African Journal of Rural Development, Vol. 7 (1): January-April 2022: pp. 20-37. ISSN 2415-2838

Influence of land tenure security on household food security among small holder farmers in Narok County, Kenya

J. J. MBUDZYA,* E. O. GIDO. and G. OWUOR
Department of Agricultural Economics and Agribusiness Management, Egerton University, P.O.Box 536-20115, Egerton, Kenya
*Corresponding Author: jabujoseph@gmail.com

ABSTRACT

A secure tenure over agricultural land is crucial in efforts aimed at improving the livelihoods of rural people. However, empirical studies to validate this statement are still limited especially in Sub Saharan Africa. This study analysed the influence of land tenure security on household food security among small holder farmers in Narok County, Kenya. The study used cross-sectional data collected from 366 small holder farmers obtained from a multistage sampling procedure. Endogenous switching regression (ESR) model was used to obtain econometric results for this study. Household food security was measured by food consumption scores and the ESR model results show that, household food security status was influenced by marital status, education level and age of the household head as well as household size, household income, maize productivity, number of contacts with extension agent, access to credit, and ownership of an ox. Land tenure insecure households would increase their food security by 38% if they were land tenure secure while land tenure secure households would have decreased food security status by 4% if they were land tenure insecure. Therefore, land tenure security increased household food security. The findings call for enactment of policies and strategies that would facilitate access to secure ownership and transfer land rights by rural farming households thereby encouraging farm investments for improvement of household food security.

Key words: Endogeneity, endogenous switching, food consumption score, Kenya, land rights, land tenure security, self-selection

RÉSUMÉ

Une tenure foncière sécurisée sur les terres agricoles est cruciale dans les efforts visant à améliorer les moyens de subsistance des populations rurales. Cependant, les études empiriques pour valider cette affirmation sont encore limitées, en particulier en Afrique subsaharienne. Cette étude a analysé l'influence de la sécurité de la tenure foncière sur la sécurité alimentaire des ménages parmi les petits agriculteurs du comté de Narok, au Kenya. L'étude a utilisé des données transversales collectées auprès de 366 petits agriculteurs obtenues à partir d'une procédure d'échantillonnage à plusieurs niveaux. Le modèle de régression à commutation endogène (ESR) a été utilisé pour obtenir les résultats économétriques de cette étude. La sécurité alimentaire des ménages a été mesurée par des scores de consommation alimentaire et les résultats du modèle ESR montrent que l'état de sécurité alimentaire des ménages était influencé par l'état civil, le niveau d'éducation et l'âge du chef de ménage, ainsi que la taille du ménage, le revenu du ménage, la productivité

Cite as: Mbudzya, J.J., Gido, E.O. and Owuor, G. 2022. Influence of land tenure security on household food security among small holder farmers in Narok County, Kenya. *African Journal of Rural Development* 7 (1): 20-37.

Received: 29 January 2021
Accepted: 28 November 2021
Published: 30 April 2022

du maïs, le nombre de contacts avec un agent de vulgarisation, l'accès au crédit et la propriété d'un bœuf. Les ménages dont la tenure foncière était incertaine augmenteraient leur sécurité alimentaire de 38% s'ils avaient une tenure foncière sécurisée, tandis que les ménages dont la tenure foncière était sécurisée verraient leur état de sécurité alimentaire diminuer de 4% s'ils avaient une tenure foncière incertaine. Par conséquent, la sécurité de la tenure foncière augmentait la sécurité alimentaire des ménages. Les résultats appellent à l'adoption de politiques et de stratégies facilitant l'accès à la propriété sécurisée et au transfert des droits fonciers par les ménages agricoles ruraux, encourageant ainsi les investissements agricoles pour améliorer la sécurité alimentaire des ménages.

Mots clés : Endogénéité, commutation endogène, score de consommation alimentaire, Kenya, droits fonciers, sécurité de la tenure foncière, auto-sélection

INTRODUCTION

Globally, food insecurity has been a major challenge and policy issue. Majority of the policies in the developing countries have been aimed at improving agricultural productivity to ensuring food security. Out of the 768 million people who are food insecure globally, about 600 million are found in Africa, Asia and Latin America (FAO *et al*., 2022). Additionally, close to 600 million people are projected to be food insecure by 2030 (Lawry *et al*., 2017). This underscore the challenge of achieving the Sustainable Development Goals (SDG) number two of achieving zero hunger by 2030. It is estimated that more than 1.1 million people in Kenya are in acute food insecurity crisis stage and the number is expected to rise up to 3.5 million in the next half of 2022 (WFP, 2022). The world population is projected to be at 9.3 billion mark by 2030, therefore the world's food production must increase by approximately 70% in order to meet the growing food demand (FAO *et al*., 2021). According to Lawry *et al*. (2017), land tenure insecurity is identified as one of the major causes of food insecurity since majority of the resource poor small-holder farmers are the main food producers in third world countries such as Kenya. The study defines small holder farmer as one who farms on less than 5 hectares of land.

