# LAND USE PROPERTY RIGHTS AND TECHNICAL EFFICIENCY OF CASSAVA-BASED FARM HOUSEHOLDS IN OGUN STATE, NIGERIA.

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**ABSTRACT**
The relationship between access to land through land registration and land tenure system and agricultural productivity go hand in hand to determine the pattern of agrarian land use as well as agricultural performance. This study answers as to what extent land access, tenure system influence the technical efficiency of 360 randomly selected cassava-based farm households in Ogun State, Nigeria. Data collection was based on the structured questionnaire and the data were analyzed with descriptive statistics and stochastic frontier analysis (SFA). The mode of land acquisition, categorised into three –Freehold (including personally inherited (28.33 percent) and/or purchased lands (16.67 percent) to which exclusive use and transfer rights apply), Leasehold (land leased from a third-party) of 46.67 percent, and Communal (land jointly owned/controlled by extended family or other community members of 8.33 percent, to which only use right is accorded). Over 83% of the households perceived they enjoy secure tenure on the land, as most believed they could invest in tree cropping (43.33 percent), sell (59.17 percent) and/or bequeath (38.33 percent) the land to their children. However, only a few (less than 20 percent) of the landholding were registered either with the Local Government Authorities (12.5 percent). The technical efficiency of the rice farmers ranged from 0.013 to 0.982, with a mean technical efficiency of 0.769. The mode of land acquisition through leasehold (land leased from a third-party) and mode of land acquisition through Inheritance/ Purchase negatively influence the technical inefficiency level of cassava-based farmers. Cassava-based farmers who held the rights to farmland through their land related decision-making on growing tree crops, restrict access to others, lease out to others, land sales, bequeath to own children are less likely to be technically inefficient in cassava production. Also, cassava-based farmers who possesses several non-contiguous land plots, often scattered over a wide area have a higher likelihood of being technically inefficiency when compare to their counterparts who possesses consolidated land plots.
**Keywords:** inheritance, productivity, plots, resources, utilisation,

## INTRODUTION

Global production of cassava amounted to about 278 million metric tons in 2018 out of which Africa's share was put at about 61% (Food and Agriculture Organization Corporate Statistical Database [FAOSTAT], 2020). In Nigeria, cassava is one of the fastest expanding staple food crops. Cassava crop has continued to gain prominence among farmers in Nigeria while the industrial demand is also rising consistently (FAO, 2018). In 2020, Nigeria's cassava production was put at about 42.5 million metric tons which is estimated to be about 18% of global production. Nigeria's share of the world production rose to 21.5% of the world production by 2018 (FAOSTAT, 2020). According to (FAOSTAT, 2020), it is projected that by the year 2025, about 62% of global cassava production will be from SSA. This will only be possible if farmers in SSA and Nigeria in particular are efficient in their resource utilization.

As a food crop, cassava has some significant inherent characteristics which make it attractive especially to farmers in Nigeria. Firstly, it is rich in carbohydrates, especially starch, and consequently has multiplicity of end uses (Ettah and Nweze, 2016). Secondly, it is available all the year round, making it preferable to other more seasonal crops such as grains, peas, beans and other crops for food security (Emokaro and Oyoboh, 2016) and lastly it is tolerant of low soil fertility and more resistant to drought (Okoye, Abass, Bachwenkizi, Asumugha, Alenkhe, Ranaivoson, Randrianarivelo, Rabemanantsoa and Ralimanana, 2016).

According to Abolaji et al (2012) rising consumer demand for cassava from both rural and urban households have encouraged farmers to bring more land under the cultivation. The attention given to the production of the crop in Nigeria by governments at various levels will not yield the desired result if the perceived inefficiency in resource use of the farmers is not addressed. One of the factors driving the efficiency level of crop farmer is land.

