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# Climate Information and Health Variables as Determinants of Technical Efficiency: Insight from Food Crop Farmers

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**Abstract**

Climate poses challenges to the health and productivity of the populace. It is against this background that the study examined the effect of climate change and health on farmers' productivity in Southwest Nigeria. The research dwelt on cross-sectional data gathered through a structured questionnaire and a personal interview. A multistage sampling method was used to select 450 respondents at a random. Descriptive statistics and the Stochastic Frontier Production Function were used to analyse the data. The findings of the inefficiency component revealed that education, catastrophic health payment status, access to healthcare services, and adoption of adaptation measures were the most important determinants of farmer technical efficiency, with unhealthy days reducing farmer technical efficiency. The average technical efficiency value was 0.73, while the total elasticity coefficient was 1.27. It showed that food production was still operated in stage I (increasing RTS) of the production surface. Therefore, in designing sustainable agricultural development that will promote economic performance, policymakers need to incorporate health and climate adaptation measures into the production system to get optimum output in the study area.

**Keywords**:
Adaptation,
Constraints,
Productivity,
Stochastic
Frontier

## 1. Introduction

Climate change and its impact on all aspects of the economy is a major source of concern around the world. It poses challenges mainly on the health and productivity of the populace. It has been ascertained from the literature that human activities formed the bulk of its causes, which have in turn, increased human vulnerability (Dewan, 2015). Agriculture has also been described as a primary human activity that has contributed to global climate change in all parts of the world (Watson et al., 1998; Mboera et al., 2011; Olutumise et al., 2021). On the other hand, climate change has deeply affected agriculture in a dual way: agricultural produce and the health of the producers. In Nigeria and other parts of Sub-Saharan Africa, farmers' vulnerability to severe climate change effects has grown as a result of their over-reliance on rain-fed agriculture (Ehiakpor et al., 2016; Ebi and Bowen, 2016; Ekundayo et al., 2020).

Despite the economic contributions of agriculture in terms of food production, revenue generations, export earnings, raw materials to the industries, and job creation to many people in Africa countries including Nigeria; this sector is facing a threat as a result of the projected increased warming of the atmosphere and the earth's surface. The interaction of rising temperatures and unpredicted rainfall patterns greatly determines the impact of climate change on agricultural productivity (Fatuase and Ajibefun, 2014). Similarly, these changes will have significant effects on human health determinants and the natural ecosystem (Mboera et al., 2011).

Again, variations in weather and climate variability have harmed agricultural productivity over the years (Olutumise et al., 2021). According to Apata (2011) and Ehiakpor et al., (2016), unpredicted rainfall patterns also confuse farmers' production processes because farmers apply most of the inputs (factors of production) based on the rainfall pattern; and this, in turn, has led to low/poor agricultural products. Shumetie and Alemayehu (2017) stated that food security in the 21st century is strongly under threat in the rain-fed agricultural areas by climate change and variability. This will deepen poverty and also make vulnerable people struggle with ill-health and negative socio-economic well-being. Climate change affects human health and well-being through direct and indirect mechanisms that interact with social dynamics to produce health outcomes (Watts et al., 2015; Ebi and Bowen, 2016; Khalili et al., 2020). According to Intergovernmental Panel on Climate Change (IPCC) (2007), the extreme temperature can lead directly to the loss of assets and life, while climate-related disturbance in ecosystems can indirectly impact the incidence of infectious diseases. Costello et al., (2009) opined that rising temperatures affect the spread and transmission of vectors of diseases most especially mosquitoes that cause malaria in the body of human beings. Mortality and morbidity have clear implications as a result of the frequency and intensity of extreme temperature, rainfall, and wind speed; while the increase in floods and storms poses a risk of deaths and non-fatal injuries (IPCC, 2007). Food-borne and water-borne illnesses are strongly associated with heavy rainfall, and an increase in the frequency and severity of weather events would both affect human health (Lina, 2009). The irony is that both direct and indirect effects of climate change have greatly led to low productivity among agricultural producers in Nigeria.

