; Measured in years
Yeduc	Years of schooling
Hhsize	Number of members in a farm family who share food from a single source; Absolute number of members in a family
Educ	Formal education received by a farmer; Categorized as 0 = none; 1 = primary and 2 = post primary
Yield	Production of maize grain per unit area (kg/ha)

The empirical model used is described in Equation (3).

$$LnYield = \beta_0 + \beta_1 LnFerti + \beta_2 LnCapi + \beta_3 LnLab + \beta_4 LnWeedi + \beta_5 LnLand + \beta_6 LnSeed + \beta_7 Credit + \beta_8 Market + \beta_9 Sex + \beta_{10} Exten + \beta_{11} Expe + \beta_{12} Yeduc + V_1 \quad (3)$$

where *Yield* is the maize production per hectare and V_1 is the equation error term. Details of the variables used in the regression analysis along with their measurements are given in Table 1.

Efficiency Model

Two broad approaches (data envelopment analysis (DEA) and stochastic frontier analysis (SFA)) have been developed to measure efficiency according to Farrell's definition. SFA is adopted because of its capacity to take into account several exogenous factors (weather patterns, diseases, poaching, etc) that are not under a farmer's control but can affect the farmer's efficiency. SFA also takes into account measurement errors, statistical noise, and differential rates of adoption of technology that can affect the farmer's efficiency (Aigner, Lovell, & Schmidt, 1977; Meeusen & van den Broeck, 1977).

Following Farrell's (1957) conception of technical efficiency as deviations from an idealized frontier isoquant, Aigner et al. (1977) and Meeusen and van den Broeck (1977) proposed that the production technology of a farm is represented by a stochastic frontier production function. The model has the form shown in Equation (4):

$$Y_i = f(X_i, \beta)\exp(\varepsilon_i) = f(X_i, \beta)\exp(v_i - u_i) \quad i = 1, \ldots, N \quad (4)$$

where Y_i is the observed output of farm i and $f(X_i, \beta)$ is a function such as a Cobb–Douglas or translog production function of the vector and represents the maximum quantity that can be produced with X_i (vector of inputs) and technology described by the parameters β. Furthermore, ε_i is the error term that is composed of two independent elements v_i and u_i such that $\varepsilon_i = (v_i - u_i)$. Production can deviate from the deterministic frontier because of random shocks v_i, which could be positive or negative, or because of the non-negative inefficiency error term u_i, which reduces output ($u_i \geq 0$). Finally, v_i is an *iid* error term with mean zero and constant variance assumed to be independent of u_i. The aim of the stochastic frontier model is to construct the production frontier and the inefficiency can be estimated by the deviations from this frontier.

The technical efficiency (TE) of the *i*th farm is provided by Equation (5):

$$TE_i = exp(-u_i) = \left(\frac{f(X_i, \beta) \times exp(v_i - u_i)}{f(X_i, \beta) \times exp(v_i)}\right) \quad (5)$$

where TE is the ratio of actual output relative to the potential output. TE takes a value between 0 and 1 with a smaller ratio reflecting inefficiency.

The estimation of the parameters of the production function requires the imposition of an appropriate distribution concerning the inefficiency error term u_i. Using the assumption that the inefficiency effects are half normally distributed i.e. $u_i \sim iidN^+(0, \sigma_u^2)$, the technical inefficiency effect is defined using Equation (6):

$$u_i = Z_i \delta + \theta_i \quad (6)$$

where Z_i is a $(P \times 1)$ vector of explanatory variables associated with the technical inefficiency effect such as socio-economic, farm management, and institutional characteristics and θ is the error term of the inefficiency.

Model Specification

A Cobb–Douglas production function as shown in Equation (7) was chosen in this study with the imposition of monotonicity and the quasi-concavity hypothesis on the production function. This functional form was chosen because it is flexible, self-dual, and its returns to scale are easily interpreted (Bravo-Ureta & Evenson, 1994).

$$Y_i = \alpha_i + \sum_{j=1}^{J} \beta_j X_{ji} \quad (7)$$

where Y_i is the output of maize (kilograms) produced in 2015 cropping season by the *i*th farmer; *X* is a set of eight inputs: land size, labor, seed, weedicide, equipment, fertilizer, β denotes the unknown parameters to be estimated, *vi* denotes random shocks, and *ui* is the one-sided, non-negative error representing inefficiency in the production. The empirical model used is described in Equation (8).

$$LnOutput = \beta_0 + \beta_1 LnFerti + \beta_2 LnCapi + \beta_3 LnLab + \beta_4 LnWeedi + \beta_5 LnLand + \beta_6 LnSeed + \varepsilon \quad (8)$$

where *Output* is the output of maize (kilograms) and ε is the equation error term. Details of the variables used in the regression analysis along with their measurements are given in Table 1.