Land is one of the vital assets throughout the world either in urban centers or rural environments' where lives and survival is based and build on the cultivation of land (Agricultural Promotion Policy, 2016). According to Umeh and Chukwu, (2014) smallholder

farmers play key roles in achieving food security but unfortunately, they face limited access to land resources due to different socio-economic and land tenure factors. Land tenure is essentially, the methods by which individuals or groups acquire, hold, transfer or transmit property rights in land (Terngu, Okeke, Iortima, Imbur, and Ahire 2017). The term tenure means the sum of rights an individual, household or community may have with respect to land or water or other resources for that matter. It is a mix or number of entitlements (rights and duties) concerning the use of land resources (Terngu et al., 2017).

By Land Tenure and Property reference is made to – the rights that individuals, communities, families, firms, and other community structures hold in land and associated natural resources. LTPRs are secure (de facto or de jure) if clearly defined, exclusive, enforceable and transferable as well as recognized by relevant authorities (Feder and Feeny, 1991). In Nigeria, a State Governor grants official recognition of a landholder's LTPRs through the issuance of a Certificate of Occupancy, which is granted after following some due process that includes boundary survey and submission of a duly verified deed of transfer (Shittu et al., 2018). Local government councils may also grant customary rights of occupancy to individuals, firms, and communities (Laws of the Federation of Nigeria [LFN], 2004). The customary right of occupancy is, however, considered de facto held by holders of agricultural lands in non-urban areas that have been under use for agricultural purposes prior to the enactment of the Land Use Act of 1979 (Shittu et al., 2018; LFN, 2004: Section 36 [2 & 3]). This practically leaves the control of most rural (agricultural) lands in Nigeria within the purview of the informal customary tenure systems at various localities. However, registration of such titles, especially when transferred from one party to another, are commonly registered at the affected State's land registry upon submission of the approved perimeter survey plan, the deed of transfer, and payment of stamp duty fees (Shittu et al., 2018).

On theoretical grounds, Food and Agriculture Organization FAO (2002) explains land tenure security as the certainty of which rights to the land of a particular individual will be recognized by others and protected in cases of specific challenges. Specifically, the literature has identified three main channels through which improvements in land tenure security contribute to economic growth. First, land tenure security has been argued to provide incentives and assurance for making a long-term agricultural and land-related investment (Lawin and Tamini, 2019; Melesse and Bulte, 2015). Second, formal land tenure security has been posited to increase credit access by using the land asset as collateral (Melesse and Bulte, 2015; Muchomba, 2017). Third, secure, transferable land rights are assumed to enhance factor mobility by making it easier for farmers to rent or sell their land (Abdulai et al., 2011).

However, regarding examinations of the impact of land tenure security on agricultural productivity and technical efficiency, the literature has produced ambiguous findings. For instance, some studies in Ethiopia have found a positive effect of land tenure security on technical efficiency and productivity (Ahmed et al., 2002; Ghebru and Holden, 2015; Holden et al., 2009; Melesse and Bulte, 2015). Similarly, in Ghana, Abdulai et al. (2011) report that land tenure security has a positive and significant effect on investment and farm productivity. In the Philippines, Koirala et al. (2016) also find that secure land ownership has a positive impact on the technical efficiency and productivity of rice farms. By contrast, Ma et al. (2017) and Lawin and Tamini (2019) study China and Benin and report a negative impact of land tenure security on technical efficiency. However, other studies have found no statistically significant results regarding the impact of land tenure security on-farm productivity and efficiency (Gavian and Ehui, 1999; Pender et al., 2004; Place and Hazell, 1993). Various authors have argued that these mixed results can be attributed to the widely different contexts and the overarching macro and sectoral conditions within which the land tenure systems operate (Lawin and Tamini, 2019; Ma et al., 2017; Place, 2009). Therefore, further research is necessary to contribute to the debate on land tenure security and technical efficiency relationship.

**METHODOLOGY**

This study was carried out in Ogun State, Nigeria.

Primary data used for this study were collected from a cross section of arable crop farmers in Ogun State with the aid of a structured questionnaire between August and December, 2023. Both individual and communities level data was used. The information collected were socioeconomics characteristics.