Land tenure security and food security have conventionally been viewed as distinct subjects. This is because land tenure security is primarily seen as using legal and institutional angle while food security is explained using economic, social and bio-medical terminologies (Maxwelll and Wiebe, 1999). In addition, research on land tenure security especially in developing countries is faced with variations and complexities associated with land tenure systems (Holden and Ghebru, 2016). The policy significance of the linkage between land tenure security and food security is further emphasized by the increasing land scarcity especially in poor countries who face climate related risks (Godfray *et al*., 2010; Holden and Otsuka, 2014). However, their definitions indicate close conceptual linkages. Land tenure security occurs when someone has unlimited rights of access to and use of land due to social, legal systems, and governing institutions (Holden and Ghebru, 2016). Food security on the hand is defined as "a situation when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life" (FAO, 1996). Therefore, in conceptual terms, the contribution of land tenure security on food security occurs when people have secure access to land and related resources such as forests, rivers, and lakes. The resources would enable them to produce enough food for their own consumption or sale to get income that could be used to buy food. The linkage can also be manifested by the relationship between land tenure security, resource use, agricultural productivity, and income generation (Ghebru

and Holden, 2013; Mendola and Simtowe, 2015; Lovo, 2016).

Land tenure security is key in the achievement of poverty reduction, food, and nutritional security for rural households whose livelihood depends on agriculture (Higgins *et al*., 2018). Similar findings by Espinosa (2019) indicates that there is a 3.2% significant increase in food availability for families with secure land tenure than those with insecure land tenure. Land tenure security reduces incidences of land disputes, promotes use of land as a collateral for credit facilities, and encourages both short term and long term investments that would increase productivity and incomes (Linkow, 2016; Lovo, 2016). ANGOC (2017) noted that land tenure security stimulates investments in agriculture as well as reduces unfair land expropriation and forced migration thus increasing households' resilience. Ajefu and Abiona (2020) argue that food security is not only affected by climatic and weather conditions but also land tenure security. However, recent literature on the linkage between land tenure security and food security has been conflicting (Payne *et al*., 2016). Kenny-Lazar (2016) argues that, persons with land tenure insecurity, may still be food secure if they have access to employment opportunities due to higher education levels. Research by Bamire (2010) indicates that land tenure security had no significant effect on household food security. Land titling did not have an impact on land investment (Besley, 1995; Deininger and Castagnini, 2006; Deininger and Jin, 2006). Moreda (2018) in Ethiopia suggests that, land tenure insecurity doesn't contribute to land degradation but rather limited access to other resources such finance. Other studies such as Migot-Adholla *et al*. (1994) and Pinckney and Kimuyu (1994) found no significant effect of land titling on agricultural productivity. In most developing countries, food security is associated with a particular crop.

In Kenya, maize farming plays a vital role in the overall contribution to food security. Maize (*Zea mays*) is one of the major cereal crops in the world, ranked third after rice and wheat (Mekureyaw, 2017). It is the most widely cultivated cereal grain in Africa and is considered a staple food (Nagarajan *et al*., 2019). In Kenya, it is considered as both a food security and the main staple food crop hence its inclusion in this studywas deemed necessary. Previous studies by GoK (2021) have shown that, maize productivity has been on the decline. Land tenure insecurity has been cited as one of the key contributors to conflict, low land investments, and low maize productivity (Mekureyaw, 2017). Despite the importance of land tenure security on food security as highlighted, there is limited literature on this crucial subject especially in Sub Saharan Africa. Thus, to bridge this knowledge gap, the study seeks to answer a key research question on whether land tenure security influences household food security. This is expected to provide empirical evidence on the influence of land tenure security on household food security in Narok, county, Kenya.

Conceptual framework. Conceptually, the main causes of land tenure insecurity are encroachment and grabbing of land by private investors or reallocation by government. According to Holden *et al*. (2013) land rights can be categorized into three namely; user rights, transfer rights and mortgaging rights. However, in this study, land rights are broadly grouped into two, that is user rights and transfer rights because mortgaging rights as mentioned by Holden *et al*. (2013) may involve the transfer of land rights from one party another hence can still be classified under the transfer rights. User rights include; right to choose which crop to grow, the right to do land fallowing, right to develop the land, right to dispose of crop produce after harvesting, and the right to prevent others from using such as grazing. On the other hand, transfer rights are the right to give land under customary line, right to inherit land, right to lease or rent land, right to sell the land, and the right to mortgage.

Transfer rights such as the right to rent or lease or right to sell may have restrictions and therefore affect the functionalities of land markets. Furthermore, such restrictions also affect who is allowed to produce on the land, or whether they will produce only for home consumption, for the market or both. This therefore affects the

food security of both the users and owners. Additionally, it affects the supply of food in the market. In the presence of well-defined and stronger user rights, rights holders are more likely to increase their investments on the land and thereby increase productivity. Since most of the rural dwellers are small holder farmers and food is the main product producing mainly for home consumption and the remaining for the market, enhancing their rights would more likely improve their food security status. Land can also be used as a collateral to access credit facilities in financial institutions. If the credit is invested on the land, it is more likely to increase agricultural productivity and also food security. In addition, to land tenure security, household food security is affected by other socio-economic, land and institutional characteristics such as age, marital status, education level of the household head, household size, land and parcel size, land access, group membership, market access among other factors.

RESEARCH DESIGN

Study area and sampling procedure. The study was carried out on 366 randomly selected farming households in Narok county, Kenya. The county consists of six (6) sub-counties and 30 wards. According to the KNBS (2019) the county population is approximately 1,057,873 persons with a gender ratio of 1:1. Land ownership in the county is categorized into three (3); community, trust, and private land. In order to select the respondents, the study used a multistage sampling procedure. Firstly, a purposive selection of Narok county was done due to the high incidences of land tenure insecurity related conflicts (Kariuki *et al*., 2016). Secondly, two sub counties (Transmara West and Transamara East) were chosen because of the highest reported cases of land based conflicts in the county. Thirdly, two wards were chosen in each sub county since they had the highest number of small holder farmers in the respective sub-counties (CGN, 2018). Lastly, to obtain the 366 small holder respondents, every 5th person on an alphabetically arranged list of 2000 eligible small holder farmers obtained from the county agricultural offices was chosen. The sample size per ward was based on proportionate to the size of the small holder farmers in the respective ward. Data were collected using questionnaires installed in Open Data Kit (ODK) software while data analysis were done using Stata 15 computer software (Stata Corp, 2014).