The inefficiency model of the stochastic frontier function is given by Equation (9):

$$u = \delta_0 + \delta_1 Credit + \delta_2 Market + \delta_3 Sex + \delta_4 Exten + \delta_5 Expe + \delta_6 Dferti + \delta_7 Hhsize + \delta_8 Educ + \theta \quad (9)$$

where μdenotes farm specific inefficiency, δ denotes a set of parameters to be estimated, and the variables that explains farmers' inefficiency equation are explained in Table 1.

Hypothesis Test

The following hypotheses were investigated:

(1) $H_0 : \lambda = 0$, the null hypothesis specifies that inefficiency effects are absent from the model at every level. However, $\lambda > 0$ means that the technical inefficiency effects are present in the model and hence the use of a stochastic frontier model is best.

(2) $H_0 : \delta_1 = \ldots = \delta_8 = 0$, the null hypothesis that farm specific factors do not influence the inefficiencies.

These hypotheses were tested using the generalized likelihood-ratio statistic.

Data Collection

A multi-stage, cluster-based, random sampling approach was used to select the respondents. The first stage of the design consisted of the random selection of one municipality in each of the three climatic zones present in the country. The municipalities of Kandi, Glazoué, and Zè were then randomly selected. In Benin, a municipality consists of several districts. The second stage of the selection process, therefore, consisted of the random selection of three districts per selected municipality. The third stage of the selection process consisted of the selection of villages in each district. Two villages were randomly selected from each district, making up 18 villages for the nine districts and the three municipalities. The fourth and final stage was the actual selection of farmers to be interviewed. A structured questionnaire was used for the interview. The optimal sample size for the number of farmers selected for the whole study was 323. The determination of the optimal sample size was based on Babbie (2016) dealing with sampling from very large population sizes. Oversampling was used and hence 396 farmers were chosen for the study. This oversampling was done due to the possibility of some farmers refusing to participate in the study. The survey was conducted in 2015. For each village, the approximate number of farmers was provided by the village chief. The farmers selected were those known to be available in the village at the time of the study. Twenty-two (*22*) farmers were randomly selected from each village. Amegnaglo, Anaman, Mensah-Bonsu, Onumah, and Amoussouga Gero (2017) presented details on the sampling techniques and the study areas.

Table 2
Socio-economic characteristics of survey respondents

Variables	Mean	Std. Dev.
Mean maize yield (kg/ha)	1,347	484.6
Use of fertilizer *(%)*	56.8	49.6
Quantity of fertilizer used (kg/ha)	94.7	104.5
Weedicide applied (L/ha)	1.2	2.3
Capital (USD/ha)	34.7	39.7
Labor (labor-days/ha)	150.6	80.2
Farm size (ha)	3.9	4.4
Seed used (kg/ha)	16.5	11.2
Farm size (ha)	3.9	4.4
Sex (percentage male)	73.1	44.4
Age (years)	41.7	12.6
Maize farming experience (years)	22.2	11.7
Household size	10.9	7.1
Access to extension services *(%)*	33.9	47.4
Access to credit *(%)*	52.2	50.0
Access to market *(%)*	89.8	25.2
Educational attainment level		
No education at all	61.6	48.7
Primary School	28.5	45.2
Post Primary School	9.9	29.9

Data Analysis

About 38 percent of farmers interviewed came from Kandi municipality, 32 percent from Zè and 30 percent from Glazoué. About 73 percent of the respondents were male and one-third of the farmers were young (18–35 years). The mean age of sampled farmers was 41.7 years (with 12.6 as the standard deviation) with the youngest being 18 and the oldest 85 years (Table 2). Respondents with no schooling were predominant (61.6%), while primary school leavers were the second largest class of respondents (28.5%). The mean farming experience regarding maize production is 22 years (with 11.7 as standard deviation). The mean farm size for the whole group was about 3.9 hectares (with 4.4 as the standard deviation). One-third of farmers interviewed had interacted with extension services during the last three farming seasons (2012–2014). About 57 percent of farmers had applied fertilizer during the last cropping season. On average, a farmer used 94.7 (±104.5) kg of fertilizer, 1.2 (±2.3) L of weedicide, 16.5 (±11.2) kg of seed, 150.6 (±80.2) labor/day and USD 34.7 (±39.7) as capital per hectare for the production of an average of 1,347(±484.6) kg of maize per hectare (Table 2).