Multistage sampling method was used for this study. The first stage involves random selection of one (1) block from each zone making three (4) blocks, out of which five (5) cells were selected randomly making a total of 20 cells. The list of cells comprising many farming communities was obtained from OGADEP and was used for the sampling frame. The second stage is a random selection of 20 farmers from each of the 20 cells targeting a total of 400 farmers. After cleaning the data from the consistent response and potential outlier information, out of which 360 farm households were used for analyses.

Analytical techniques employed include descriptive statistics and stochastic frontier production. Descriptive statistics: Descriptive statistics such as frequency tables, percentages means were used to analyze farmers' socio-economic characteristics, land ownership, use, tenure and property rights, crop production and cropping system.

Following Farrell (1957), three forms of efficiency were defined: technical, allocative, and economic efficiencies. This study focused on technical efficiency which refers to achieving the highest output with little effort (Hossain, 2012). The stochastic production frontier was used to determine the technical efficiency of the cassava-based farmers. It's commonly applied when there's an assumption that observed production outcomes may not be solely due to technical efficiency but could also be influenced by factors beyond the control of farmers (Battese and Coelli, 1995).

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_4 X_4 + V_i - U_i \quad (1)$$

Where:

Y = Quantity of cassava output (t/ha), $\beta_0$, $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$ - the coefficients estimated for each variable, $X_1$ = Farm size, $X_2$ = Labor, $X_3$ = Fertilizer usage, $X_4$ = cassava stem cutting, $V_i$ = symmetric component that captures random error associated with random factor under the control of cassava farmers; $U_i$ = asymmetric error component represents the deviation from the frontier production (the technical inefficiency). Meanwhile, technical inefficiency effects are specified below:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \cdots \ldots\ldots\ldots\ldots\ldots + \delta_{12} Z_{12} + \varepsilon_i \quad (2)$$

Where:

$U_i$ = Technical inefficiency, $Z_1$ = Age (years), $Z_2$ = Sex (1 = male, 0 = otherwise), $Z_3$ = Marital status (1 = married, 0 = others), $Z_4$ = Education (years of schooling), $Z_5$ = Household size (persons), $Z_6$ = Extension contacts, $Z_7$ = Farming experience (years), $Z_8$ = Distance between plots (Kilometer), $Z_9$ = Farm income (NGN/year), $Z_{10}$ = Access to credit (1 = yes, 0 = otherwise), $Z_{11}$ = Number of plots, $Z_{12}$ = Fragmentation (index), $Z_{13}$ = Livestock ownership (Total Livestock Units), $\delta_1 . \delta_{13}$ = estimated parameters, ε = error term.

## RESULTS AND DISCUSSION

### Description of the socioeconomic characteristics of cassava-based farm households

Table 1 shows the socioeconomic characteristics of farm households'. The result showed that 63.33 percent of the respondent were male while 36.67 percent were females. This implies that farming in the study area was predominantly concentrated by male. It is clear that there is a gender imbalance in farming. Majority (65.83 percent) of the respondents were married while 20.0 percent were single. This implies that married people were predominated in farming. Majority (71.67 percent) of the respondent were between the ages of 31 – 50 years with an average age of 45 years. This is an indication that the respondents were in their economic active age. Majority (51.67 percent) of the respondents has household size within 4 – 6 with a mean household size of approximately 5 persons. This shows that the respondents had relatively large household size and this implies that they could draw family labour which would be cheaper than engaging hired labour in certain agricultural production. This in turn could enhance their productivity and efficiency. Approximately, 27.50 percent of the respondents had no formal education. This shows that majority of the respondent in the study area are literate with about 72.50 percent. Majority (61.67 percent) of the respondents have between 11-20 years' experience in farming experience with a mean experience of 14 years. Also, 36.67 percent do have access to credit as against 63.33 percent who do not have access to credit. Access to credit is an important factor needed to enhance production efficiency of the respondent especially in the expansion of enterprise scale and acquisition of input resources. The result also revealed that 31.67 percent of the respondent had extension contact.