Analytical Framework

Measurement of key variables . The study used household food security as the dependent variable and land tenure security as the main independent variable. Household food consumption score (HFCS) was used to measure household food security. HFCS is a 7-day recall period method that captures the degree and frequency of consumption of 12 food groups (Kennedy *et al*., 2010; Wekesa *et al*., 2018). A higher score represents a higher food security status. The longer reference period allows for capturing of wide range of food groups consumed hence the best indicator of food security (Wekesa *et al*., 2018). HFCS was used as a continuous variable. Food security can be analysed at different levels such as individual, household or regional. This study used the household level since it is the institution used by most rural dwellers to gain access to both food and other resources such as land. In addition, the household head is likely to be a key decision maker on matters production, consumption and investment as suggested by Mallick and Rafi (2010), Kassie *et al*. (2014) and Tibesigwa and Visser (2016).

In order to measure land tenure security, the study employed a composite measure consisting of various rights over the land. Security of land tenure can be assessed using three dimensions: user rights, transfer rights, and the autonomy given to the holders of rights, specifically the transfer rights (Brasselle *et al*., 2002). In achieving this purpose, the study used ten indicators of land rights categorized into two broad categories (right to use and right to transfer) (Table 1). The study adopted Brasselle *et al*. (2002) approach that appreciates the

different weights each right possesses as opposed to assigning equal weight to all the rights as suggested by Place (2009). In this approach, respondents were asked whether they had a permanent, transitory (temporary), or none of the user rights while on transfer rights, they were asked whether, they required approval from someone else or not.

The indicators of land user rights are as follows; (i) choice of crop to grow, (ii) land fallowing and cultivation at the end of fallow period, (iii) make land developments, (iv) dispose of crop produce, and (v) prevent people's livestock from grazing on the land. On land transfer rights, respondents were asked if they required any approval from someone else to enjoy the following indicators of rights of land transfer (vi) give land along customary lines, (vii) transfer land as an inheritance, (viii) lease land in exchange for cash, (x) sell land, and (xi) mortgage the land. All the indicators of user and transfer rights were measured as dummy variables. These rights capture the existing concerns relating to land tenure security that may affect investment.

Table 1 presents the frequency distribution results of the various land rights (to use and transfer) held by the respondents in the study area. Among the sampled households, choice of crops to grow (97.81%), land development (91.80%), and the right to prevent grazing (92.62%) were the most common rights, hence could not to be used in categorization. On the other hand, prevalent transfer rights were inheritance right (77.87%), followed by right to lease land (68.85%), right to give land along customary lines (65.03%), right to sell the land (60.38%), and lastly right to mortgage (60.65%). Thus only two user rights; right to land fallowing (81.97%) and right to dispose of crop produce after harvesting (86.34%), in addition all the transfer rights were used to create categories since they exhibited sufficient variations.

Table 1. Frequency distribution table of sampled households based on possession of the various land rights

Type right	%	Type of right	%
(i) Choice of crop to grow		(vi) Give land also customary line	
No right	2.19	No right	34.97
Temporary right	14.75	Without Approval	39.07
Permanent right	83.06	With Approval	25.96
(ii) Land fallowing		(vii) Inherit land	
No right	18.03	No right	22.13
Temporary right	13.39	Without Approval	51.09
Permanent right	68.58	With Approval	26.78
(iii) Land development		(viii) Rent or lease land	
No right	8.20	No right	31.15
Temporary right	17.21	Without Approval	40.98
Permanent right	74.59	With Approval	27.87
(iv) Dispose of crop produce		(ix) Sell land	
No right	13.66	No right	39.62
Temporary right	12.84	Without Approval	31.69
Permanent right	73.50	With Approval	28.69
(v) Prevent grazing		(x) Mortgage land	
No right	7.38	No right	39.35
Temporary right	12.84	Without Approval	28.96
Permanent right	79.78	With Approval	31.69
Total	100.00	(366 households)	100.00

To differentiate between secure and insecure land tenure households, two (2) categories, secure land tenure and insecure land tenure were derived from the data hence making the land tenure security (LTS) a binary variable. Category 1 (land tenure insecure) if they do not hold any transfer rights or only hold right inherit and right to give land along traditional lines or one of the two rights and don't hold more than two user rights (whether permanent or transitory) or do not hold the latter two rights (or one of them) or have at least two permanent or transitory user rights in addition to rights (i), (iii) and (v). Category 2 (land tenure secure) if apart from the rights to inherit and to give land along customary line, they hold rights to rent or lease land, to sell land, to mortgage land (with or without approval), and at least two permanent rights of use in addition to rights (i), (iii) and (v). This approach allows for capturing of the different roles of land tenure security alternatives for rural dwellers (Brasselle *et al*., 2002).

