Does Land Ownership Security Matter in Agricultural Productivity? Evidence from Panel Data in Tanzania

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Abstract

This paper investigates the effect of land ownership security on agricultural productivity, specifically maize yield. It applies a Random Effect Model on a balanced panel sample size of 672 smallholder maize farmers derived from the last two waves of the Tanzania National Panel Survey (TNPS) data, which were collected in 2014/2015 (wave 4) and 2019/2020 (wave 5). The empirical results reveal that land ownership security is a significant factor in promoting agricultural productivity. Moreover, the results indicate that gender, farm size, education, and improved agricultural technologies significantly influence maize productivity. Thus, policies aimed to promote legal land ownership security are important in boosting smallholder farmers' agricultural productivity and food security.

Keywords: Agricultural productivity; land ownership security; panel data; maize smallholder farmers; Tanzania.

JEL Classification Codes: Q12, Q15, Q18

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1.0 Introduction

Agricultural development is one of the significant initiatives for ending extreme poverty (World Food Programme (WFP), 2019). The World Bank (2020) documents that 65 percent of poor working households engage in the agricultural sector globally for their livelihoods. In Tanzania, the agricultural sector accounts for 26.6 percent of the GDP, 30 percent of export earnings, and 65 percent of domestic industries' raw material in addition to employing about 67 percent of the country's labour force (United Republic of Tanzania (URT), 2020; WFP, 2019). The sector in Tanzania is crucial for both export earnings and most of the rural communities, who largely rely on agriculture for their livelihood. Overall, agricultural land is a vital component of the country's economy and food security (URT, 2013a; Collins, 2019).

Despite the significance of the agricultural sector in providing employment, generating income, and fostering food security, evidence of low agricultural growth persists and translated into low economic growth and limited headway in poverty reduction in Tanzania[1] (Food and Agriculture Organisation - FAO, 2016). This poor performance in the agricultural sector is attributable to a limited agricultural productivity among smallholder farmers who dominate the agriculture sector (Mashindano *et al*., 2011; Msambichaka *et al.*, 2015; Selejio, 2015; Selejio and Lasway, 2019; Diao *et al*., 2020).

According to the International Fund for Agricultural Development (IFAD), Tanzania's productivity of most agricultural produces remains below global averages (IFAD, 2016). Impliedly, returns from the major productions remain below the average returns registered at a global level. For instance, the average yield from major cereal crops, such as maize and paddy, stands at 1.6 and 2.7 tonnes per hectare, respectively, whereas the global average yield for the same cereals, is 4 and 3.5 tonnes per hectare, respectively (National Bureau of Statistics - NBS, 2017).

This low agricultural productivity is linked to the challenges in land ownership security[2] for agricultural activities, among other reasons (FAO, 2016; Gebreeyosus *et al*., 2020). Available statistics also indicate that less than 17 percent of the smallholder farmers in Tanzania have both formal and informal title deeds for their land, which is considered as a source of high land tenure security (Kabubo-Mariara and Linderhof, 2010; URT, 2013a; URT, 2016b). In other words, most of the smallholder farmers had limited land ownership security, which might also contribute to low agricultural productivity among smallholder farmers. URT (2013a) identifies lack of land tenure security as one of the contributory factors to the decline in the productive capacity of agricultural land due to unsustainable and inappropriate land use practices.

In the last three decades, Tanzania has been one of many SSA countries that implemented land reforms. In fact, Tanzania is one of the countries with best practices in land reforms following its introduction of stronger legal recognition of existing customary land rights, buttressed by the enactment of the Village Land Act and Land Act of 1999 (USAID, 2016; Collins, 2019). These

[1]Tanzania is one of the 29 Sub-Saharan countries that achieved the Millennium Development Goals linked to reducing by half the prevalence problem of under-nutrition by 2015 (World Food Programme, 2019).

[2] Land ownership security in this paper is considered as right to own land legally by smallholder farmers as defined by Charoenratana and Shinohara, 2018; Paltasingh, 2018; Tenaw et al, 2009)

reforms have accorded both women and men opportunities for equal participation in land rights and decision-making. Also, the Village Land Act of 1999 states that land is owned either under a statutory individualized title or under a customary ownership (CCRO) that the village authorities have endorsed (Sipangule, 2017). The concerted governmental efforts withstanding, there is low or ineffective governance of land as few smallholder farmers[3] in Tanzania have legal land ownership status (URT, 2016; Sipangule, 2017).

Yet studies on the impact of land tenure security on agricultural productivity among farmers have yielded mixed results. Some studies have indicated that farmers' land ownership security is not a significant determinant of agricultural productivity (Migot-Adholla *et al*., 1991; Place and Migot-Adholla, 1998; Matchaya, 2010; Moreda, 2018). On the other hand, other studies have concluded that farmers' land ownership security can determine agricultural productivity (Goldstein and Udry, 2008; Dillon and Voena, 2018; Charoenratana and Shinohara, 2018; Bambio and Agha, 2018). The studies further explain that farmers with land ownership security can use their lands collateral for accessing agricultural loans and other benefits from improved agricultural technologies that boost agricultural productivity. Against this non-definitive background, the big question among scholars has remained: "Does smallholder farmers' land ownership security affect agricultural productivity?" This paper, therefore, uses maize[4] as a reference crop for empirical analysis in answering this question in the context of Tanzania.