Ajani and Ugwu (2008) reported that the importance of health as a form of human capital cannot be over-emphasized. Good health and productive agriculture are important in the economy of any nation, especially in the fight against poverty. Health enhances work effectiveness and the productivity of an individual or firm through the increase in physical and mental capacities. There is a connection between worker health and efficiency, both skilled and unskilled. Good health has a positive association with labour output and better production because people of good health generally have better intellectual capacities, as a result, farmers' income and economic growth will be improved. Health affects the agricultural system through the health of the producers. Poor health will result in the loss of workdays or decrease worker’s capacity, decrease innovation ability and the ability to explore diverse farming practices, and by such makes farmers capitalize on farm specific knowledge. Donald and Evans (2006) opined that health capital is affected by some preventable diseases: Malaria, musculoskeletal disorders, HIV/AIDS, farm injuries, yellow fever, typhoid fever, Schistosomiasis, Onchocerciasis, Diarrhoeal diseases, respiratory diseases and skin disordered, etc. and these diseases are influenced by climate variability and change. The implication of these diseases, according to Ajani and Ugwu (2008), makes farmers unable to fully utilize all inputs at their disposal and incapacitates farmers' physical performance and equally impacts negatively on the farm profit levels. Again, Khalili et al., (2020) affirmed that healthcare requirements have been noticed to be on the increase due to household vulnerability to climate extremes, while the farming household finds it hard to finance the healthcare requirements due to low income accrued from the farm enterprise. Therefore, to protect the world's most vulnerable people from the impact of climate change on human health and well-being, comprehensive health adaptation strategies are needed (Lina, 2009). Again, people would be better able to cope with the health impacts of climate change if vulnerabilities are reduced and resilience is increased. This includes strengthening health systems and ensuring adequate water and sanitation facilities for all.

There is no doubt that there are many studies that either relate agricultural productivity with climate change (Apata, 2011; Fatuase and Ajibefun, 2014; Shumetie and Alemayehu, 2017; Ekundayo et al., 2020), farmers’ health status with productivity (Ajani and Ugwu, 2008; Akindode et al., 2011; Aminu et al., 2013), or climate change with farmers’ health (Mboera et al., 2011; Watts et al., 2015; Khalili et al., 2020; Olutumise et al., 2021). However, there is a scarcity of information on studies that show the relationship between agricultural productivity, climate change and farmers' health status in the literature, especially in Nigeria. The study is also unique because none of the previous studies have used Stochastic Frontier Production Function (SFPF) to examine productivity as it is done in this study. The study went beyond socioeconomic factors by modeling climate and health factors, unlike other studies. Therefore, to achieve sustainable agriculture under a conducive environment, the synergy among climate change, health status, and productivity needs to be critically examined. It is against this background that the study specifically and quantitatively examined the: (i) determinants of technical efficiency; (ii) effect of climate and health factors on the technical inefficiency of the farmers; (iii) estimation of production elasticity; and (iv) identification of the main constraints militating against food production in the area.

The null hypothesis of the study was stated in null form ($H_0$) as: There is no significant relationship between health variables and the adoption of climate adaptation measures.

## 2. Materials and Methods

This research was conducted in the Southwestern region of Nigeria. According to Figure 1, the geographical coordinates of the region are revolved around the longitude 20 321 and 60 001 east, while the latitude 60 21' and 80

37' north. The region observes two distinct seasons: dry and wet periods. The rainfall and temperature ranges are 1500 mm – 3000mm and 210C and 340C, respectively. The uniqueness of the region is the presence of three agroecological zones (humid forest, derived savannah, and guinea savannah) and a favourable climate that supports food crops (Ekundayo et al., 2020 and Olutumise et al., 2021). The research employed cross-sectional data which were sourced with the help of a structured questionnaire and a scheduled interview. The survey was conducted with the assistance of qualified enumerators in the area between June and November 2019. In selecting the sample size, a multi-stage sampling procedure was used to select the interviewed respondents. In stage one, the study randomly selected three (3) out of the six (6) states constituting the Southwest region using a simple random sampling technique. The second stage involved a purposive sampling technique where six (6) Local Government Areas (LGAs) were purposively selected from each state, making eighteen (18) LGAs from the three states (Ekiti, Ondo, and Oyo). The LGAs were selected based on the information from each state Agricultural Development Programme (ADP) which ranked the selected LGAs as the highest food crop producers and the prevalence of farming activities in the area. Again, this allows the analysis to cover all the three agroecological zones as well as a large number of the region's food farmers. The third stage involved selecting five (5) communities from each of the selected LGAs using a simple random sampling technique, for a total of ninety (90) communities. In the fourth stage, five (5) arable crop farmers were selected at a random from each community using a simple random sampling technique. Therefore, a total of 450 respondents were interviewed; however, due to missing and insufficient information provided by the respondents, only 443 copies of the questionnaire were valid for the data analysis.