**Table 1. Socioeconomic characteristics of the respondents**

| Characteristic | Frequency | Percentage |
|---|---|---|
| **Sex** | | |
| Male | 228 | 63.33 |
| Female | 132 | 36.67 |
| **Age** | | |
| <30 | 54 | 15.00 |
| 31-50 | 258 | 71.67 |
| 51 and above | 48 | 13.33 |
| Mean age (years) | 45 | |
| **Level of education** | | |
| None | 99 | 27.50 |
| Primary | 162 | 45.00 |
| Secondary | 84 | 23.33 |
| Tertiary | 15 | 4.17 |
| **Monthly income** | | |
| <30000 | 87 | 24.17 |
| 31000-50000 | 177 | 49.17 |

| | | |
|---|---|---|
| 51000 and above | 96 | 26.67 |
| Mean | 45,000.00 | |
| **Marital status** | | |
| Single | 48 | 13.33 |
| Married | 252 | 70.00 |
| Others | 60 | 16.67 |
| **Access to credit** | | |
| Yes | 132 | 36.67 |
| **Access to Extension** | | |
| Yes | 114 | 31.67 |
| **Household size** | | |
| 1-3 | 111 | 30.83 |
| 4-6 | 186 | 51.67 |
| 7 and above | 63 | 4.17 |
| Mean | 15 | |
| **Farming experience** | | |
| >10 years | 78 | 21.67 |
| 11-20 | 222 | 61.67 |
| 21 and above | 60 | **16.67** |
| **Farm size** | | |
| Small farm (<2) | 231 | 64.17 |
| Medium farm (2–5) | 75 | 20.83 |
| Large farm (>5) | 57 | 15.83 |
| Mean Farm size = 2.09 | 42 | 11.67 |

**Source: Field Survey, 2023**

**Patterns of land use and property rights of cassava-based farming households**

Two key indicators were employed in assessing Land Tenure and Property Rights of farmers in this study. They include: Tenure type and Tenure security (legal).

**Tenure type:** This depicts the mode of land acquisition, categorised into three –Freehold (including personally inherited (28.33 percent) and/or purchased lands (16.67 percent) to which exclusive use and transfer rights apply), Leasehold (land leased from a third-party) of 46.67 percent, and Communal (land jointly owned/controlled by extended family or other community members of 8.33 percent, to which only use right is accorded). These were represented in the study models in terms of the proportion of the farmlands cultivated by all members of the households that fall under each of the three categories. Meanwhile, the share of communally owned/controlled land was dropped as the reference tenure-type variable. The mode of land acquisition Leasehold (land leased from a third-party) according for 46.67 percent.

**Tenure security (legal):** In view of provisions of Nigeria's Land Use Act (LFN, 2004), a tenure is de jure secure, if it is duly registered with the land registry and/or the holder is issued a statutory Certificate of Occupancy by the Governor of the State where it is located. Holders of inherited and/or purchased lands that are not in dispute, even though commonly perceived as de facto secure, may be affected by unfair expropriation of such lands. Therefore, this study focused on de jure with a view to examining the importance of title registration, which was captured in the model as the proportion of household's farmland to which the household holds registered title.

Over 83% of the households perceived they enjoy secure tenure on the land, as most believed they could invest in tree cropping (43.33 percent), sell (59.17 percent) and/or bequeath (38.33 percent) the land to their children. However, only a few (less than 20 percent) of the landholding were registered either with the Local Government Authorities (12.5 percent) or the State authorities (3.33 percent).

The result shows that most farmers (63.33 percent) had 2 plots of unequalled sizes located at different distances from each other while 27.5 percent and 9.17 percent, 3 and 5 plots of farm land respectively at different locations seperated by distance. The mean farm holdings of cassava farmers in the study area was 2.09 ± 1.01 plots per farmer while the mean plot size was 2.432 acres (1.115 ha).

Land fragmentation can be defined as a situation where a farming household possesses several non-contiguous land plots, often scattered over a wide area. Majority (65.00 percent) reported that have several non-contiguous land plots, scattered over a wide area. Land fragmentation is a phenomenon that exists when a household operates a number of owned or rented noncontiguous plots at the same time. Various factors are responsible for agricultural land fragmentation. Among the main factors that have directly or indirectly contributed to subdivision and fragmentation is the traditional system of inheritance of land (inheritance laws, which divide a family's land among all the remaining sons, ensure that, as the population increases, not only does the size of holdings fall, but they are increasingly fragmented into small plots, scattered over a wide area.