Unlike most previous studies that had used cross-sectional data, the current paper uses the Tanzania National Panel Survey (TZPS) data gathered during the last two waves (2014/15 and 2019/20). Its use of panel data addresses the endogeneity[5] problems that can lead to estimate bias when using cross-sectional data (Wooldridge, 2019; Wang and Yang, 2021). This bias inherent in cross-sectional data might explain the mixed results evident in previous studies. key results from descriptive statistics analysis in this paper show that, on average, smallholder maize farmers' households with formal and informal land title deeds stood at 33.3 percent, implying that most of them had limited land tenure security. The econometrics results indicate that there is a significant positive impact of secure land ownership on agricultural productivity among smallholder maize farmers. Moreover, the results indicate that gender, farm size, education and improved agricultural technologies also have a significant bearing influence maize productivity.

The rest of this paper is organized as follows: Section 2.0 reviews literature, Section 3.0 covers the methodology and Section 4.0 presents and discusses the empirical findings. Finally, the final section concludes the paper and outlines the policy implications.

2.0 Literature review

Several works attribute low agricultural productivity among smallholder farmers in Africa to factors such as soil fertility, limited access to extension services and improved agricultural technologies, and poor access to credit among farmers (Kassie, *et al* 2015; Selejio and Lasway,

[3] For example, in 2015 the statistics indicate that less than 17 percent of the smallholder farmers in Tanzania had legal land ownership status (URT, 2016).

[4] Maize is one of the significant food crops in Tanzania accounting for 45 percent of the cultivated area. The maize production also contributes around 70 percent of the cereal produced in the country (World Food Programme, 2019). Hence, this sector presents a huge potential in fostering economic growth and trade expansion.

[5] Endogeneity problem occurs when the predictor variable in a regression model is correlated with the error term

2019; Lasway *et al*., 2020). Of late debate among scholars has ensued on the impact of smallholder farmers' land ownership security on improving agricultural productivity. Malley *et al*. (2009), who had examined agricultural productivity and environmental insecurity in the Usangu plain of Tanzania focusing on the rice and maize production, used the cross-sectional data from 266 households in six villages, found that environmental insecurity had a significant and negative impact on agricultural productivity. The study had employed ordinary least square regression model to estimate the relationship. Moreover, the study found that a decline in fertilizer consumption and inconsistent rainfall contributed to a drop in agricultural productivity. Based on these findings, Malley *et al*. (2009) had called for measures to enhance education for the farmers on the sustainable use and management of land resources, improve the rural policies in the agricultural development and environmental governance and promote the use of soil fertility enhancing materials to raise agricultural productivity.

Tenaw and Parvianen (2009), who had used cross-sectional data to study the effects of land tenure and property rights on agricultural productivity in Ethiopia, Namibia, and Bangladesh, found that policy for proper land ownership was important for smallholder farmers to increase productivity in the rural areas across countries. The common problem smallholder farmers faced in the three countries was the increasing rate of poverty caused by poor land administration. The findings were also in connection with land insecurity as a cause of Africa's agricultural crisis and the effect of climatic change on agriculture.

Furthermore, Holden and Otsuka (2014), who had examined the roles of land tenure reforms and land markets in the context of population growth and land use intensification in Africa using cross sectional data, found a positive relationship between land governance and land productivity in SSA of Ethiopia and Rwanda. The study had also explored the existence of an inverse relationship between farm size and land productivity as well as the implication of this relationship for efficiency and equity. Its findings further indicated that countries with strengthened property rights through land certification witnessed increased investment in land and land productivity by 40 percent. Also, the study found that having unrestricted land markets and secured property rights resulted into efficiency and equity. Similarly, Kille and Lyne (1993) found a positive relationship between land ownership security and farming input use among farmers in South Africa, which subsequently improved agricultural productivity. These findings further concur with those of Hayes *et al.* (1997) who concluded that land ownership security positively affected the agricultural investments and productivity of Gambian farmers.

Using a cross-sectional study in Zambia, Nkomoki *et al*. (2018) established that farmers with legal status ownership of land were more likely to adopt sustainable agricultural practices that contribute to increased productivity than otherwise. Also, the study found that legal land ownership among farmers promoted crop diversity. Thus, for Zambia to increase food security, policymakers should focus on strengthening land legal status ownership among smallholders. Similarly, Bellemare (2013) had established that tenure insecurity negatively affected the relationship between the right to lease land and agricultural productivity in Madagascar.

Using cross-sectional data, the study of Paltasingh (2018) in India found that farmers with secure land ownership were more likely to improve their agricultural productivity by adopting improved paddy technology than those with no such land ownership security. In addition, tenants with long-term land tenure tended to be more secured and were adept at adopting Improved Varieties Technology (IVT) than others lacking such a portfolio. Thus, the study called for the reforming of the agricultural tenancy system and lift ing of the legal ban on land tenancy.