Model Specification

The study used endogenous switching regression (ESR) to analyse the influence of land tenure security on household food security. The endogenous switching probit regression method was modelled in two stages as illustrated by Di Falco *et al*. (2011). Stage one involved analysing the determinants of land tenure security. In this stage, a probit model was used since land tenure security was measured as a binary variable (secure land tenure =1 and insecure land tenure= 0). Stage two was the analysis of the effect of land tenure security on food security estimated separately for both households with secure land tenure and those with insecure land tenure. The effect of land tenure security on food security was modelled following the utility maximization approach. In the approach, it was assumed the following; U_{i1}^{*} represents the latent variable of the expected utility that i^{th} household derives by having secure land tenure compared to one who has insecure land tenure U_{i0}^{*}. Household land tenure security occurs if net benefits outweighs the net costs, that is $C_i^{*} = U_{i1}^{*} - U_{01}^{*} > 0$. C_i^{*} is a function of latent variables determined by socio-economic, land related, and institutional characteristics and the residual term as represented in equation 1.

$$C_i^{*} = X_i^{*}\beta + \mu_i .. \qquad (1)$$

$$\begin{bmatrix} C_i = 1 \; if \; C_i^{*} > 0 \\ = 0 \; if \; C_i^{*} \leq 0 \end{bmatrix} \qquad (2)$$

where *C* is a binary variable which takes a value of 1 if the household is land tenure secure and 0 if the household is land tenure insecure. β is a vector of unknown parameters to be estimated in the model while *X* is a vector of explanatory variables and μ represents error term with a mean of 0 and variance of δ^2. Since land tenure security affects household food security, let the household food security be *(Y)* which is a function of other factors, J_i is the vector of the exogenous variables. Equation 2 presents the criterion of a household being land tenure secure or otherwise. In the ESR, the study used two separate models (regimes) for those with secure and insecure land tenure as expressed in equations 3 and 4.

$$Y_{1i} = \alpha_1 J_{1i} + \varepsilon_{1i} \text{ if } G_i = 1 \qquad (3)$$

$$Y_{0i} = \alpha_{01} J_{01i} + \varepsilon_{0i} \text{ if } G_i = 0 \qquad (4)$$

where variables Y_1 and Y_0 represent household food security under secure land tenure and insecure land tenure respectively. J_1 and J_0 are vectors of independent variables explaining the outcome variables Y_1 and Y_0. Y_1 and Y_0 are observable based on the criteria presented in equation 2. Ordinary Least Square (OLS) estimates was biased as the study suffered from sample selection bias and the errors ε_{1i} and ε_{0i} conditional to the sample selection criterion had a non-zero value (Lee and Trost, 1978; Maddala, 1983). The error terms, μ ε_1 and ε_0 are assumed to have a tri-variate normal distribution with a 0 mean and non-singular covariance matrix Σ that is $(\mu, \varepsilon_1, \varepsilon_0)' \approx N(0, \Sigma)$ as shown in equation 5.

$$\text{With } \Sigma = \begin{bmatrix} \sigma_{\varepsilon 1}^2 & \sigma_{\varepsilon 1\varepsilon 0} & \sigma_{\varepsilon 1\mu} \\ \sigma_{\varepsilon 1\varepsilon 0} & \sigma_{\varepsilon 0}^2 & \sigma_{\varepsilon 0\mu} \\ \sigma_{\varepsilon 1\mu} & \sigma_{\varepsilon 0\mu} & \sigma_{\mu}^2 \end{bmatrix} \quad (5)$$

where σ_{μ}^2 represent the variance of the error in the criterion equation 1 assumed to be equal to 1 since according to Maddala (1983) the coefficients are estimated up to a scale factor. $\sigma_{\varepsilon 1}^2$, and $\sigma_{\varepsilon 0}^2$ represents the variance of ε_1 and ε_0 respectively in outcome equation in 3 and 4 respectively. The values $\sigma_{\varepsilon 1\mu}$ and $\sigma_{\varepsilon 0\mu}$ are the covariance of error terms μ, ε_1 and ε_0 . As suggested by Maddala (1983), the outcome of equation 3 and 4 is not observed simultaneously and hence the covariance between and are not defined. Since the error μ of equation 1 is correlated with the error terms of the outcome equation 3 and 4, the expected values of the error terms were not equal to zero given the sample selection bias as expressed in equations 6 and 7.

$$E[\varepsilon_{1i} | G_i = 1)] = \sigma_{\varepsilon 1\mu} \frac{\phi(\beta X_i / \sigma)}{\phi(\beta X_i / \sigma)} \equiv \sigma_{\varepsilon 1\mu} \lambda_{1i} \quad (6)$$

$$E[\varepsilon_{0i} | G_i = 0)] = -\sigma_{\varepsilon 0\mu} \frac{\phi(\beta X_i / \sigma)}{1 - \phi(\beta X_i / \sigma)} \equiv \sigma_{\varepsilon 0\mu} \lambda_{0i} \quad (7)$$

where ø (.) and ø (.) represent the standard normal probability density function and normal cumulative density respectively. λ_{1i} and λ_{0i} is the inverse mills ratio representing the estimated ratio of ø (.) and ø (.) estimated at. If $\sigma_{\varepsilon 1\mu}$ and $\sigma_{\varepsilon 0\mu}$ are statistically significant, then, land tenure security and household food security were correlated hence evidence of endogeneity and presence of sample selection bias (Maddala and Nelson, 1975). Asfaw *et al.* (2012) suggest that, maximum likelihood estimation is an efficient method of estimating ESR. Considering the assumption of logarithmic likelihood function, the error distribution in equation 1, 3 and 4 can be expresses as in equation 8

$$LnL = \sum_{i=1}^{N} G_i \left[\ln \phi(\frac{\varepsilon_{1i}}{\sigma_{\varepsilon 1}}) - \ln \sigma_{\varepsilon 1} + \ln \Phi(\phi_{1i}) \right] \cdot$$
$$+ (1 - G_i) \left[\ln \phi(\frac{\varepsilon_{0i}}{\sigma_{\varepsilon 0}}) - \ln_{\varepsilon 0} + \ln(1 - \Phi(\phi_{0i})) \right]$$

where $\phi_{ji} = \frac{(\beta X_i + y_j \varepsilon_{ji} / \sigma_j)}{\sqrt{1 - y_j^2}}$, j=0,1 with representing the correlation coefficient between the error term (μ_i) of the criterion model in equation 1 and the errors (ε_{ji}) of the outcome equations 3 and 4.