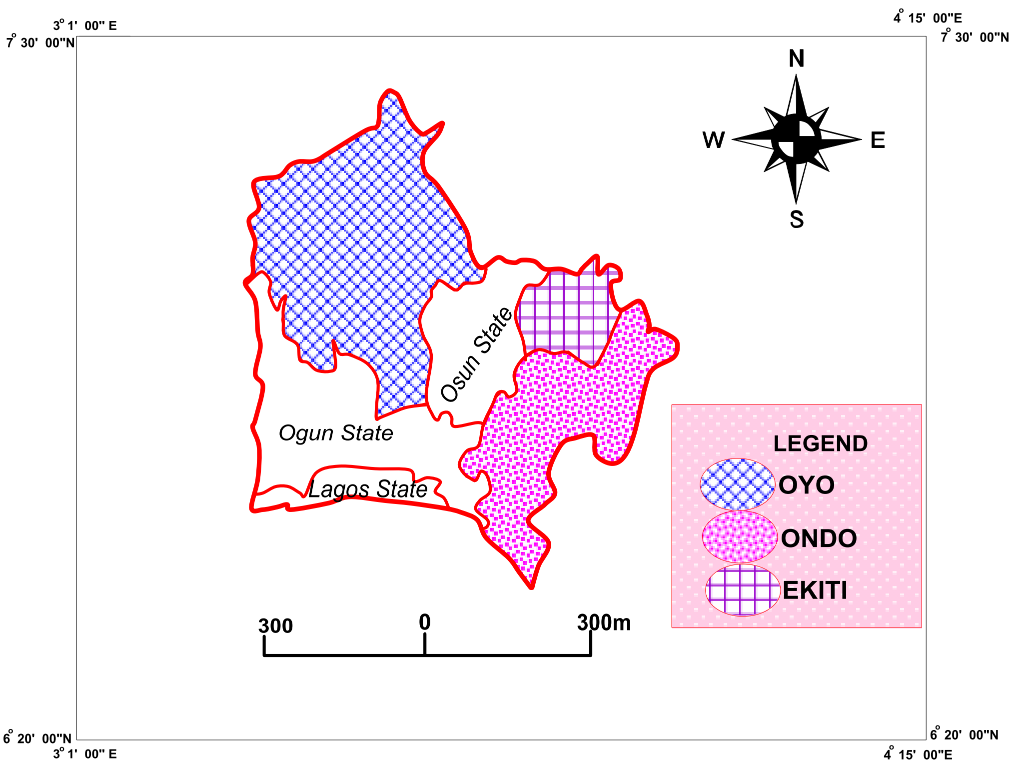


Figure 1. Map of the Research's Locations

Data Analysis: The study employed descriptive statistics for the summary characteristics of the variables used; Chi-square test for the hypothesis testing; and Stochastic Frontier Production Function (SFPF) for the technical efficiency measurement. SFPF is an econometric technique that evaluates the resource-use efficiency and the determinants of a firm's technical inefficiency. According to Battese and Coelli (1995), the model is implicitly specified by:

$$\ln Y_i = f(X_i; \beta) + (V_i - U_i) \quad (1)$$

where:

The Vis are random errors, having N $(0,\sigma 2v)$ distribution independent of the Uis.

The Uis is inefficiency impacts, non-negative truncation of the half-normal distribution N $(0, \sigma 2u)$.

i = 1,2,………n

lnYi represents the natural log of the predicted (output),

Xi is a K x1 vector of the predictors which are the input used (or their natural logarithms),

$\beta$ is the parameter estimated from the predictors ( Xi).

The ratio of observed output (Yi) to the corresponding frontier output (Yi*), conditional on the available technology, is used to describe a firm's technological efficiency (TE). As a result, technical efficiency is defined as:

$TEi = \ln Yi / \ln Y^* = f(Xi; \beta) \exp(Vi - Ui) / f(Xi;\beta) \exp Vi = \exp(-Ui)$ .................. (2)

Where: Yi is the observed output and Yi* is the frontiers output.

The value of TE ranges from 0 to 1, with 1 indicating a technically efficient firm, and the equation [E(exp(-U)] states that the larger the Ui, the less technically efficient the entity. The TE value varies from 0 to 1, i.e. $0 \leq Te \leq 1$.

Model Specification for the General model (Productivity model).

