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ANALYSIS OF TECHNICAL EFFICIENCY OF SMALLHOLDER FOOD CROP FARMERS IN ARDO-KOLA LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA

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ABTRACT

Although food is one of the basic necessities of life, food insecurity and production inefficiency remains a major problem in Nigeria today. The study examined technical efficiency of smallholder food crop farmers in Ardo-kola Local Government Area of Taraba state, Nigeria. The specific objectives of the study were to; describe socioeconomic characteristics, determine efficiency of the farmers in food crop production and production constraints faced by the respondents in the study area. Data were collected from 140 randomly selected food crop farmers in ten villages spread across the five wards of Ardo-kola Local Government Area using structured questionnaire. The data were analyzed using descriptive statistics and inferential statistics. The result revealed that 79% were married while about 63% of the respondents were male. Majority (68%) of the respondents had some form of formal education. The respondents were mostly small-scale farmers, as they cultivated an average of about two hectares of farmland using personal savings. The maximum likelihood estimates of the stochastic frontier production function revealed that farm size, agrochemicals, inorganic fertilizer and seeds were significant and positively correlated to food crop output. The Technical Efficiency (TE) scores ranged from 0.32-0.99 with mean TE of 0.60, implying that there is possibility for increasing technical efficiency in food crop production by 40% in short run under current technology. Major challenges faced by food crop farmers in the study area included; poor access to credit facilities, inadequate extension visits and high cost of labour. The study recommended that food crop farmers should be given adequate training through extension service, timely and efficient input distribution. Farmers should explore other non-farm income generating activities that are more sustainable so as to boost income and enhance food security in the study area.

Key words: Food crop farmers, Smallholder, Technical efficiency, Production constraints

INTRODUCTION

The agricultural sector is an important sector in the Nigerian economy in terms of its role in food security, poverty alleviation and economic growth. The growth of Nigeria's economy has been linked to program in the agricultural sector severally. The sector is the second largest foreign exchange earner; next to the non-sustainable petroleum sector (Ayanwale, 2002). Majority of the rural Nigeria households are largely dependent directly or indirectly on agriculture for their food and livelihood needs (Liverpool Tasie *et al.,* 2011). Food crop production in Nigeria is dominated by small-scale farmers who cultivate between 0.10 – 5.99 hectares and produced about 85-90% of the total foods consumed in the country (Maurice *et al.,* 2013). Successive governments in the country had embarked on several programmes aimed at boosting agricultural production. These programmes include: River Basin Development Authority (RBDA), Agricultural Development Projects (ADP), Agricultural Credit Guarantee Scheme (ACGS), Green Revolution Programme (GRP), among others. The main objective of these programmes was to increase food crop production thereby solving the problem of food insecurity. According to Idachaba (2004), empirical records of many of these programmes and projects are not impressive enough to bring about the expected transformation of the agricultural sector. Poor agricultural output and widespread poverty has resulted in extensive and persistent food insecurity, with some studies

showing that as many as 70 percent of Nigerians are food insecure (Obayelu, 2010).

Stochastic production frontier Model is a parametric technique that uses standard production function methodology to estimate production or cost functions in economics, while explicitly accounting for the existence of firm inefficiency (Coelli, *et al., 1998*). The stochastic frontier production has the advantage in that it allows simultaneous estimation of individual technical efficiency of the respondents as well as determines inefficiency (Zubairu, *et al., 2018*). Technical efficiency of an individual farm is defined as the ratio of the observed output to the corresponding frontier output, given the available technology. On the other hand, technical efficiency in the production is defined as the ability of the farmer to produce the maximum output given quantities of inputs and productions technology (Ojo, 2004). This implies that the frontier output varies with the level of technology employed by the farm.

The problem of declining crop productivity in Nigerian agricultural sector is revolved around the efficiency with which farmers use resources on their farms. Despite all human and material resources devoted to agriculture, the productive efficiency for most crops still falls under 60 per cent (Ebong *et al.*, 2011). Also, technical efficiency implies the ability of a firm to obtain maximum output from the given inputs. It is the ratio of output to input and the greater the ratio, the more the magnitude of technical efficiency (Simonyan *et al.*,2012). It therefore becomes very necessary to analyse the technical efficiency of small-scale food crop farmers in Ardo-kola Local Government Area of Taraba State, Nigeria. This study, therefore, seeks to describe the socio-economic characteristics of the respondents; determine the technical efficiency of food crop farmers and identify the production constraints faced by respondents in the study area.