**Table 2: Patterns of land use and property rights of cassava-based farming households**

| Acquisition mode | Frequency | Percentage |
|---|---|---|
| Inherited | 102 | 28.33 |
| Purchased | 60 | 16.67 |
| Leasehold | 168 | 46.67 |
| Communal | 30 | 8.33 |
| **Number of plots (parcels)** | | |
| 1-2 | 228 | 63.33 |
| 3-4 | 99 | 27.50 |
| 5 and above | 33 | 9.17 |
| **Rights Held on Farmland** | | |
| Can grow tree crops | 156 | 43.33 |
| Can restrict access to others | 114 | 31.67 |
| Can develop structures on land | 87 | 24.17 |
| Can lease out to others | 192 | 53.33 |
| Can sell the land | 213 | 59.17 |
| Can bequeath to own children | 138 | 38.33 |
| **Land titling Status** | | |
| Has well defined boundaries | 66 | 18.33 |
| Registered with Traditional Council | 219 | 60.83 |
| Registered with Local Government | 45 | 12.50 |
| Registered with the State | 12 | 3.33 |
| **Land Fragmentation (Simpson Index)** | | |
| Fragmented | 234 | 65.00 |
| Consolidated | 126 | 35.00 |
| Mean Simpson Index= 0.23 | | |

**Source: Field Survey, 2023.**

**Factors influencing their level of land use and property rights.**

The results of the socioeconomic factors influencing the level of land use and property rights cassava-based farmers reveals that one out of the seven hypothesized determinants were the significant factors influencing the level of land use and property rights cassava-based farmers. The negative coefficient of Age of the household head implies that the younger farmers have a likelihood of increased of the level of land use and property rights. However, other significant variables were all positive implying male headed households with higher number of years of schooling, have a higher likelihood of increased level of land use and property rights.

**Table 3. Tobit regression analysis results of the factors influencing the level of land use and property rights among cassava-based farmers**

| Explanatory variables | Coefficient | Standard error | Z | P >/Z/ |
|---|---|---|---|---|
| Age of the household head (years) | -0.442*** | 0.192 | -2.302 | 0.055 |
| Sex of the household head (1=male, 0=otherwise) | 0.172 | 0.311 | 0.553 | 1.298 |
| Education of the household head (years) | 5.265** | 2.372 | 2.220 | 0.052 |
| Farmers' awareness of land property rights security (yes=male, no=otherwise) | 0.122*** | 0.026 | 4.692 | 0.002 |
| Ownership of land contract certificate (yes=male, no=otherwise) | 0.358** | 0.111 | 3.225 | 0.001 |
| Distance of land from market (km) | 0.222** | 0.103 | 2.155 | 0.066 |
| Access to credit (yes=male, no=otherwise) | 3.099*** | 1.024 | 3.026 | 0.009 |

| | | | | |
|---|---|---|---|---|
| Income (₦/month) | 0.275* | 0.103 | 2.669 | 0.049 |
| Number of observations = 360 | | | | |
| LR $Chi^2$ (13) = 584.381 | | | | |
| Prob>$Chi^2$ = 0.0003 | | | | |
| Pseudo $R^2$ = 0.7406 | | | | |
| Log likelihood = -886.43 | | | | |

Note: *** implies the 1%, ** implies the 5% and * implies the 10% significance level.

**Technical efficiency level of cassava-based farmers in the study area**

Table 4 presents the frequency distribution of the technical efficiency of the sampled maize farmers. The predicted technical efficiencies (TE) ranged between 0.288 and 0.989 with a mean level of technical efficiency of cassava-based producers of 0.769 which indicates that there is a possibility for the cassava output to increase by 23.1 percent at a given level of input consumption. The wide variation shows possibility for improvement by some cassava-based farmers.

The minimum efficiency score is 28.8 percent, while the maximum efficiency score is 98.9 percent. The results from the maximum-likelihood estimate of the frontier model for this study showed that averagely, farmers were 23 percent technically efficient, implying that 77 percent of cassava yield was not realized.