Similarly, Sossou and Mbaye (2018) findings on the impact of land ownership security onhouseholds agricultural productivity in Benin stemming from cross-sectional data indicated that farmers with land ownership certificates had a 0.238 unit higher likelihood to invest in agricultural equipment than those without secured land tenure. As such, the study suggested that public authorities should enhance land ownership among farming households to foster agricultural investments aimed to ease food insecurity in Benin.

Likewise, Charoenratana and Shinohara's (2018) investigation of food security of rural farmers in vis-à-vis their land rights in two farming communities in the Northern Province of Thailand used cross-sectional data. The study Province is the largest food producer in that country. The study, which sought to contribute to ongoing debate on food insecurity dogging many developing countries despite being food producers, found a positive and significant relationship between land property rights and agricultural production. Moreover, the study affirmed that land rights had a significant positive impact on the income of farmers in addition to engendering sustainable food security and fostering their well-being.

Singirankabo and Ertesn (2020), who had reviewed 85 papers, found mixed arguments on the relationship between land registration and agricultural productivity. On the one hand, legal land ownership papers might enhance the attainment of financial services for farmers and improve their agricultural productivity; on the other hand, such land certification could increase tenure insecurity and erode agricultural productivity. In addition. Singirankabo and Ertesn's (2020) study demonstrated that land registration tends to improve agricultural productivity only when supported by effective implementing institutions as well as land and agricultural policy.

However, some empirical works found farmers' land ownership security not a key determinant of promoting crop productivity. Place and Otsuka (2002), for example, analysed land tenure systems and their impact on agricultural investment and productivity in Uganda but found no impact of tenure on agricultural productivity. Coffee planting helped to enhance land tenure security whereas fallowing promoted more secure holdings. Implicitly, the study had found that farmers considered tenure implications while making investment decisions; yet the existence of different tenure systems did not imply increase in investment.

Ghatak and Roy's (2007) study on the impact of land reform on agricultural productivity in India aimed at generating empirical evidence with policy implications regarding the economy on land reform issues and their impact on agricultural productivity, poverty, and other variables. The study found that land reform legislation had a negative and significant effect on agricultural productivity for all the states studied due to alternative use of land with legal status. Furthermore, the study found that the tenancy reform had increased inequality in operational land holdings in India primarily because legal land ownership was associated with unaffordable cost for some community groups. The study had concluded that there were frictions on the allocation of land either due to agency costs or imperfect property rights. Correspondingly, Matchaya (2010), who adopted cross-sectional data to investigate the determinants of input use, investment and land productivity under customary land ownership in rural areas of Malawi, found that secured land was not a key determinant of promoting productivity. Furthermore, the findings reveal that input use and extension services are the key drivers in boosting crop productivity.

Generally, the prevailing empirical debate on land ownership security and agricultural productivity among farmers, limited works of literature have focused on Sub-Saharan African countries, Tanzania inclusive, and most of these studies have used cross-sectional data, which suffers endogeneity problems and biased estimation (Wooldridge, 2019; Wang and Yang, 2021; Cameron and Trivedi, 2010). This paper, therefore, intends to bridge this gap by modelling the effect of land ownership security on agricultural productivity among maize farmers in Tanzania using a national panel survey dataset.

3.0 Methodology

3.1 Econometric Modelling

This paper models the effect of land ownership security status on agricultural productivity using national panel data. However, the agricultural productivity in the study area also depended on the farming household characteristics such as socio-economic, demographic, and environmental characteristics. As a result, the methodology of this paper considers the characteristics highlighted by Sossou and Mbaye (2018). Consequently, the modelling in this paper includes socioeconomic, demographic, and environmental characteristics acquired from the field survey as they are considered as appropriate control variables from literature in analysing the effect of land ownership security status on agricultural productivity. In this case, it analyses households that have land ownership security and those without it to gauge the differences in productivity attributable to land ownership status.

The paper uses fixed effect model (FEM) and a random effect model (REM) to investigate the effect of land ownership security on agricultural productivity. In this analysis, the dependent variable is agricultural productivity (measured as output produced/area harvested) whereas the independent variables comprise age, education, gender, land ownership security, accessibility of extension services, access to improved agricultural technologies (IATs), agricultural credits, household size, farm size, and soil quality characteristics.

3.2 Fixed Effect Model

The FEM is shown as follows:

$$W_{it} = \beta_0 + \beta_1 Q_{1it} + \cdots + \beta_k Q_{kit} + \alpha_i + \varepsilon_{it} \qquad (1)$$

With i = 1, 2,.., n and t = 1, 2,.., T. The α_i are specific intercepts that captures heterogeneities.

Thus, the representation of this model is given by:

$$W_{it} = \beta_0 + \beta_1 Q_{1it} + \cdots + \beta_k Q_{kit} + \gamma_2 D2_i + \gamma_3 D3_i + \cdots + \gamma_n Dn_i + \varepsilon_{it} \qquad (2)$$

Where the $D2_i$, $D3_i$, …, Dn_i are dummy variables.