METHODOLOGY

The study was conducted in Ardo-kola local government area of Taraba state. The study area is situated in the northern part of the State and it has a total land area of about 2,262 km^2 with an estimated population of about 86,921 (NPC, 2006) but base on the 2.8% yearly increment, the estimated population as at 2016 stands at 117,737 persons. The study area is located between latitude $8^0$34' and $9^0$10' of the equator and between longitude $10^0$58' and $11^0$30 east of the Greenwich meridian. The local government is bordered to the east by Jalingo, Gassol to the west, Karim Lamido to the north and Bali local government area to the south. The temperature of the area ranges from 28^0 to 35^0 with annual rainfall of between 800mm to 1,525mm (Oruonye and Bashir 2011). Most of the inhabitants in the area are: Jukun-kona, Mumuye, and Fulani. These ethnic groups are predominantly agriculturally inclined. Most of the agricultural activities found in the area include crops and livestock production such as maize, rice, cowpea, cattle, goat and poultry.

Sampling Procedure

Simple random sampling technique was used to select the respondents for the study. Firstly, five (5) wards were randomly selected out of the ten (10) wards in Ardo-Kola Local Government Area. Second stage sampling involved the random selection of two (2) villages in each of the selected wards to give a total of ten villages. From the ten villages, a total of 140 questionnaires were randomly administered in proportionate to the size of the villages and returned with useful information, hence were used for the study.

Analytical Framework

Descriptive statistics such as mean, percentages and frequency tables were employed to describe the socio-economic characteristics of the farming households in the study area.

Model Specification

This study adopted the stochastic frontier production model proposed by Battese and Coelli (1995). The model is expressed below;

$Y_i^* = f(x_i:\beta_i) \exp(V_i - U_i)$ I = 1, 2, 3 …. n ……. (1)

Where,

Y_i = Output of the ith farm (kg/ha),

X_i = Vector of input quantities whose value are functions of inputs and other explanatory variable for the ith farm

β_1 = Vector of unknown parameter to be estimated

$f(x_i:\beta_i)$ = is the production frontier

Vi = Symmetric error which account for random variation in output due to factors beyond the control of the farmer.

μ_i= inefficiency components of error term
Ln Yi = βo+β1Ln.vi+β2LnX2 +β3 LnX3 +β4 LnX4 + ---- Vi -μ) …….. (2)
Where:
Ln = Denote logarithm to base e
Y = Farm output (Grain equivalent)
X_1 = Farm Size (in hectares)
X_2 = Hired labour (Man days)
X_3 = Family labour (Man days)
X_4 = Seeds (Grain equivalent)
X_5 = Amount of Agrochemicals used (in litres)
X_6 = Quantity of fertilizer used (in Kilograms)
Vi = Random variability in the production that cannot be influence by the farmer
Ui = Deviation from maximum potential output attributable to technical inefficiency
βo = Intercept
β = Vector of production function parameter to be estimated.

Inefficiency model
The technical inefficiency effect model is define by βδ;
μi = δ0 + δ1Z1 + δ2Z2 + δ3 Z3+ δ4Z4+ δ5Z5+ei …… (3)
Where;
μi = technical inefficiency effect of the ith farm;
Z_1 = Household size (number of people)
Z_2 = Years of formal education
Z_3 = Cooperative membership (Dummy; 1 = member, 0 = Otherwise)
Z_4 = Age of farmers in years
Z_5= Primary occupation
Z_6 = Farmer's experience
Z_7 = Extension contacts (number of meetings)
δ = parameters to be estimated.
ei= random disturbance following half-normal distribution

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents The results of the socio-economic characteristics of the respondents are presented in Table 1. The result indicated that 63% of the respondents were male, while 37% were females. Age distribution of the respondents showed that 35% fall within the age of 40-49. This means the respondent were still very active to engage in agricultural activities and were therefore expected to be productive, *ceteris paribus.* This finding is in line with the findings of Akerele *et al*. (2019) on productivity and technical efficiency of cassava production in Ogun State, Nigeria. Who reported that farmers in their study are more energetic, mature and can use innovation. Marital status of the respondents indicated that 79% were married with 68% literacy attainment at various level of education (Primary, Secondary and Tertiary). This showed that most food crops farmers in the study area were educated. Education affects productivity through a choice of better inputs and output, and through a better utilization of existing inputs and also adoption of new innovation (Godfrey *et al.,* 2021). Farming is the major occupation of the respondents representing 83%. Majority (55%) had the highest farming experience of 11-20 years with 84% of the respondents having farm size of 1-5 hectares. This showed that the farmers in the study area were small scale holders. The result further showed that 48% of the respondents have household size of 1-5 person with mean household size of 6 which is relatively large and can serve as source of family labour even though dependency ratio will be high. The finding is also in corroboration with that of Sanusi *et al.* (2022) who in their study on resource-use efficiency of smallholder rice production farmers in Federal Capital Territory, Nigeria. Reported that Household size is a crucial factor, especially in determining labour for farm work in the agrarian community. A farmer with a large household size has the potentials to use family members as part of their farm labour.

Table 1. Socio-Economic Characteristics of the Respondents.