Conditional expectations, treatment and heterogeneity effects. Since, ESR has the ability to estimate the effect of a variable for actual and counterfactual conditions as suggested by Di Falco *et al*. (2011), the study estimated the expected and counterfactual household food security under the two regimes. That is comparison of the expected household food security of the land tenure secure households (equation 9) with respect to the land tenure insecure household (equation 10) and to analyse the expected household food security in the counterfactual hypothetical (equation 11)) that the land tenure secure households are land tenure insecure, and (equation 11) that the land tenure insecure households are land tenure secure. This is the decision stage of the model. The observed household food security and counterfactual conditions are represented by equations 9, 10, 11 and 12.

$$E(y_s | A_i = 1) = X\beta_s + \sigma_{s\eta} \lambda_s \quad (9)$$

$$E(y_{ns} | A_i = 0) = X\beta_{ns} + \sigma_{ns\eta} \lambda_{ns} \quad (10)$$

$$E(y_{ns} | A_i = 1) = X\beta_{ns} + \sigma_{ns\eta} \lambda_{ns} \quad (11)$$

$$E(y_s | A_i = 0) = X\beta_s + \sigma_{s\eta} \lambda_s \quad (12)$$

Cases 9 and 10 along the diagonal of Table 2 show the actual observed expectations in the selected sample while cases 11 and 12 are the counterfactual expected outcomes.

Table 2. Treatment and heterogeneity effects

Sub-samples	Decision stage		Treatment effects
	Secure land tenure	Insecure land tenure	
Secure land tenure households	(9) $E(y_s \mid A_i = 1)$	(11) $E(y_{ns} \mid A_i = 1)$	TT
Insecure land tenure households	(12) $E(y_s \mid A_i = 0)$	(10) $E(y_{ns} \mid A_i = 0)$	TU
Heterogeneity effects	BH_1	BH_2	TH

where;
$A_i = 1$ is if households were land tenure secure while $A_i = 0$ is if households were land tenure insecure$y_s$represents household food security for land tenure secure households whereas $y_{ns}$is the household food security for land tenure insecure households. On the treatment effects column, TT refers to the effect of treatment on the treated, TU denoted the effect of treatment on the untreated,$BH_1$is the effect of base heterogeneity for land tenure secure households, BH_2 is the effect of base heterogeneity for land tenure insecure households, and TH =(TT-TU), the transitional heterogeneity.

In Table 2, the effect of treatment of the treated (TT) refers to the difference between expected value of the household food security (outcome variable) for land tenure secure households and the expected value of household food security if they were land tenure insecure (cells 9 and 11). The effect of treatment on the untreated (TU) is the difference between the expected household food security for land tenure insecure households and the expected value of household food security if they were land tenure secure (cells 12 and 10). Study used exclusion restrictions as instruments for the model to be identified. This is in addition to the already generated from the selection model of determinants of land tenure security. For instruments to be valid they must be directly correlated with endogenous/selection variable (land tenure security) but not outcome variable (household food security) (Di Falco *et al*., 2011). Study used number of years' household had stayed on the land and the number of years the household had stayed on the ward as instruments in the model. A falsification test was carried out to determine the validity of the instruments and results presented in Appendix 1. Results show the selected instruments were valid since they are jointly significant determinants of land tenure security(model 1; X^2= 34.29; p=0.00) however they were not significant determinants of household food security as shown in Model 2 (F-statistics=5.25, p =0.000) while model 3 (F-statistics=5.38, p =0.00).

Results and Discussion

Results in Table 3 show that, on average, household heads in land tenure secure category were significantly older compared to those in the land tenure insecure category. Furthermore, land tenure secure households had fewer household members and more land than land tenure insecure households. Moreover, land tenure secure household heads had stayed on the land for more years and the household heads walked for more minutes to reach their parcels of land than land insecure households. Additionally, household heads from land tenure secure category reported higher food security and higher maize productivity levels compared to those with insecure land tenure. Majority of households with secure land tenure owned oxen an indication of availability of farm labour. Households heads from the land tenure category also acquired land through purchase and had fertile land.

Effect of land tenure security on household food security. Endogenous switching regression model results consist of two parts. The first part is the decision stage on the determinants of land tenure security as presented in Table 4.The second part is the effect of land tenure security on household food security as presented in Table 5.