Secondly, introducing the dummy variable to gauge the effect of time passage on the dependent variable.
As a final point, we obtain a FEM after combining individual characteristics and time effects respectively, which form one model as equation 3 illustrates.

$$W_{it} = \beta_0 + \gamma_2 DLOS_i + \gamma_3 DIAT_i + \gamma_3 DAC_i + \gamma_4 DES_i + DG_i + DSQ_i + \beta_1 A_{it} + \beta_2 HS_{it} + \beta_3 FS_{it} + \beta_4 E_{it} + \varepsilon_{it} \quad (3)$$

Where, W_{it} = Maize productivity (kg/acre), $DLOS_i$ = a dummy variable for land ownership security captures a value of 1 for land having land ownership security[6] and 0 otherwise, $DIAT_i$= a dummy variable for Improved Agricultural Technologies takes a value of 1 for adopting IATs and 0 otherwise. DAC_i= a dummy variable for access to credit (AC) captures a value of 1 for accessing AC and 0 otherwise; DES_i= a dummy variable for access to extension services (ES) captures a value of 1 for a farmer to access extension services and 0 otherwise; DSQ_ia dummy variable for Soil quality (SQ) captures a value of 1 for good SQ, and 0 otherwise. HA_{it}= a continuous variable for the age of household head; HS_{it}= a continuous variable for household size involving active members engaging in particular agricultural activities; E_i= a continuous variable for household head education level captured by level of education attained; DG_i= a dummy variable for household head gender assumes a value of 1 for a farmer to be male and 0 otherwise.

The FEM captures all the time-invariant differences between individuals for the estimated coefficients without bias due to the omission of the time-invariant characteristics such as gender, education level, culture, religion, and race. Conversely, one side-effect of the characteristics of the FEMs is that they are not useful in examining time-invariant causes of the dependent variables. Technically, time-invariant features of the individuals are perfectly collinear with the entity dummies.

3.3 Random Effect Model

The REM is specified as follows:

$$W_{it} = \beta_i Q_{1it} + \cdots + \beta_k Q_{kit} + \alpha_i + \mu_{it} + \varepsilon_{it} \quad (4)$$

With μ_{it} signifying between entity error and ε_{it} representing within entity error, one of the advantages of REM is the inclusivity of time-invariant variables (i.e. gender and education level)[7]. Under REM, instead of treating β_0 as fixed in equation 8 above, we assume it is a random variable with mean α_0. Moreover, instead of using a dummy variable to gauge the status of a household head farmer on land ownership security, we use the error term, ε_{it}. Therefore, REM is specified as follows:

[6]The household in this study has land ownership security if it owns legal/formal land certificates/ titles (Granted right of occupancy (GRO), Certificate of customary rights of occupancy (CCRO) and other informal certificates/titles as described in Section 4.2 , which warrant high and strongest rights or tenure security among other factors (Kabubo-Mariara and Linderhof, 2010; URT, 2013). However, this paper does not consider other measures of land ownership security such as perceived tenure security since the information on the variables were missing in the NPS data used.
[7]In FEM, the time-invariant models are absorbed by the intercept.

$$W_{it} = \alpha_0 + \gamma_2 DLOS_i + \gamma_3 DIAT_i + \gamma_3 DAC_i + \gamma_4 DES_i + DG_i + DSQ_i + \beta_1 A_{it} + \beta_2 HS_{it} + \beta_3 FS_{it} + \beta_4 E_{it} \quad + \ \omega_{it} \qquad (5)$$

Where, $\omega_{it} = \mu_{it} + \varepsilon_{it}$ signifies within entity error and between entity error.

The REM accepts that the entity's error term does not correlated with the predictors allows for time-invariant variables to act a role as independent variables. Therefore, as equation 10 illustrates, the final REM includes time-invariant variables such as gender and education level. A Hausman, (1978) test was employed to determine the correct model between REM and FEM.

Data

This paper uses data from the last two waves of TZNPS—wave 4 (2014/2015) and wave 5 (2019/2020). The data was collected by the National Bureau of Statistics (NBS) of Tanzania in the collaboration with the World Bank (WB). Originally, the dataset contained 3,352 households for the fourth wave (2014/2015) and 5,587 households for the fifth wave (2019/2020), respectively. The original sample size included farmers cultivating different types of crops such as banana, paddy, maize, and sorghum (for more details, see NBS, 2019 and 2020). To have a balanced panel dataset, data merging, appending, and cleaning was done to track only smallholder maize farmers who either had or had not owned secured farmland for maize cultivation within a surveyed period. Consequently, the analysis of balanced panel data was based on 672 concrete observations that include a sample of 336 smallholder maize farmers which appeared in each wave. The purpose was to ensure consistent tracking of the same household members in the two waves. The data used contain useful information on the interviewees' education level, age, gender, education, household size, extension services, area harvested, quantity harvested, productivity, accessibility to improved agricultural technologies, land ownership security, access to credit services, and farm size. Hence, we used rich information to analyse the linkages of interest as noted in our research questions.

4.0 Results and discussion

4.1 Descriptive statistics of variables

Table 1 (below) presents the summary statistics of the variables that have extracted from the panel data of National Panel Survey for the two waves (wave 4 and wave 5). The results in Table 1 show that on average maize productivity was 574 kg per acre. Compared to other developing countries, maize productivity in Tanzania is low. According to the World Bank (2020), maize productivity of Uganda, Kenya, and Malawi are 1081, 1220, and 1329 kg per acre, respectively.