Following the method used in Fatuase (2017), the Cobb-Douglas frontiers production function for the arable crop farmers was assumed to be specified and defined as follows:

Implicit function: $Yi = \beta o Xi bie$

Explicit function: $\ln Y = \ln\beta o + (\beta i \ln Xi) + (Vi - Ui)$ ................................................ (3)

Where:

Y = Output (kg)

Xi are basic arable crop farm inputs and they are:

X1 = Labour (man-days)

X2 = Fertilizer (kg)

X3 = Farm size (ha)

X4 = Agrochemicals (litres)

X5 = Cost of planting materials (Naira)

Vi = Random error assumed to be independent of Ui. Identical and normally distributed with zero mean and constant variable N $(0, \sigma 2v)$.

Ui = Technical inefficiency effect as stated above, which is independent of Vi, it is a non-negative truncation at zero - N $(0, \sigma 2u)$

$\beta j = \sigma 2v, \sigma 2u, \sigma 2$ are unknown scalar coefficients.

Technical Inefficiency Model

On average, the technical inefficiency was evaluated by the mode of truncated normal distribution. The model is defined in line with Ogundari and Ojo (2007) and Fatuase (2017) as follows:

$Ui = \partial 0 + \partial 1Z1 + \partial 2Z2 + \partial 3Z3 + \partial 4Z4 + \partial 5Z5 + \partial 6Z6 + \partial 7Z7 + \partial 8Z8 + \partial 9Z9$................ (4)

Where:

Ui = as specified above.

Zi is socio-economic, health, and climate factors which were presented below.

Z1 = Years spent in school

Z2 = Years of farming experience

Z3 = Family size (numbers)

Z4 = Catastrophic health payment status (dummy: 1= farmers faced catastrophic health expenditure or payment; 0= otherwise). This was estimated using the benchmark of two-third of the mean per capita health expenditure of the respondents following the approach of (Cavagnero et al., 2006 and Olutumise et al., 2021). Farmers that faced catastrophic health payments were those that their health expenditures were equal or above the benchmark (coded as “1”).

Z5 = Access to healthcare services (dummy: 1=access; 0=otherwise)

Z6 = Farmer’s unhealthy day per year (numbers)

Z7 = Access to climate information (dummy: 1=access; 0=otherwise)

Z8 = Awareness of climate change (dummy: 1=aware; 0=otherwise)

Z9 = Adopt Adaptation strategies (dummy: 1=adapt; 0=otherwise)

$\partial 1 - 9$ = unknown scalar parameters to be estimated.

$\partial o$ = constant.

### 3. Results and Discussion

### 3.1. Summary Statistics of the Variables used in the Data Analysis

Presented in Table 1 are the summary statistics of variables used in estimating the production function. Averagely speaking, the total output produced by the sampled respondents was 21,195.33kg with a significant variation among the respondents given the value of standard deviation (17,710.65). The wide variation may be due to a small number of large-scale farmers. Similarly, the majority of the farmers in the sample have small farms of 1.59 hectares, resulting in a yield of 13,330.40kg per hectare. A total of 113.71 man-days per hectare is used by the farmers. This indicates that arable crop production in the region is labour intensive, which may be due to manual farming operations, vegetation types, and soil structure in the area. The mean values of quantity of fertilizer, agrochemical, and planting materials were 84.12kg, 14.99 litres, and N6,154.40 per hectares, respectively. Generally speaking, there are lots of variations in the input used by the farmers based on the values of their standard deviation in the Table and the probable reason is that many of them were not able to quantify the input correctly and the majority of them rarely used inputs such as fertilizer and agrochemical. Again, it was observed that many of them found it hard to separate labour on arable crops only from other farm activities because the same labour was used to carry out all farm activities including tree or cash crop farms in the area. According to the summary statistics of the variables used in the inefficiency component, the sampled farmers had an average of 22 years of farming experience and nearly 9 years of schooling. It can be deduced that the farmers in the region tended to embrace new technology and techniques, as well as a clear perception of their environments (Aphunu and Nwabeze, 2012; Olutumise et al., 2021). The average family size of about 8 persons per household could serve as a proxy to labour availability which may influence the adoption of innovative technology positively as its availability reduces the labour constraints (Teklewold et al., 2006; Ehinmowo et al., 2017). The value of the number of farmers that faced catastrophic health payments was 0.37, while access to healthcare services was 0.45, and then, farmers' unhealthy day per year was 8.11. The findings suggest that farmers in the area could be dealing with health issues that are affecting their production, as evidenced by previous studies in the area (Ajani and Ugwu, 2008; Akanbi et al., 2009; Akindode et al., 2011; Olutumise et al., 2017; Olutumise et al., 2021). The climate variables revealed that few farmers (0.52) had access to climate information, but the majority were aware of climate change and some had implemented one or more adaptations to combat the effects of climate change on both crops and their bodies. Again, the results of the hypothesis using Chi-square test showed that there was a significant difference between the adoption of climate adaptation measures and farmers' unhealthy days, and between the adoption of climate adaptation measures and suffering from catastrophic health payment status in the area as reported in the Table 2. However, there was no significant difference between the adoption of climate adaptation measures and access to healthcare services in the area given the P-value ($P > 0.05$). It can be deduced from the results that farmers that do adopt climate adaptation strategies might have less unhealthy days and as well might not suffer from catastrophic health expenditure in the area.