As clearly indicates, the 7.50 percent of cassava-based producing farmers were operating with technical efficiency score less than 0.50. However, 17.50 percent have a technical efficiency interval of (0.5–0.69), 48.33 percent were operating with technical efficiency score interval equal to 0.70-0.89. In addition, 26.677 percent of cassava-based producing farmers were operating at efficiency score level greater than 0.90.

**Table 4. The distribution of the technical efficiency scores.**

| Scores | Frequency | Percentage |
|---|---|---|
| <0.5 | 27 | 7.50 |
| 0.50–0.69 | 63 | 17.50 |
| 0.70–0.89 | 174 | 48.33 |
| 0.90–1.00 | 96 | 26.67 |
| Mean | 0.769 | |
| Minimum | 0.288 | |
| Maximum | 0.989 | |
| Number of observation | 360 | |

**Source: Field Survey, 2023.**

**The maximum likelihood estimate of the stochastic frontier production function.**

Table 5 shows the maximum likelihood estimates for parameters of the stochastic translog production frontier. Following Coelli et al. (2005), all the variables were normalised through mean correction and hence can be interpreted as partial elasticities. Since the sum of the model's first-order coefficients is positive, the monotonicity condition is met. The estimates of sigma-square (σ2) were 0.011 for the cassava-based farmers. This indicates a good fit and correctness of the distribution assumption specified. The variance ratio gamma ($\gamma$), which measures the effect of technical efficiency in the variations of the observed output, had values of 0.722. This implies that 72 percent of the difference between the observed and maximum production frontier outputs occurred due to differences in the producer's level of technical efficiency. The estimated chi-squares were large and significantly different from zero at 1 percent, indicating goodness of fit (best fit) and the correctness of the specified distribution assumptions for the decomposed error term. Table 5 shows that fertiliser, farm size, labour and quantity of cassava settings used significantly affect the level of cassava output in the study area.

**Farm size:** This variable is significant at 1 percent level of significance and its coefficient is positive, indicating that there is a positive relationship between maize productivity per hectare and the amount of per hectare chemical fertilizer used for cassava production. The coefficient of the hectares of farm size used for cassava production indicates that a 1 percent increase in the hectare of farm size usage for cassava production leads to 12.8 percent (the coefficient of farm size was 0.128) increase in the cassava yield per hectare. This implies that when farm size increases by 100%, holding other variable inputs constant, the output would increase by about 83 percent. This result is consistent with Abdulai et al. (2018) and Amaechina and Eboh, (2016).

**Labour:** This variable is significant at 1% level of significance, and its coefficient is positive, indicating that there is a positive relationship between cassava productivity per hectare and the number of workdays of labour used. This result indicate that there is a direct relationship between cassava productivity per hectare

and the amount of man hours employed for cassava production.

**Fertilizer/Agrochemicals:** The coefficient of amount of chemical fertilizer used for cassava production indicates that a 1 percent increase in the amount of fertilizer usage for cassava production leads to 23.4 percent increase in the cassava yield per hectare. The study also indicates that the coefficient of fertiliser was 0.234 and statistically significant at 1 percent. This connotes that when the quantity of fertiliser used increases by 100 percent, holding other variable inputs constant, the output would increase by about 23 percent. This finding conforms to the results of Amaechina and Eboh (2016) and Mabe et al. (2018) but contrary to the result of Abdulai et al. (2018).

**Cassava stem cuttings:** This variable is significant at 1% level of significance, and its coefficient is positive, indicating that there is a positive relationship between cassava productivity per hectare and the amount of cassava input used for cassava production. The coefficient of amount of cassava stem used for production indicates that a 1 percent increase in the amount (kg) of cassava input used for cassava production leads to 0.443 percent increase in the cassava yield per hectare.