Furthermore, the findings indicate that the age of the sampled maize smallholder household heads on average were aged 49 years. Most of the households (76.6%) were headed by males, with a smaller fraction by females (23.4%). The average household size was 5.3, which concurs with official national household size (5.2 persons per household) in rural Tanzania as reported in the 2012 National Population Census (URT, 2013b). Moreover, the results show that the average number of years of education of the maize farming household head was six years or Standard 6. In other words, most of the household heads had at least a primary education.

Descriptive statistics indicate that the average household farm size was 5.4 acres, which does not deviate much from the national average household farm size of 5.5 acres (URT, 2016). Moreover, 73 percent of the sampled households indicated that the soil quality was good. Furthermore, the results show that smallholder maize farmers with land title deeds (formal and informal documents), which they believed to provide them with land ownership security accounted for 33 percent. Impliedly, most of smallholder farming households had limited land ownership security. The findings are supported by both Ali et al. (2016) and NBS (2017) since most of the smallholder farmers had limited land ownership security in Tanzania because of limited land literacy and cultural reasons.

Table 1: Descriptive Statistics from Panel Data

Variable	Observations	Mean	Std. Dev.	Min	Max
Maize productivity (kg/acre)	672	574.279	1263.71	1	30000
ln Maize productivity (kg/acre)	672	5.797	1.113	0	10.309
Age (years)	672	48.704	15.772	16	95
Gender (1 = male; 0 = otherwise	672	.766	.423	0	1
Household Size (number)	672	5.338	3.365	1	34
Education (years in school)	672	5.849	3.611	1	20
Soil Quality (1= good; 0 = otherwise)	672	.734	.442	0	1
Land Ownership Security (1 = 1 land having LOS; 0 = otherwise)	672	.333	.472	0	1
Improved Agricultural Technologies (1= adopting IATs; 0 = otherwise)	672	.426	.495	0	1
Extension services (1 = access to services; 0 = otherwise	672	.007	.086	0	1
Credit services (1= access to credit; 0 = otherwise	672	0.01785	.1325	0	1
Farm Size (number)	672	5.441	7.504	.1	50.3

Source: Author's computations based on 2014/2015 and 2019/2020 panel data.

With regard to credit access, descriptive statistics show that the sample average of smallholder maize farmers accessing loans accounted for only 1.7 percent. Implicitly, most of the smallholder farmers do not have loan accessibility because of limited collaterals, financial literacy, and other reasons as established by other studies (Mashindano *et al.,* 2011; URT, 2016a; Lasway *et al.*, 2020). Descriptive statistics further show that only 0.7 percent of maize smallholder household heads accessed agricultural extension services from the government. These findings are like Selejio and Lasway (2019) and Kaliba *et al*. (2000) who found most of the maize farmers to lack access to agricultural extension services due to limited number of extension officers.

Table 2 presents the differences between households for key characteristics and productivity outcomes with respect to secured land ownership. The implication is that secured land ownership and non-secured land ownership households do not differ significantly with respect to both productivity outcome and household characteristics but for household size and farm size. Non-secured land ownership households have significantly higher mean than those with secured land ownership households in both household size (6 persons) and farm size (6 acres), implying that, non-secured land ownership households had more household labour to work on large farms since the dependency ratio was low.[8] This set-up buffers the differences between the two groups in terms two household characteristics (household size and farm size). The two groups (non-secured land ownership and secured land ownership households) did not differ significantly in terms of age, gender, use of IAT, education, and soil quality as well as access to extension and credit services.

Table 2: Differences in household characteristics and productivity outcome by land security ownership status

Variable	Non-Secured Land Ownership	Secured Land Ownership	Difference	t-value	Observations
Household size	5.6272	4.7589	0.8683	3.1749***	672
Farm Size	6.1006	4.1227	1.9779	3.2440***	672
Age	48.7589	48.5937	0.1652	0.1279	672
Gender	0.7790	0.74107	0.0379	1.0952	672
IAT	0.4084	0.4598	-0.0513	-1.2685	672
Productivity	5.7728	5.8467	-0.0739	-0.8116	672
Education	5.7098	6.1294	-0.4196	-1.4209	672
Extension services	0.0046	0.0133	-0.0089	-1.2693	672
Soil Quality	0.7544	0.6919	0.0625	1.4290	672
Access to Credit	0.0201	0.0133	0.0066	0.6172	672

Legends: ***, **, * represents significant difference at 1%, 5%, and 10% respectively.

Source: Authors' computation from the Tanzania National Panel Survey Dataset

4.2 Status of Land ownership summary

This paper has categorised the status of land ownership in four main groups: Granted right of occupancy (GRO), Certificate of customary rights of occupancy (CCRO), other titles[9] and no title as indicated in Figure 1. About 67 percent of smallholder farmers had no title deed whereas those with GRO, CCRO and other titles accounted for eight percent, 9.9 percent and 15 percent, respectively.