Table 1. Summary Statistics for Variables in the Stochastic Frontier Model

| Variable | Mean | Standard deviation |
|---|---|---|
| | Technical Component Variable | |
| Total output (kg) | 21,195.33 | 17,710.65 |
| Total labour in man-days | 113.71 | 87.16 |
| Fertilizer (kg) | 84.12 | 64.53 |
| Farm size (ha) | 1.59 | 7.02 |
| Agrochemical (litres) | 14.99 | 19.14 |
| Planting materials (N) | 6154.40 | 553.38 |
| | Inefficiency Component Variable | |
| Years spent in school | 8.79 | 12.02 |
| Years of farming experience | 21.74 | 13.27 |
| Family size | 7.97 | 5.34 |
| Catastrophic health payments status | 0.37 | 0.64 |
| Access to healthcare services | 0.45 | 0.64 |
| Farmer's unhealthy day | 8.11 | 7.34 |
| Access to climate information | 0.52 | 0.61 |
| Awareness of climate change | 0.97 | 0.31 |
| Adaptation strategies | 0.79 | 0.46 |

Table 2. Results of the Chi-square Test for the Hypothesis

| Variable | $\chi^2$ Coefficient | df | Sig. | Remark |
|---|---|---|---|---|
| Adaptation to climate change and unhealthy days | 253.48 | 23 | 0.000 | Significant |
| Adaptation to climate change and access to healthcare services | 0.082 | 1 | 0.775 | Non-significant |
| Adaptation to climate change and catastrophic health payment status | 141.25 | 1 | 0.000 | Significant |

### 3.2 Resource Use Efficiency Analysis

Table 3 shows the maximum-likelihood estimates of the stochastic frontier production function parameters for arable crop farmers in the area. According to the estimated coefficients of the explanatory variables, labour and planting materials had a negative effect on output variation, whereas fertilizer application, farm size, and agrochemicals had a positive effect on output variation. At the 1% stage, labour and planting materials were statistically significant, suggesting that as these variables rise, the production value decreases. The probable reason for the results might be the overutilization of labour and the inability of the farmers to plant precisely and at a recommended rate. Again, an increase in the values of fertilizer application, farm size, and agrochemicals will increase the output, ceteris paribus.

This means that these variables differed significantly from zero and were thus important in crop production in th e research area. However, the positive and significant coefficients of fertilizer, farm size, and agrochemicals corroborate the findings of Ajibefun (2002) and Aminu et al., (2013) on their work among small-scale farmers in Ondo State and vegetable farmers in Lagos State, respectively. The negative and significant coefficients of the labour and planting materials were contrary to the findings of Ojo (2004), Ogundari and Ojo (2005, 2007), which were carried out among peasant farmers in Nigeria.

Table 3. The Stochastic Production Frontier MLE Estimates

| Variables | Parameters | Coefficients | Std. Error | t-ratio |
|---|---|---|---|---|
| Constant | $\beta_0$ | 3.579 | 0.671 | 5.332 |
| Labour (man-day) | $\beta_1$ | -0.231*** | 0.079 | -2.933 |
| Fertilizer (kg) | $\beta_2$ | 0.639*** | 0.087 | 2.762 |
| Farm size (ha) | $\beta_3$ | 0.443*** | 0.098 | 4.515 |
| Agrochemicals (litre) | $\beta_4$ | 0.591 | 0.404 | 1.463 |
| Planting materials (N) | $\beta_5$ | -0.169** | 0.083 | -2.047 |
| | | Inefficiency model | | |
| Constant | $\delta_0$ | 2.278 | 0.752 | 3.031 |
| Education | $\delta_1$ | -0.119* | 0.063 | -1.897 |
| Experience | $\delta_2$ | -0.007 | 0.035 | -0.210 |
| Household size | $\delta_3$ | 0.077 | 0.134 | 0.573 |
| Catastrophic health payment status | $\delta_4$ | -0.763*** | 0.290 | -2.628 |
| Acess to healthcare services | $\delta_5$ | -0.247*** | 0.089 | -2.762 |
| Unhealthy days | $\delta_6$ | 0.487*** | 0.165 | 2.949 |
| Access to climate information | $\delta_7$ | -0.011 | 0.007 | -1.581 |
| Awareness of climate change | $\delta_8$ | 0.049 | 0.038 | 1.313 |
| Adoption of adaptation strategies | $\delta_9$ | -0.736*** | 0.178 | -4.140 |