Characteristics	Frequency N=140	Percentage (%)
AGE (Years):		
20-29	11	8
30-39	45	32
40-49	49	35
50-59	30	21
60-69	5	4
SEX:		
Male	88	63
Female	52	37
MARITAL STATUS:		
Single	11	8
Married	110	79
Divorced	9	6
Widow	10	7
HOUSEHOLDS SIZE:		
1-5	67	48
6-10	56	40
11-15	12	8
16-20	5	4
EDUCATIONAL LEVEL:		
No formal Education	45	32
Primary Education	42	30
Secondary Education	27	19
Tertiary Education	26	19
FARM SIZE:		
≤1	15	11
1-5 `	118	84
6-10	7	5

Source: Field survey (2020)

Technical Efficiency of Food Crop Farmers

The Maximum Likelihood Estimate (MLE) of the stochastic frontier production for food crop farmers in the study area are presented in Table 2. The estimated coefficient of some of the parameters of production function were positive. The sigma square (δ^2) was 0.626 and is significant at 1% level. This indicates a good fit for the model and the correctness of the specified distributional assumption of the composite error term. The value of gamma (γ) was estimated to be 0.75 and is significant at 1% probability level. The Gama estimate indicated that 75% of variation in food crop output was because of the technical inefficiency of the food crop farmers; in other words, due to factors beyond the farmers' control. However, the estimated coefficients of some of the parameters of production function (Farm size, Agrochemicals, Fertilizer and Seeds) were positive and significant at 5% level of probability.

Farm size had an elasticity coefficient of 0.929 implying that a 10% increase in hectares of land used in production would increase the total output of food crop by 9.29%. This is an indication that land as a factor of production is very significant in the study area. The result is in consonance with Onyegbulam *et al.* (2018) who stated that there is possibility for increasing output by increasing farmland. Furthermore, the result showed that Agrochemicals was the second most important factor, it was found to be positive (0.403) and significant at 5% level. This means that the output of food crop increases with rise in the amount of Agrochemicals used by the food crop farmers and vice-versa. This agrees with the finding of Akpaeti and Frank (2021) who in their study technical efficiency of cassava cooperative farmers in South-South Nigeria: A comparative analysis. Opined that the use of herbicide reduces drudgery, enable farmers to decrease the risk pose by weeds and also increase their farm size.

The production elasticity value of fertilizer was 0.104 and the coefficient was significant at 5% probability level. This means a 10% increase in the use of fertilizer would increase output of food crop by 1.04%. Crops thrive well on fertile soil, therefore there is need to maintain and enrich the soil for good yield.

The seed input had an elasticity coefficient of 0.159. It was significant at 5% probability level and positively related to total

output of food crop in the study area. By implication, raising the productivity of seed was expected to translate into a more than proportionate increase in the output of food crop per hectare. This is in consonance with the findings of Shehu *et al.* (2010) who reported that higher seed rate would result in higher yield in crop production.

The inefficiency parameters were specified as those relating to farmers specific socioeconomics characteristics and were examined using the estimated sigma (δ) coefficient. Generally, a negative sigma (δ) coefficient indicates that the parameter has a positive effect on efficiency and vice versa. The result showed that primary occupation, farming experience and age have negative signs. The coefficient of primary occupation was estimated to be negative and significant at 5% level. This indicated that respondents whose main occupation was farming tend to be technically efficient compared to part time farmers.

The coefficient of farming experience was estimated to be negative and significant at 1% level. This implies that years of farming experience increase technical efficiency. An increase in efficiency may also be attributable to the experience they have gained over time specifically with regard to production techniques and combination of resources in the study area. This agrees with the findings of Godfrey *et al.* (2021) who in their study technical efficiency of cucumber production in Jos-East, Plateau State, Nigeria. Reported that years of farming experience was positively correlated with farm efficiency; farmers with more years of experience tend to become more efficient through 'learning-by-doing'. The coefficient of age variable was estimated to be negative and significant at 5% level. This implied that as farmers advance in age, they become more efficient in food crop production and vice versa. In other words, older farmer tends to be more technically efficient than the younger one. This result corroborates the findings of Zubairu *et al.* (2018) who reported that age of farmers was statistically significant at 1% level and had a greater influence on the technical efficiency of farmers in their study on technical efficiency of cassava production in Ardo-kola local government area of Taraba State.