[8] The dependency ratio was less than 50 percent in both non-secured land ownership and secured land ownership households (URT, 2021).

[9] Other certificates/titles include farmers with village-government-witnessed purchase, local-court-certified purchase agreement, inheritance letter, letter of allocation from village government, other government document, official correspondence, utility, or other bill certificates.

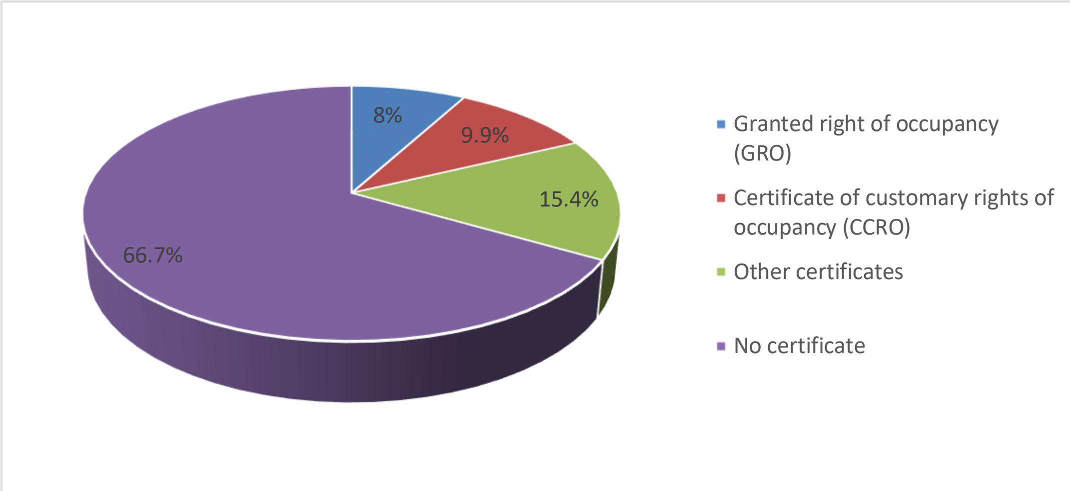

Figure 1: Status of Land Ownership
Source: Author's computations based on 2014/2015 and 2019/2020 panel data

4.3. Land ownership and productivity by Gender

Descriptive statistics further indicate that most of the farmers with land ownership security, i.e., 166 out 515 (75.0%) were male household heads (Figure 2). Correspondingly, female household heads with land ownership security accounted for 36.9 percent (58 out of 157). The results in Figure 2 also indicate that the male-headed households had higher mean maize yield per acre (608.14 kg) than female-headed households (463.19 kg).

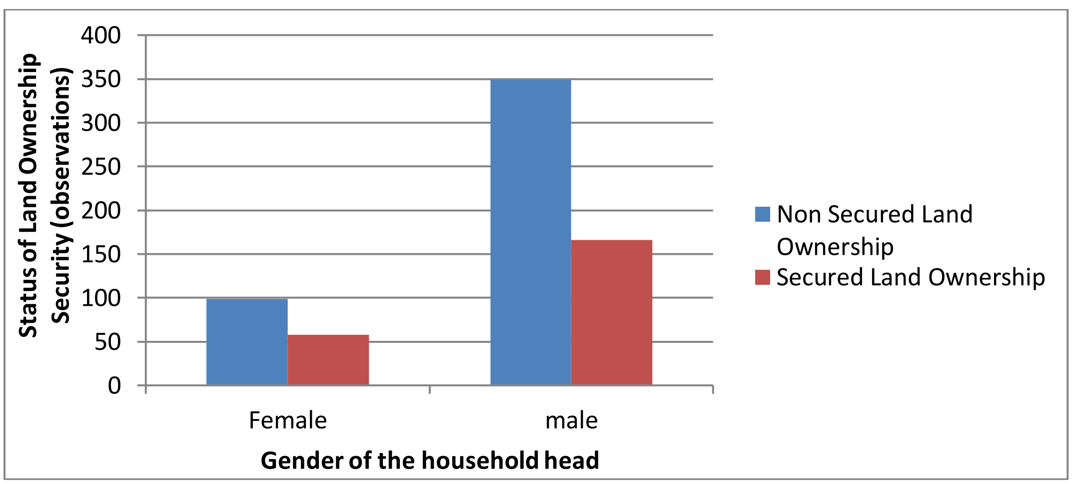

Figure 2: Land Ownership by Gender of the Household Head
Source: Author's computations based on 2014/2015 and 2019/2020 panel data