Determinants of land tenure security. In order to take care of the possible endogeneity, the study used ESR model. Table 4 represents results of the first stage of the ESR model on the determinants of land tenure security. Household size, land acquisition through purchase, land fertility, period the household has stayed on the land, and walking time between the homestead and the parcel in minutes were found to be significantly influencing land tenure security. An increase in the household size by one member reduces the likelihood of being land tenure secure. More members in the household may translate to increase in incidences of land sub-division hence making it difficult to secure land (Valkonen, 2021). As the number of household members increase, the power to

Table 3. Description and measurement of variables used in the study

Variable Name	Description and measurement of variables	Insecure LT	Secure LT	Significance
Continuous variables		***Mean***		***t-statistic***
Age	Age of the household head in years	38.099	42.134	-3.343***
Education level	Years of schooling of the household head	8.331	8.754	-1.003
Household size	Number of people in the household	4.880	4.330	2.959***
Land stay	Number of years household has stayed on the land	14.268	18.058	-3.057***
Ward stay	Number of years household has stayed in the ward	26.662	27.103	-0.268
Land size	Total land size in Ha	1.347	1.838	-3.119***
Market access	Walking time from homestead to the nearest market in minutes	37.986	39.045	-0.326
Parcel access	Walking time from the homestead to the parcel in minutes	2.787	4.255	-4.639***
Road access	Walking time from the homestead to the nearest tarmac road in minutes	10.373	11.416	-1.110
Extension contacts	Number of contacts the respondent had with an extension agent	1.193	1.398	-1.491
Household food security	Level of food security	55.257	59.217	-2.226***
Maize productivity	Productivity of maize (Kg/Ha)	2309.972	2594.835	-2.137***
Household income	Total household income in KES	241567.700	266127.500	-1.117
Categorical variables		***Percentage***		X^2
Land tenure security	% of respondents as per the land tenure security category	38.800	61.200	
Sex	% of male decision makers	19.010	24.110	1.308
Marital status	% of married decision makers	70.420	69.200	0.062
Community leadership	% of household heads with community leadership	13.3800	16.960	0.849
Oxen ownership	% of respondents owning an oxen	10.560	22.320	8.226***
Credit access	% of respondents with access to credit	45.070	45.540	0.008
Group membership	% of respondents who are members of at least one group	71.130	76.790	1.468
Land concentration	% of respondents with land concentrated in one area	99.300	96.880	2.382
Land acquisition	% of respondents who acquired land through purchase	12.680	28.570	12.630***
Land topography	% of respondents with a hilly land	32.390	39.290	1.778
Land dispute	% of respondents with land disputes	9.860	10.710	0.068
Land fertility	% of respondents with fertile land	64.080	76.790	6.932***

*** represents significance level at 1%

control ownership of land reduce hence more likely to have insecure land tenure. However, in contrast to this finding, Ghebru and Lambrecht (2017) argue that, an increase in the members in the household may mean increase in food requirements hence may signal the household heads to secure the land so as to provide for their families.

Household who acquired land through purchase were more likely to be land tenure secure. The land purchasing process especially in areas with developed land markets is a structured and legal process hence after the process, there is likely to be security of land tenure. However, corruption by land markets participants such as government officials may pose a threat to the trust accorded to the land buying process (Djurfeldt, 2020). Land fertility also positively and significantly influenced land tenure security. Ownership of a fertile land increases the probability of household being land tenure secure. Fertile land is usually competitive in the land market and therefore owners are more likely to secure it to safeguard it from land grabbers. Coulibary (2021) argue that, due to the expected high productivity from fertile land, holders would secure it to maintain its stream of benefits.

Farmers who have stayed longer on the land are more likely to be land tenure secure. The longer a person stays on the land, the more likely they are to make investments such as planting trees. These investments may increase land tenure security. In areas using customary land tenure, land holders who have stayed longer on the land are viewed as part of the community and hence become more land tenure secure (Brasselle *et al*., 2002). Land tenure security was also influenced by the access to the parcel of land. The more time it takes to reach the parcel from the homestead, the more land tenure secure it is. Distant parcels are more exposed to land grabbers and hence it's reasonable to secure it. Sitko *et al*. (2014) argue that, in scenarios where the owners are not seen on the land for some time due the long distance, people tend to

Table 4. Results of the determinants of land tenure security (first stage of ESR)

Variables	Standard Error	Coefficients
Socio-economic characteristics		
Sex	0.201	0.136
Marital status	0.181	-0.104
Age	0.0085	0.006
Education level	0.023	0.0101
Household size	0.044	-0.128***
Household income	3.871	2.071
Maize productivity	0.000059	4.871
Institutional characteristics		
Community leadership	0.218	-0.066
Land related characteristics		
Land size	0.046	0.048
Land concentration	0.617	-0.306
Land acquisition	0.188	0.762***
Land topography	0.157	0.082
Land dispute	0.240	0.106
Land fertility	0.175	0.387**
Land stay	0.0088	0.019**
Parcel access	0.034	0.155***
Model fit results		
Constant	0.807	-0.597
Number of observations		366
Log likelihood		-205.091
Prob>ch^2		0.000

, * represents significance level at 5%, and 1% respectively

assume they are absentee landlords hence grab the land. Thus such landlords are more likely to secure the land.

Effects of land tenure security on household food security. The Wald test results (46.16) in the endogenous switching regression model (Table 5) indicate that is significant at 1% level hence implying a goodness of fit of the model. Additionally, it suggests the presence of endogeneity problem and hence justifying the use of ESR. The likelihood ratio test of independence equations that is the selection and outcome equations (X^2 =3.430, P = 0.0) is positive and significant at 10% indicating that the two equations are positively correlated. This implies that, land tenure security is positively correlated with household food security. The negative and significant (/ro 0= -0.033, P = 0.0; /ro1= -1.017, P = 0.000) coefficients imply that farmer with higher household food security were likely to self-select themselves to be land tenure secure.