Table 2: Maximum Likelihood Estimate of the Parameter of the Stochastic Frontier Production Function

Variable	Parameter	Coefficient	t-ratio
Production Factors			
Constant	β_0	0.386	14.44*
Farm Size (X_1)	β_1	0.929	5.39*
Family Labour (X_2)	β_2	0.216	0.10
Hire Labour (X_3)	β_3	0.110	0.64
Agrochemicals (X_4)	β_4	0.403	2.08**
Fertilizer (X_5)	β_5	0.104	2.42**
Seeds (X_6)	β_6	0.159	2.02**
Inefficiency Effects			
Household Size (Z_1)	δ_1	-0.682	-0.53
Educational Level (Z_2)	δ_2	0.611	0.32
Cooperative Membership (Z_3)	δ_3	-0.247	-0.89
Primary Occupation (Z_4)	δ_4	-0.202	-2.26**
Farming Experience (Z_5)	δ_5	-0.102	-3.67*
Extension Contact (Z_6)	δ_6	0.205	0.76
Age (Z_7)	δ_7	-0.332	-2.11**
Diagnostic statistic			
Likelihood ratio		1.369	
Sigma-Square	(δ^2)	0.626	2.908*
Gamma	(γ)	0.745	10.001*

Source: Computer output from Frontier.
*Significant at 1% level, ** Significant at 5% level.

Distribution of Technical Efficiency Level of Food Crop Farmers

The distribution of farmers' technical efficiency indices derived from the analysis of the stochastic production function is shown on Table 3. The technical efficiency of the sampled farmers was less than 1.00, indicating that food crop farmers in the study area were producing below the maximum efficiency frontier. There was a variation in the level of efficiency among the farmers, ranging from 0.30-0.99%. The best farm had a technical efficiency of 0.99 (99%)

while the worst farm had a technical efficiency of 0.32 (32%). The mean technical efficiency was 0.60 (60%) implying that, on an average the farmers were able to obtain 60% of potential output from a given mix of production inputs. This indicated that in the short run, there is scope for increasing technical efficiency in food crop production in the study area by 40 percent.

The distribution of technical efficiency of the farmers revealed that about 25% had technical efficiency of less than 50 percent while 55% had technical efficiency of 50-69 percent. However, 20% of the farmer had technical efficiency of 70% and above. The study also showed that the crop farmers were relatively technically efficient with 44.3 percent of them having technical efficiency above mean technical efficiency of 0.60 in the study area. This means majority of the farmers are not efficient.

Table 3. Technical Efficiency Distribution of Food Crop Farmers

Efficiency level	Frequency	Percentage (%)
0.30-0.39	13	9.3
0.40-0.49	22	15.7
0.50-0.59	43	30.7
0.60-0.69	34	24.3
0.70-0.79	13	9.2
0.80-0.89	11	7.9
0.90-1.00	4	2.9
Total	140	100
Mean	0.60	
Minimum	0.33	
Maximum	0.99	

Source*:* Field Survey, 2020

Constraints to Food Crop Production in the Study Area

The distributions of the respondents based on constraints faced by food crop farmers in the study area are presented in Table 4. The result revealed that the most severe problems affecting food crop farmers are poor access to credit facility (19.12%), High cost of Agrochemicals (18.24%) and Inadequate and high cost of fertilizer (17.65%) which were ranked 1st, 2nd and 3rd respectively according to severity. The finding indicated that all the respondents were faced with one problem or the other. Other problems faced by the respondents included high cost of labour, drought/flood and pest and diseases. This was partly responsible for the small size of farmlands cultivated by the farmers (Adebayo, 2012).

Table 4. Distribution of respondents based on Production Constraints faced in alleviating food Insecurity

Constraints	Frequency	Percentage (%)	Ranking
Poor access to credit facilities	130	19.12	1
High cost of agrochemicals	124	18.24	2
Inadequate & high cost of fertilizer	120	17.65	3
Inadequate extension visit	61	8.97	4
Shortage of labour	60	8.82	5
Poor storage Facilities	55	8.09	6
High cost of labour	50	7.35	7
Drought/ flooding	40	5.88	8
pest and diseases	40	5.88	8
Total	**680***	**100**	

Source*:* Field Survey, 2020 ***** Multiple Response

CONCLUSION

Based on the study, the following conclusions were made. Food crop production in the study area was mostly undertaken by the male that were in their prime age. They cultivated an average farm size of about 2 hectares. The finding showed that the Technical Efficiency (TE) scores ranged from 0.32-0.99 with mean TE of 0.60. It was concluded that the crop farmers were relatively technically efficient with 44.3 percent of them having technical efficiency above mean technical efficiency of 0.60 in the study area. The major challenge faced by food crop farmers were; Poor access to credit facilities, high cost of agrochemicals, inadequate extension visits, inadequate and high cost fertilizer and high cost of labour.

RECOMMENDATION

Based on the finding, the following recommendations were made:

I. Farmers should be encouraged to form co-operatives/union/groups so as to enable them access farm inputs, from either the government or private organizations at subsidize rate.
II. There is also need for Policy amendments to ensure availability of land for farming activities.
III. Stakeholders should intensify sensitization to farmers on appropriate application and utilization of agricultural resources through improve frequency of farmer's extension contact.

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