Sigma-squared ($\sigma^2$) = 0.221*** (10.081); gamma ($\gamma$) = 0.890*** (16.349); log likelihood function = -654.251

### 3.3 Effect of Socio-economic, Climate, and Health Characteristics of Respondents on Technical Efficiency

The calculated gamma parameter ($\gamma$) of 0.890 was highly significant at a 1% level of measurement error and other random disturbance, suggesting that technical inefficiency was responsible for around 89% of the variance in arable crop production. The sigma-squared ($\sigma^2$) of 0.221 was statistically significant at a 1% level, which indicates a good fit and correctness of the distributional form assumed for the composite error term. The estimated coefficients of the predictors in the inefficiency equation, as presented in Table 3, are crucial and have significant implications. The negative coefficients of education, experience, catastrophic health payment status, access to healthcare, access to climate information, and adoption of climate adaptation measures signify a positive effect on farmers' technical efficiency, while the positive coefficients of household size and awareness of climate change signify a negative effect on farmers' technical efficiency in the area. Statistically, the education of the respondents was significant at a 10% level, and this implies that the efficiencies of the food farmers increase with an increase in the number of years spent in school. The catastrophic health payment status of the respondent was also significant at 1% level and it indicates that farmers that do not face catastrophic health expenditure will likely be efficient in crop production than those that are experiencing catastrophic health expenditure in the area by 76.3%, *ceteris paribus*. Again, access to healthcare services was significant (P<0.001), and thereby increasing the efficiencies of the arable crop farmers more likely than not having access to the healthcare services by 24.7%, *ceteris paribus*. Furthermore, adopting adaptation measures was significant at a 1% level, implying that employing adaptation measures increased efficiencies of the crop farmers by 73.6% than those that do not adopt adaptation strategies in the area. The studies carried out in the region using time series data (Hamzat et al., 2017; Olutumise et al., 2017 and Ekundayo et al., 2020) confirmed the relationship between crop output and climate variables. It was reported that rainfall and sunshine hours had a positive association with crop output, while temperature had a negative relationship in the long-run. Therefore, these variables conform with the *a priori* expectation that healthy and educated farmers that have access to healthcare service and as well employed climate change adaptation measures to combat effects of climate change on arable crops will be efficient, effective, and productive in crop production giving the inputs in the table. Again, the number of unhealthy days was significant at a 1% level. This means that the more the number of unhealthy days, the more the inefficiencies of the farmers. This is justifiable because, as stated by Aminu et al., (2013), the higher the number of illness episodes, the higher the number of days absent from farm work, and hence, the higher the farmers' inefficiency levels. The findings of this study are similar to the work of Ajani and Ugwu (2008) on the impact of adverse health on the agricultural productivity of farmers in Kainji Basin North Central Nigeria using a stochastic production frontier approach. It also supported the findings of Aminu et al., (2013) who found that the number of days away from the farm due to illness was positive and important in the inefficiency model. Akindode et al., (2011) also ascertained the effect of disease burden on technical efficiency among rice farmers in North Central Nigeria.

**3.4 Farmers' Level of Efficiency**

Given the specification of the Cobb-Douglas stochastic frontier model, the predicted technical efficiency varies widely among the sampled crop farmers. The value ranged from 0.12 to 1.00 with an average technical efficiency of 0.73. From Figure 2, the distribution of the technical efficiency was skewed heavily in the class interval of 0.70 and 0.89, and this represents 52.9% of the sampled respondents. The findings affirmed that most farmers were not allocating their resources efficiently. This is because of the wide variation in technical efficiency estimates, and the implication is that there still exists opportunities for improvement on their current level of technical efficiency as observed by Ajibefun (2002), Aminu et al., (2013) and Fatuase (2017). Apart from this, it could be deduced from the average technical efficiency (0.73) that arable crop production could increase their efficiency by 27% through better and appropriate use of available resources. Therefore, the average technical efficiency computed from this study is similar to the values reported in the literature, such as Ogundari and Ojo (2007), Adedapo (2008), Ojo (2009), Adeyemo et al., (2010) and Aminu et al., (2013), but very low compared with Zalkuwi et al., (2010).