**The determinants of technical inefficiency in cassava production**

Table above reveals the analysis of the inefficiency model. The signs and significance of the estimated coefficients in the inefficiency model have important implications for the cassava farmers' technical efficiency. A negative sign means that the variable increases efficiency, whereas a positive coefficient means a decrease in the efficiency level. The parameter estimates from the inefficiency model included in the stochastic production frontier estimation revealed that extension contact and education have significant negative effect on inefficiency. This implies that farmers who claimed to have frequent contact with extension agents, and more educated cassava farmers were more technically efficient than those who claimed not to have frequent contacts with extension agents and had lower levels of formal education. The negative value of gender coefficient means that female farmers were less technically efficient than their male counterpart. It should be recalled that male were scored 1 in the quantification of the dummy variable (gender) while females were scored zero. The variables capturing the farmers and herders clash are all positive, which implies that the higher the number of conflict episodes, extent of conflict, and the economic cost of conflict, the lower the efficiency level of cassava-based farmers.

**Sex of the household head:** This variable is found significant at 1 percent level of significance. The expected sign of this variable is negative and the result obtained is in line with the expectation which indicates that sex of the household head being male as compared to female household head can have negative impact on farm in inefficiency. Expressed differently, gender of the household head being male as compared to female household head can have positive impact on farming efficiency. This is due to fact that the agricultural activities in the study areas male-dominated, and it was even considered as a males' work and, hence, males allocate the majority of their times for outdoor activities in which agriculture is the paramount one. Therefore, this causes the yield per hectare of male - headed household to outweigh the female headed household.

**Age of the head of household:** This variable is significant at 10 percent level of significance. Higher age is, therefore, an indication of higher farm experience in rural area where agriculture is the main means of livelihood. The expected sign is positive but we obtain a negative coefficient as per not the expectation. The negative coefficient implies higher age leads to an increase of the inefficiency of cassava farmers. From the result of the study, as the cassava farmer gets older, the level of technical inefficiency increases. A 1 percent increase in the age of the head of the household leads to 0.02 percent increase in the technical inefficiency of the farmers.

**Education level of the household head:** This variable has a negative sign and significant at 1 percent implying that cassava-based farmers who achieved relatively higher education level are believed to have higher exposure to agricultural technology and agricultural technology adoption possibility. This could enhance the farm productivity per hectare, since better educated farmers are more likely to adopt modern equipment efficiently, hence their efficiency.

**Livestocks ownership:** The amount of livestock owned by a farmer is measured by tropical livestock unit (TLU). This variable is significant at 5 percent level of significance. The results show that the coefficient for this variable is negative which is similar to the expected sign. For rural households, livestock can be a source of income, a source of food, and a means of transportation, and their manure can be used as compost. Thus, the negative sign for this coefficient indicates that as the number of livestock owned by cassava-based farmers increased, it leads to reduction in inefficiency of farmers in cassava production.

**Farm income:** This variable is significant at 5 percent level of significance. The results show that the coefficient for this variable is negative which is similar to the expected sign. Farmers need money to purchase seed, fertilizer, pesticides, and herbicides, and to pay for the hired labor in addition to financing

the household consumer goods demand. Therefore, higher farm income means higher purchasing power of the farmer to different farm inputs. Hence, higher farm income can reduce the farmers' technical inefficiency in cassava production.

**Access to credit:** This variable is significant at 5 percent level of significance. The results show that the coefficient for this variable is negative which is similar to the expected sign. Sometimes farmers need credit to finance their farm's various input requirements. The regression result obtained in our maximum-likelihood estimation coefficient of access to credit which is equal to −0.127 indicates that compared to the farmers who have no access to credit, those who have access to credit have 0.127 percent lower technical inefficiency in cassava production.

**Mode of land acquisition:** The Mode of land acquisition was found to be negatively significant at various levels. However, the share of communally owned/controlled land was dropped as the reference tenure-type variable. The mode of land acquisition through leasehold (land leased from a third-party) and mode of land acquisition through Inheritance/ Purchase negatively influence the technical inefficiency level of cassava-based farmers. This implies that cassava-based farmers whose mode of land acquisition are through leasehold Inheritance/ Purchase are less inefficient compared to the mode of land acquisition are by communally owned/controlled land.