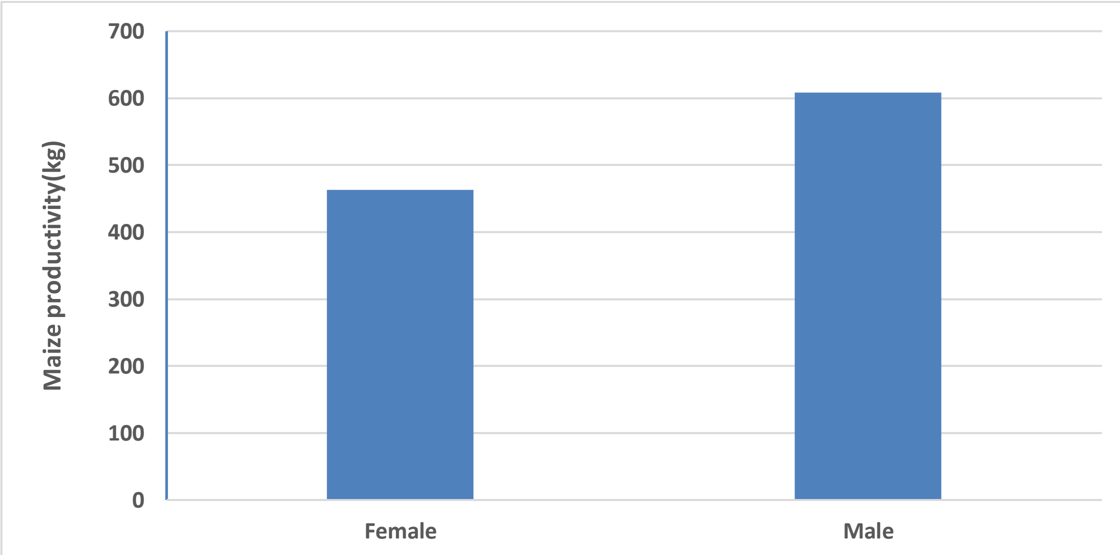

Figure 2: Maize productivity by Gender
Source: Author's computations based on 2014/2015 and 2019/2020 panel data.

However, the results from independent t-test results presented in Table 3 show that differences in means for both land ownership and maize yield between male and female headed households were insignificant, implying the good implementation of the policies that advocate for the gender balance in right of ownership of legal land and productivity.

Table 3: T-test mean comparison of land ownership security and productivity between male and female headed households

Variables	Male headed households	Female headed households	Mean Diff	t-value
	Mean	Mean		
Land Ownership Security (1 =yes)	.3694268	.3223301	.0470967	1.0952
Productivity (kg)	608.1444	463.1908	-144.95	-1.2587

Legends: ***, **, * represents significant difference at 1%, 5%, and 10% respectively.
Source: Authors' computation from the Tanzania National Panel Survey Dataset

4.4 Econometric analysis

Fixed effect model and Random effect models are employed to examine the effect of land ownership security on agricultural productivity. The Hausman test is then used to choose the appropriate model between the two models. The results of the Fixed effect model and Random effect model are given by Table 4 and 5, respectively:

Table 4: Fixed Effect Model Regression Results

Productivity	Coef.	Std. Err.	t-value	P-value	[95% Conf.	Interval]	Sig
Land Security	0.0521	0.0281	1.85	0.065	-0.003	0.107	*
IAT	0.1420	0.0322	4.42	0	0.079	0.205	***
Credit Service	0.0023	0.0905	0.03	0.98	-0.176	0.180	
Extension Service	0.0294	0.1397	0.21	0.833	-0.245	0.304	
Education	0.0064	0.0190	0.34	0.737	-0.031	0.044	
Gender	0.0689	0.0292	2.36	0.019	0.011	0.126	**
Age	0.0005	0.0008	0.56	0.574	-0.001	0.002	
Household Size	-0.0004	0.0037	-0.1	0.919	-0.008	0.007	
Soil Quality	0.0244	0.0273	0.89	0.372	-0.029	0.078	
Farm Size	-0.0719	0.0299	-2.4	0.017	-0.131	-0.013	**
_cons	1.6588	0.0720	23.04	0.000	1.517	1.800	
Mean dependent var		5.796	SD dependent var			1.118	
R-squared		0.0951	Number of obs			672.000	
F-test		4.177	Prob> F			0.000	
Akaike crit. (AIC)		1485.845	Bayesian crit. (BIC)			1535.293	

**** p<.01, ** p<.05, * p<.1*

Source: Author's computation from the Tanzania National Panel Survey Dataset

Table 5: Random Effect Model Regression Results

Productivity	Coef.	Std. Err.	t-value	P-value	[95%Conf.	Interval]	Sig
Land Security	0.040	0.020	1.94	0.052	-0.0003	0.080	*
IAT	0.096	0.023	4.13	0	0.050	0.141	***
Credit Service	0.073	0.066	1.1	0.271	-0.056	0.202	
Extension Service	0.074	0.101	0.73	0.465	-0.124	0.272	
Education	0.023	0.014	1.7	0.088	-0.003	0.051	*
Gender	0.066	0.021	3.1	0.002	0.024	0.108	***
Age	0.001	0.001	1.39	0.164	-0.000	0.002	
Household Size	-0.002	0.003	-0.91	0.360	-0.007	0.003	
Soil Quality	0.003	0.019	0.18	0.860	-0.035	0.042	
Farm Size	-0.049	0.021	-2.23	0.026	-0.091	-0.005	**
_cons	1.626	0.051	31.46	0.000	1.524	1.727	***
Mean dependent var			5.796	SD dependent var		1.118	
Overall r-squared			0.9661	Number of obs		672.000	
Chi-square			57.782	Prob> chi2		0.000	
R-squared within			0.7352	R-squared between		0.9706	

**** p<.01, ** p<.05, * p<.1*

Source: Author's computation from the Tanzania National Panel Survey Dataset using

Table 6: Hausman Test
Hausman (1978) specification test

	Coef.
Chi-square test value	4.637
P-value	.914

Source: Author's own computation from TZNPS Dataset

Since p-value is greater than five percent in Table 6, we accept the null hypothesis to the effect that there is no connection between the time invariant and the explanatory variable, which means Random effect is appropriate. The effect of land ownership security on agricultural productivity resulting from the Random effect model indicates that five variables are significant. The variables are Land ownership security, Improved Agricultural Technologies, farm size, education and gender.