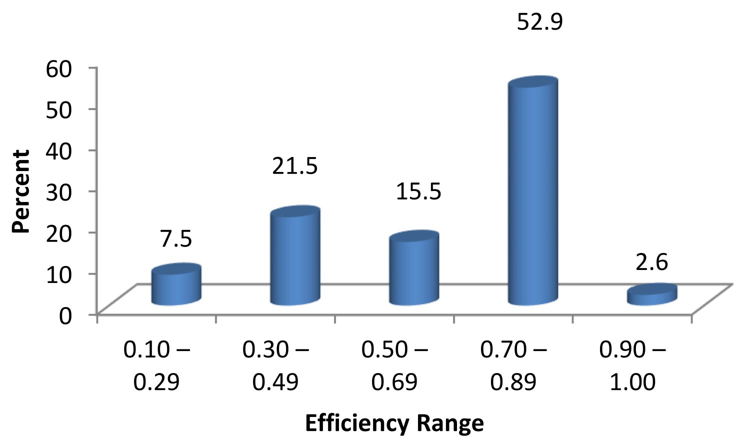


Figure 2. Disaggregation of Technical Efficiency Indices
Minimum = 0.12; Maximum = 1.00; Mean = 0.73

### 3.5 Elasticity of Production and Return-to-Scale Analysis

The production elasticity measures the proportional change in output resulting from a proportional change in the i-th input level, with all other input levels held constant (Ajibefun, 2002; Fatuase, 2017). The input elasticities of production and returns-to-scale (RTS) values are shown in Table 4. The elasticity of crop output with respect to labour, fertilizer, farm size, agrochemicals, and planting materials are -0.23, 0.64, 0.44, 0.59, and -0.17, respectively. It means that labour and planting materials were overutilized in the study area, while fertilizer, farm size, and agrochemicals were underutilized. On the other hand, a 100% increase in the use of fertilizer, farm size, and agrochemicals will increase crop output by 64%, 44%, and 59%, respectively. This is an indication that variables allocation and use were in the stage of economic relevance of the production function as also reported by Amos (2007). Furthermore, the elasticity coefficients of labour and planting materials were negative, meaning that they are in stage III of the production function. The negative decreasing function of these variables is also an indication that the factors were overutilized.

The estimated elasticity coefficient was 1.27, and this implies that arable crop production was still carried out in stage I (increasing RTS) of the production surface in the area. The RTS parameter indicates what happens when all production resources are varied in the long run by the same proportion, that is, increasing productivity per unit of input (Ajibefun, 2002; Ehinmowo et al., 2017). As a consequence, the increasing-returns-to-scale (1.27) implication is that arable crop farmers should increase their efforts to extend the current scale of crop production to optimize productivity with current resources. Also, the crop farmers could as well reduce the use of labour which is influenced by family labour and planting materials to actualize the potentials therein as also reported by Aminu et al., (2013). The RTS value obtained in this study is similar to those of Ajibefun (2002), Amos (2007), Ojo (2009), Adeyemo et al., (2010), and Aminu et al., (2013) which are 1.26, 1.26, 1.31, 2.62, and 1.15, respectively, among Nigerian food farmers.

Table 4. Elasticity of Production and Return-to-Scale of the Respondents

| Variable | Elasticities of production |
|---|---|
| Labour (man-day) | -0.231 |
| Fertilizer (kg) | 0.639 |
| Farm size (ha) | 0.443 |
| Agrochemicals (litre) | 0.591 |
| Planting materials (N) | -0.169 |
| RTS | 1.273 |