Results and Discussion

Determinants of Productivity

The results of the estimation suggested that the quantity of labor, fertilizer, capital, and seeding rate had significant and positive effects on the productivity of maize farmers (Table 3). The use of fertilizer significantly increased land productivity. Furthermore, WFP (2014) showed that depletion of land fertility and land degradation are the

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Table 3
Productivity model results

Variable	All variables		Only significant variables	
	Coefficient	*t*-value	Coefficient	*t*-value
LnFerti	.0521***	4.82	.0546***	5.22
LnCapi	.0953***	4.56	.0952***	4.66
LnLab	.0985***	2.95	.0982***	2.79
LnWeedi	.0293	1.25		
LnLand	−.3481***	−6.83	−.3475***	−6.96
LnSeed	.1199***	3.17	.1215***	3.42
Credit	−.0231	−.64		
Market	.1380**	2.16	.1455**	2.29
Sex	.0204	.54		
Exten	.0919**	2.15	.0893**	2.28
Expe	.0002	.12		
Yeduc	.0017	.35		
Constant	5.7604***	28.78	5.1435***	20.80
	Number of obs = 354, F(12, 341) = 29.89, Prob > F = .0000, R-squared = 0.4335		**Number of obs = 354, F(7, 346) = 48.13, Prob > F = .0000, R-squared = 0.4295**	

$^{**}p < .05$, $^{***}p < .01$

main problems faced by farmers in Benin, making access to fertilizer indispensable for maize production in the country.

Farm size significantly and negatively affected farmers' productivity. The inverse size–productivity relationship has been observed by several researchers in Africa and this relationship is explained in the literature by factors like market imperfections, lack of data on soil condition, and measurement error (Ali & Deininger, 2015; Carletto, Savastano, & Zezza, 2013; Houssa et al., 2017).

Access to market significantly increased maize yield. It is argued that commercialization can positively affect yield through specialization (better resource allocation), intensification (increased use of inputs), and the reduction of loss of perishable harvests (Jaynes, 1994; Nonvide, 2017). Access to extension services significantly and positively increased maize productivity. Extension workers can provide information on and explain the best agricultural technologies and practices. Farmers who benefit from extension visits are more likely to use the recommended technologies appropriately (Onumah, Brümmer, & Hörstgen-Schwark, 2010).

Efficiency Model

The estimated parameters of the stochastic frontier model (Table 4) and the inefficiency model (Table 5) are presented below as Frontier and Inefficiency models. The results of the estimation showed that the test of absence of inefficiency effects in the model was rejected. Furthermore, the test specifying that the inefficiency effects are not stochastic was strongly rejected. The estimated lambda was significantly greater than zero, implying that the traditional average for the ordinary least squares, (OLS) function is not an adequate representation for the data. The hypothesis stating that the intercept and the coefficients associated with all variables in the technical inefficiency model are zero was strongly rejected. This suggested that the exogenous variables jointly explained the technical inefficiency effects. Therefore, it allows the identification of relevant policy variables.

Table 4
Maximum likelihood estimates of Stochastic Cobb–Douglas production frontier of maize

Variable	Coefficient	*t*- value
LnCapi	.09530***	5.46
LnFerti	.1805***	4.06
LnLab	.0992***	2.80
LnWeedi	.0061	.190
LnLand	.7406***	13.56
LnSeed	.0399	1.21
Constant	.2318***	4.27
Log-likelihood function	−115.7352	
Sigma square) δ^2(	.1821	6.54
Lambda) λ(	1.2045***	15.75
δ_u^2	.3283	5.8442
δ_v^2	.2726	11.3545

$^{***}p < .01$

The expected coefficients of all the factors were positive but the coefficients of seedling rate and weedicide were not significant. The highest elasticity was related to the land size, implying that a 1 percent increase in land size devoted to maize culture will increase the production by 0.74 percent. Compared to the results obtained earlier (Table 3), land had a positive effect on maize output but a negative impact on maize yield. Farmers with a small-sized maize farm may apply better monitoring on their farms (field maintenance, fertilizer application on time) and use technologies (such as application of manure) which are not convenient on large-sized maize farms. Subsequently, they obtained better yield.

The output elasticity for fertilizer was 0.18 percent, indicating that an increase in fertilizer use by 1 percent will increase maize production by 0.18 percent. The elasticities of output with respect to capital and labor were 0.09 percent and 0.10 percent, respectively. The return to scale was 1.11. This finding suggests that if all the inputs were multiplied by 1 percent, the mean production would be multiplied by 1.11 percent, thus revealing the existence of economies of scale.

Estimated parameters in the technical inefficiency model revealed that access to market, access to extension services, and gender significantly reduced farmers' technical inefficiency while education, household size, and farming experience significantly increased farmers' technical inefficiency (Table 5).