**Rights held on farmland**: The rights held on farmland by cassava-based farmers were negatively significant at various levels. The share of develop structures on land was dropped as the reference rights held on farmland variable to avoid dummy variable trap. The rights held on farmland by cassava-based farmers have proven in the improvement of technical efficiency. Thus, the negative coefficient obtained indicates that cassava-based farmers who held the rights to farmland through their land related decision-making on growing tree crops, restrict access to others, lease out to others, land sales, bequeath to own children are less likely to be technically inefficient in cassava production.

**Land fragmentation:** Land fragmentation have a positive effects on the technical inefficiency level of the cassava-based farmers. Thus, the positive coefficient obtained indicates that cassava-based farmers who possesses several non-contiguous land plots, often scattered over a wide area have a higher likelihood of being technically inefficiency when compare to their counterparts who possesses consolidated land plots.

**Table 5. The maximum likelihood estimate of the stochastic frontier production function.**

| Variables | Coefficients | t-values |
|---|---|---|
| **Efficiency function** | | |
| Farm size (ha) | 0.128*** | 4.162 |
| Labour (mandays) | 0.195** | 2.073 |
| Irrigation/water (litres) | 0.011 | 0.634 |
| Fertilizer/agrochemicals (Litre) | 0.234** | 2.321 |
| Quantity of cassava stem cuttings (kg) | 0.443*** | 3.894 |
| Constant | 0.183*** | 3.197 |
| **Inefficiency function** | | |
| **Socioeconomic characteristics** | | |
| Age (Years) | -0.152* | -1.915 |
| Gender (1=male, 0=otherwise) | -0.224** | -2.268 |
| Marital status (1=married, 0=others) | 0.303 | 0.317 |
| Education (Years of schooling) | -1.214*** | 3.044 |
| Household size (number of persons) | 0.238 | -1.181 |
| Extension contact | -0.262** | -2.181 |
| Farming experience (Years) | -1.044** | -2.165 |
| Livestock ownership (Total Livestock Units) | -0.167*** | -3.892 |
| Farm income (N/year) | -0.029** | -2.312 |
| Access to credit (1=Yes, 0=otherwise) | -0.127*** | -3.152 |
| **Mode of land acquisition** | | |
| Inherited/ Purchased (1=Yes, 0=otherwise) | -1.185*** | -4.003 |
| Leasehold(1=Yes, 0=otherwise) | -0.273** | -2.384 |
| Communal (the share of communally owned/controlled land was dropped as the reference tenure-type variable) | | |
| **Rights held on Farmland** | | |
| Can grow tree crops (1=Yes, 0=otherwise) | -0.224* | -1.921 |
| Can restrict access to others (1=Yes, 0=otherwise) | -0.078*** | 3.448 |
| Can lease out to others (1=Yes, 0=otherwise) | -0.118** | 2.432 |

| | | |
|---|---|---|
| Can sell the land (1=Yes, 0=otherwise) | -0.209** | 2.128 |
| Can bequeath to own children (1=Yes, 0=otherwise) | -0.421*** | 4.562 |
| Can develop structures on land (the share of develop structures on land was dropped as the reference rights held on farmland variable) | | |
| **Land fragmentation** (index) | 0.364** | 2.003 |
| Constant | | |
| **Diagnosis statistics** | | |
| Sigma-square ($\sigma 2$) | 0.011 | 2.353 |
| Gamma ($\gamma$) | 0.722 | 8.046 |
| Number of observation | 360 | |
| Wald chi2(3) | 688.2 | |
| Log likelihood | -22.718 | |
| Prob> chi2 | 0.000 | |

Note: *** implies the 1%, ** implies the 5% and * implies the 10% significance level.

## CONCLUSION

This study was tailored towards addressing effects of land access and tenure rights on agricultural productivity especially the technical efficiency of cassava-based farmers. The empirical results indicate that the cassava-based farmers whose mode of land acquisition are through leasehold inheritance/ purchase are less inefficient compared to the mode of land acquisition are by communally owned/controlled land. Therefore, improving the efficiency of cassava farmers will contribute to its local production.

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