### 3.6 Problems Militating against Arable Crop Production in the Study Area

From Table 5, the result showed that the problems facing arable crop farmers ranged from inadequate fund, difficulty in accessing healthcare services, lack of storage facilities, inadequate climate information on health, extreme weather events, rodents, pests and diseases infestations, agrochemicals cost, shortage of labour to high cost of planting materials in the study area. It was observed that inadequate funds ranked first as the most serious problem facing the arable crop farmers in the efficient production of food crops. This finding conforms with Fatuase et al., (2015) who reported that lack of capital as the most serious constraint to yam production in Owo LGA of Ondo State, Nigeria. Another germane problem reported by farmers was difficulty in accessing healthcare services. The farmers, most especially in the rural areas, complained of the rickety and non-functioning government-owned healthcare equipment. The result was similar to the finding of Osondu et at. (2015) who identified sickness as one of the main problems encountered by the smallholder arable crop farmers in Abia State, Nigeria due to the lack of accessible healthcare services. Inadequate climate change information on health and extreme weather events (such as storms, drought, flood, and heavy rainfall) were ranked fourth and fifth, respectively. Ehinmowo et al., (2015) had similar results in their study where the environmental hazard was identified as the second most serious problem facing cassava farmers in Southwest, Nigeria. The farmers intricately expressed how flood and storm destroyed their produces in the previous seasons. Lack of storage facility ranked third and it was traced mainly to the epileptic power supply in the country. Again, incidences of pests and diseases, inadequate agricultural inputs, shortage of labour, and high cost of planting materials were also reported as serious constraints to the production of food crops and this is corroborated by several studies carried out in Southwestern Nigeria (Zaknayiba and Tanko, 2013; Omojola, 2014; and Fatuase et al., 2015).

Table 5. Distribution of Respondents by the Problems Faced by the Farmers

| Problems | Frequency | Percentage | Rank |
|---|---|---|---|
| Inadequate fund | 397 | 93.0 | 1st |
| Difficulty in accessing healthcare services | 351 | 82.2 | 2nd |
| Lack of storage facilities | 334 | 78.2 | 3rd |
| Inadequate climate information on health | 291 | 68.1 | 4th |
| Extreme weather events | 225 | 52.7 | 5th |
| Rodents, Pests and Diseases infestations | 210 | 49.2 | 6th |
| High cost of agrochemicals | 198 | 46.4 | 7th |
| Shortage of labour | 120 | 28.1 | 8th |
| High cost of planting materials | 116 | 27.2 | 9th |

Note: *Multiple Responses Exist

## 4. Conclusion and Recommendation

The study concluded that climatic variables, health factors, and socio-economic characteristics had significant effects on the technical efficiency of arable crop farmers in the area. From the study, it is affirmed that fertilizer application and farm size were positively and significantly affecting crop output, while labour and planting materials were negatively and significantly affecting the output of arable crop farmers in the study area. Education, catastrophic health payment status, access to healthcare service, and adoption of adaptation measures to climate change increased the technical efficiency of the crop farmers. The number of unhealthy days, on the other hand, reduced the technical efficiency of the arable crop farmers. It was ascertained that the farmers were relatively efficient and they were operating at stage I of the production surface. The farmers should reduce the costs of labour and planting materials in the study area, while fertilizer application, farm size, and agrochemicals need to be increased to get optimum output at the level of given inputs. It is, therefore, recommended that government should subsidize the agricultural inputs, most especially planting materials and agrochemicals, to reduce the costs incurred by the farmers in the course of production. Through government and cooperative efforts of the farmers, manual labours should be substituted through modern technologies such as tractors and other machines. Farmers should be able to access funds through agricultural and commercial banks. The interest rate must not be more than one digit value, and it must be accessible and available to the farmers by situating the funding institutions very close to the farmers. Government should also provide basic accessible healthcare facilities with the provision of modern and functioning facilities. The government should make it a priority to educate farmers about the effects of climate change on human health and the environment. This could be achieved through disease prevention and environmental sanitation under the framework of the primary health care programme. This could also be achieved through the provision of evidence-based information such as radio programmes in order to broaden their knowledge, thereby trigger climate change adaptation actions that will protect present and future generations in the area. Finally, in determining the technical efficiency of arable crop farmers, policymakers need to take climatic variables and health characteristics seriously in order to get optimum crop output in the study area. This can be achieved by providing a conducive environment such as social amenities and infrastructure that will balance a synergy between climate change and the health status of the farmers.

Limitations: The use of spatial interpolation to calculate location-specific farm-level temperature, rainfall and relative humidity would have formed more quantitative data instead of farmers' perception about climate change used in this study. The use of spatial interpolation to calculate location-specific farm-level temperature, rainfall and relative humidity involves getting farm coordinates of each of the respondents, which will make it more capital intensive. Hence, the reason for the use of farmers' perception about climate change since the study is self-sponsored. Also, findings from this study cannot necessarily be used to draw conclusions for Nigeria as a whole because different cultural and operational practices for crop production as well as environmental issues are found from one geopolitical zone to the other. Therefore, further studies that collect data on the coordinates of each of the respondents' farms and extend the scope of the research to cover the whole of Nigeria should be conducted.

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