The empirical results in Table 5 indicate that secured land ownership has a statistically significant positive impact on agricultural productivity. The findings further show that agricultural productivity increases by 0.04 units when smallholder farmers had land security/land certificates. In this regard, the empirical results concur with Sossou and Mbaye (2018) who studied the impact of land ownership security on household's agricultural productivity in Benin. The study's findings further indicate the likelihood of farmers increasing agricultural productivity because of land ownership security due to more investment in agricultural equipment than in the case of farming households without such land tenure security. Similarly, Bambio and Agha (2018) had argued that reinforcement of legal land ownership boosted the farming investments, which increased agricultural productivity among households in rural areas.

Furthermore, the study findings corroborate with Migot-Adholla *et al*. (1991), Place and Migot-Adholla (1998), Matchaya (2010), and Moreda (2018) on how land ownership security does not constitute the only factor inducing a positive significant impact of enhancing agricultural productivity. The results indicate that smallholder farmers who adopted improved agricultural technologies had a higher likelihood of enhancing agricultural productivity than those lacking such an advantage. The empirical findings further associate accessibility to improved agricultural technologies with a positive effect on agricultural productivity. In other words, smallholder farmers adopting improved agricultural technologies such as inorganic fertilizers, herbicides, and improved seeds raised agricultural productivity by 0.1 units. This finding agrees with Charoenratana and Shinohara (2018) and Selejio and Lasway (2019) who also found improved agricultural productivity among smallholder farmers who had adopted agricultural technologies.

The study also found that education had a positive impact on agricultural productivity. Indeed, the estimated coefficient for education was statistically weakly significant at the 10 percent level. Implicitly, household heads with a higher education level had on average a 0.02 unit higher level of agricultural productivity than those with lower education. The findings of Matchaya (2010) and Moreda (2018) are congruent with those of the current study on education influence on agricultural productivity. Overall, education helps to improve decision-making when an investment or risk can be taken.

Additionally, the study has established an inverse relationship between farm size and productivity. The results show that the estimated coefficient of farm size is statistically significant at 5%. In other words, household heads with large farm size have a 0.05 unit lower productivity level than those with smaller farm sizes. These empirical findings are supported by Chand *et al*. (2011), and Muyanga and Jayne (2019) since small farms are more productive than larger ones because they have lower farm risks and production costs per acre than the former. Conversely, Dyer (1997), Havnevik and Skarstein (1997), Hazell *et al*. (2010), and Carletto *et al*. (2015) in their respective studies found that small farms enjoyed productivity only in the short-run since the tables turned in the long-run when a drop in productivity occurred. The long-term drop in productivity is largely attributable to intensive land cultivation, which occurs when more people in the household need to survive on the same small piece of land. In fact, owners of small farmlands do not have the necessary resources for investing in soil fertility maintenance, and soil productivity. Subsequently, these soils become too exhausted and land productivity drops, which inevitably lowers agricultural productivity.

The study has also established that gender has a positive effect on crop productivity and is statistically significant at 1%. In other words, in a male-headed household, crop productivity increases by 0.07 units. Similarly, Nkonya (2004) and Charoenratana and Shinohara (2018) found that male-headed households were generally stricter in ensuring family members participated in agricultural activities than female-headed ones. Correspondingly, males had more access to information, improved technology and other resources, than their female counterparts. Mukasa and Salami (2015) similarly found that in three Sub-Saharan African countries of Nigeria, Tanzania and Uganda, agricultural lands managed by females were 18.6, 27.4, and 30.6 percent, respectively, less productive than those overseen by males. Even though in Sub-Saharan Africa women account for 50 percent of the agricultural labour force, the plots managed by women emerged to be 20 to 30 percent less productive (Ali et al, 2015).

Overall, empirical results affirm that land ownership security significantly affects agricultural productivity in Tanzania. Other variables such as gender, farm size, education, and improved agricultural technologies also influence agricultural productivity.

5.0 Policy implications and Recommendations

The main thrust of this paper was to investigate the effect of land ownership security on agricultural productivity. Based on the evidence examined, the paper affirms that land ownership security is a significant factor in boosting agricultural productivity. Moreover, the paper signals other significant factors positively associated with productivity to include gender, farm size, education, and improved agricultural technologies. As such, promoting legal land ownership associated with other significant factors such as gender equality, access to education, and access to improved agricultural technologies, should be a policy target in Tanzania, as it has the potential of contributing meaningfully to increased agricultural productivity and enhanced food security at the household level.

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