Table 5
Estimated inefficiency of maize farmers in Benin

Inefficiency model	Coefficient	*t*- value
Constant	−2.9525***	−3.42
Credit	−.5831	−1.59
Market	−.8283*	−1.80
Sex	−.6325*	−1.71
Exten	−1.2558***	2.88
Expe	.0296**	2.09
Hhsize	.0347*	1.95
Educ		
Primary	.7796**	2.34
Post primary	1.5237***	3.11

$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$

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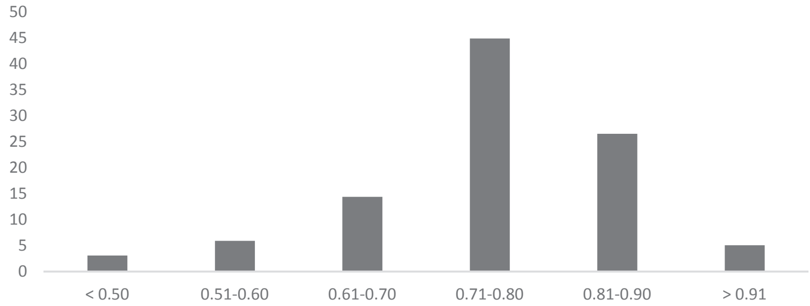

Figure 2 Frequency distribution of technical efficiency

The coefficient estimated for the gender dummy was significantly negative, indicating that male farmers operated less inefficiently than their female counterparts. Women generally lack access to financial and human resources to conduct appropriately their farming operations (Toléba Séidou et al., 2016). Furthermore, the women's domestic role does not give them enough time to spend on the farm, contributing to inefficiency of production (Onumah et al., 2010). Access to extension services improved farmers' technical efficiency as found by Toléba Séidou et al. (2016) as such access equips farmers with the requisite knowledge on the best inputs to employ and their appropriate use.

The coefficient of market access was negative and significantly related to technical inefficiency. Farmers who had access to an output market were more efficient compared to those who did not have access to markets. Access to market can positively affect efficiency through specialization, intensification, and reduction of losses (Jaynes, 1994; Nonvide, 2017).

Experience in farming was estimated to be significantly positive, indicating that the more-experienced farmers were more technically inefficient in their production than new farmers who were more willing to implement new production systems (Onumah et al., 2010). The coefficient of education in this study was surprisingly positive, suggesting that farmers with a high level of formal education (at least post primary) operated inefficiently in their production. Though education is an important factor influencing efficiency, Kalirajan and Shand (1985) argued that illiterate farmers can understand modern production technology as well as their educated counterparts when they are trained and the technology is communicated properly. Furthermore, maize is produced in Benin using traditional methods and the education of farmers might not play a role in the optimal combination of inputs. This result was substantiated by the finding of Onumah et al. (2010) but it is contrary to the findings of Toléba Séidou et al. (2016) and Battese, Malik, and Gill (1996).

Household size had a positive relationship with technical inefficiency indicating that farmers with a larger household size were less efficient than farmers with a small household size. Farmers with a larger household size rely more on family labor, however Kloss and Petrick (2014) suggested that hired labor is more productive than family labor. Furthermore, larger households in developing countries may put more pressure on farm income and thereby reduce the available income for investment in agriculture (acquisition of productivity-enhancing inputs).

Technical Efficiency of Maize Farmers

The technical efficiency of maize farmers ranged from 0.22 to 0.94 (Figure 2). The predicted mean technical efficiency was estimated to be 0.75 and this means that about 25 percent of the technical potential output was not realized.

Therefore, increasing maize farming production by an average of about 25 percent can be achieved in the short run by adopting good maize production practices.

Conclusion

This paper examined the determinants of maize farmers' performance in Benin based on a sample of 354 farmers across the three main climatic zones in Benin. The results revealed that the mean maize yield in Benin was around 1,347 kg/ha. The increase in maize yield in Benin requires production intensification (capital, fertilizer, labor, and seed) rather than increased land area. Improvement of access to extension services and markets would also contribute to yield improvement.

Another avenue for yield increase is improved farmer efficiency. The results indicated that there was significant variation in technical efficiency among maize farmers, as the estimated efficiency ranged from 0.22 to about 0.94 with mean technical efficiency levels of 75 percent. This indicates that maize production could be increased by 25 percent through better use of available resources such as land, labor, seed, and fertilizer given the state of technology. Farmers were operating at an increasing return to scale. Male maize farmers who had not had a formal education, with lower farming experience, and a smaller household size, but with relatively good access to markets, extension services, and the use fertilizer achieved higher levels of technical efficiency in maize production in Benin.

Policy Recommendation

Based on the findings, the policymakers could assist improving production and yield through better and reliable access to key inputs such as fertilizer, labor, seeds, and

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equipment. It is important for the government to create an institutional environment that facilitates reliable access to markets and extension services to farmers. Roads should be constructed that improve market access. Due to the fact that farmers operate below the frontier line, the policymakers need to organize training and educational programs to improve crop management practices and thereby the farmers' technical efficiency. Policies should be implemented that aim to empower female farmers through better access to economic resources, education, information, and decision-making.

Conflict of Interest

There is no conflict of interest.

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