Results in Table 5 column 1 and 2 which represents the second stage of the ESR model indicate that, marital status, age, education level, household size, household income, maize productivity, number of contacts with an extension agent, ownership of an oxen, and credit access significantly influenced household food security. Married people were more likely to be food secure than the unmarried ones. Marriage in most African societies is meant support to each other both emotionally and economically and therefore this could lead to improved food security. Similarly, Djangmah (2016) and Amadu *et al*. (2021) argue that, married people pool their resources together hence reduce costs. Additionally, married people are likely to save some resources to help them during times of low income hence smoothen their lives. However, Aidoo *et al*. (2013) and Akukwe (2020) suggest that unmarried people would be more food secure due to their possible smaller household size hence fewer mouths to feed than married people.

Older household heads were more likely to be food secure for both secure and insecure land tenure households. Older farmers may have more experience in food production than the younger ones which would likely increase their food security. Wekesa *et al*. (2018) argue that, older farmers may have accumulated more social and physical capital hence able to adopt latest technologies for food production. However, Kassie *et al*. (2016) suggest that, due to the labour intensive nature of agriculture, which may require healthy and energetic people, older farmers may not be able to produce enough food. Additionally, older farmers may not be aware of the latest production technologies. Older farmers may have reduced the contribution towards welfare contributions such as food security (Yahaya *et al*., 2018; Oluwatayo and Ojo, 2019).

Better educated household heads increase their likelihood of being food secure for the land tenure insecure category. Education exposes individuals to information on better and latest technologies which could increase food production. Similarly, Lutomia *et al*. (2019) argue that better educated people are likely to be more innovative and have more knowledge to access productive resources. Additionally, Fiaz *et al*. (2018) and Habtewold (2018) suggest that educated household heads may be more ready to update their agricultural knowledge and thus improve food security. Household size negatively influence household food security. Larger households reduce the probability of being food secure for the households in land tenure secure category. Increase in household size may mean increase in the number of people to feed and therefore households may likely be food insecure even with secure land tenure. Ogunniyi *et al*. (2018) argue that, households with many members may have other priority expenses and thus lack enough finances to invest in adoption of new agricultural technology to produce food. Larger households may indicate higher burden to feed them (Tiwasing *et al*., 2018; Lutomia *et al*., 2019).

Table 5. Results of the ESR model on the effect of land tenure security on household food security (second stage of the ESR)

Variables	Column 1, LTS=0		Column 2, LTS=1	
	Standard Error	Coefficients	Standard Error	Coefficients
Socio-economic characteristics				
Sex	3.543	0.305	2.453	-2.036
Marital status	2.672	4.839*	2.307	7.392***
Age	0.109	0.052	0.099	0.178*
Education level	0.373	0.850**	0.274	0.282
Household size	0.649	-0.073	0.594	-1.179**
Household income	0.0004	-0.0009***	0.274	0.000**
Maize productivity	0.001	0.003***	0.001	0.003***
Institutional characteristics				
Market access	0.037	0.029	0.037	-0.046
Extension contacts	1.102	0.428	0.818	1.956**
Oxen own	3.906	7.046*	2.533	2.111
Group membership	2.723	2.837	2.300	2.730
Credit access	2.403	3.599	1.962	8.621***
Land related characteristics				
Land size	0.758	0.434	0.478	-0.095
Constant	8.631	34.196***	7.253	39.447***
/lns0	0.059	2.567***		0.059
/lns1	0.108	2.827***		0.108
/r0	0.482	-0.033*		0.482
/r1	0.359	-1.017***		0.359
sigma0		13.024		0.772
sigma1	16.901	1.819		
rho0	-0.033	0.481		
rho1	-0.768	0.147		
LR test of independent equations	Chi(2)=3.430*			
Wald chi2(13) 46.16***				

*, **, *** represents significance level at 10%, 5%, and 1% respectively

Increase in household income decreases the likelihood of being food secure for the land tenure secure households while it increased the likelihood of being food secure for the households with land tenure security. For the unsecure land tenure households, they would probably use the increased in income to secure their land instead of food production. Land secure household on the other would invest in modern technologies to increase their food production (Ahmed *et al*., 2017). Ibrahim *et al*. (2016) indicate that, higher incomes can be used to purchase food commodities hence improve food security status. In contrast with the study finding, Habtewold (2018) argues that high income earners may invest in other commercial activities such as horticultural production where prices are highly unstable. Maize productivity also positively and significantly influenced household food security. Higher maize productivity increases the probability of being food secure for both secure and insecure land tenure households. In Kenya maize is considered as a staple food and therefore having more maize imply being food secure. Increased maize productivity translates to increased food on the table and hence increased food security (Santpoort, 2020).

Increase in the number of contacts with an extension agent positively influences the secure land tenure farmer's likelihood of being food secure. More contacts with an extension agent could increase the farmers' knowledge on the latest agricultural technologies which may be used to increase food production. Extension services are key in promotion of farmer innovative technologies and awareness creation on how to implement dietary needs for the nation (Fiaz *et al*., 2018). Al-Shayaa *et al*. (2012) indicate that extension agents have a role in advocating government policies geared towards the fight against food insecurity through advocating for the use of modern agricultural technology, and access to affordable credit and inputs.

Oxen ownership by the land tenure unsecure households increases their likelihood of being food secure. Oxen is a source of agricultural labour in the rural areas hence increase food production. Similarly, Mohammed and Mohammed (2021) found out that, oxen could be used to cultivate land and carry out other farm operations hence a key component in improving household food security. Additionally, oxen in some societies can be hired out to provide income that could be used to purchase food (Habtewold, 2018; Awoke *et al*., 2022).

The land tenure secure households with access to credit facilities were more likely to be food secure. Credit obtained could be used to invest in new agricultural technologies meant to boost food production in the household. Contrary to the study findings, Ibrahim *et al*. (2016) and Lutomia *et al*. (2019) argue that, credit may lead to food insecurities since a significant part of the household income may be used for repayment instead of purchasing food.

Endogenous switching regression impact estimates. Results of estimates for the average treatment effects on the treated (ATT), average treatment effects for the untreated (ATU) and heterogeneity effects (HE) are shown in Table 6. The results present the effect of land tenure security on household food security and also the effects of inherent characteristics of household food security. Results of the casual effects (TE) of food consumption score for land tenure secure household are approximately 2.273 and about 20.996 for insecure land tenure households if they were land tenure secure. Results of the expected household food security under actual and counterfactual scenarios for land tenure secure households are cells (a and c) and land tenure insecure households cells (d and b). The expected household food consumption score by land tenure secure households is about 59.247 and 55.371 for the land tenure insecure households. Such a simple comparison may lead to inaccurate conclusions that, land tenure security increases household food security by about 7%.

The treatment effects for land tenure security on household food security are presented in the treatment effects column. In the counterfactual side cell c for land tenure secure households, the household food consumption score would have been approximately 56.973 representing about 4% decrease, if they

were land tenure insecure. On the other hand, land insecure household's food consumption score would have increase to approximately 76.337 representing an increase of about 38% if they would have been land tenure secure. These results indicate land tenure security significantly increases household food security. The results are consistent with findings by Keovilignavong and Suhardiman (2020) who urged that, secure land tenure enables farm households to acquire credit facilities which would be invested on the farm hence increase food security. Similarly, Espinosa (2019) suggests that, land tenure secure household are more likely to carry out both long and short term farm investments that would increase their productivity hence increase food security.

CONCLUSION AND RECOMMENDATIONS

In conclusion, land tenure security improved the household food security status of the small holder farmers in the study area. This paper therefore contributes to the on-going debate on land governance in the following ways; Firstly, it re-focuses the attention of land sector stakeholders such as researchers and government not just view land title deed as a panacea to land insecurity challenges but realize that rights to use and transfer of land can also play a critical role in shaping land tenure security landscape especially in the rural areas. Secondly, it unpacks the nexus between land tenure security and food security while identifying the rural farm household's position in the linkage. Thirdly, the paper employs an innovative econometric model (endogenous switching regression model) to analyse the role of land tenure security on household food security while taking care of the possible self-selection and endogeneity problems. This will in turn assist future researchers in identification and solving endogeneity and self-selection problems. Lastly, from a policy point of view, it calls for government and other stakeholders to broaden the view that land is not just a physical space but it's a factor of production with significant implications on the welfare of rural communities.

Table 6. Average treatment effects on the treated (ATT) and average treatment effects for the untreated(ATU)

Sub-samples	Decision stage		Treatment effects	t-value
	Secure land tenure	Insecure land tenure		
Households with secure land tenure	(a) 59.247	(c) 56.973	2.273***	3.926
Households with insecure land tenure	(d) 76.337	(b) 55.371	20.966***	33.350
Heterogeneity effects	-17.090	1.602	-18.693	

*** represents significance level at 1%

ACKNOWLEDGEMENT

The authors express their gratitude to the German Academic Exchange Service (DAAD) through the African Economic Research Consortium (AERC) for funding this study.

STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

REFERENCES

Ahmed, U. I., Ying, L., Bashir, M. K., Abid, M. and Zulfiqar, F. 2017. Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PloS One* 12 (10): 1–15.

Aidoo, R., Mensah J. O. and Tuffour T. 2013. Determinants of household food security in the Sekyere-Afram Plains District of Ghana. pp. 514-521. In: 1st Annual International Interdisciplinary Conference, AIIC, Proceedings, Azores, Portugal

Ajefu, J. B. and Abiona, O. 2020. The mitigating impact of land tenure security on drought-induced food insecurity: Evidence from Rural Malawi. *Journal of Development, Studies* 56 (12): 2169-2193. doi:10.1080/00220388.2020.

1762862

Akukwe, T. I. 2020. Household food security and its determinants in agrarian communities of southeastern Nigeria. *Agro-Science* 19 (1): 54-60.

Al-Shayaa, M. S., Baig, M. B. and Straquadine, G. S. 2012. Agricultural extension in the Kingdom of Saudi Arabia: Difficult present and demanding future. *Journal Animal Plant Science* 22 (1): 239-246.

Amadu, I., Seidu, A. A., Duku, E., Okyere, J., Hagan, J. E., Hormenu, T. and Ahinkorah, B. O. 2021. The joint effect of maternal marital status and type of household cooking fuel on child nutritional status in sub-Saharan Africa: analysis of cross-sectional surveys on children from 31 countries. *Nutrients* 13 (5): 1541.

ANGOC. 2017. From the Farmland to the Table: Exploring the Links between Tenure and Food Security. Quezon: Asian NGO Coalition for Agrarian Reform and Rural Development and Global Land Tool Network.

Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L. 2012. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy* 37 (3): 283-295.

Awoke, W., Eniyew, K., Agitew, G., and Meseret, B. 2022. Determinants of food security status of household in Central and North Gondar Zone, Ethiopia. *Cogent Social Sciences* 8 (1): 2040138.

Bamire, A. S. 2010. Effects of tenure and land use factors on food security among rural households in the dry Savannas of Nigeria. African Journal of Food, Agriculture, Nutrition and Development 10 (1):1982-2000.

Besley, T. 1995. Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy* 103 (5): 903-937.

Brasselle, A.-S., Gaspart, F. and Platteau, J.-P. 2002. Land tenure security and investment incentives: puzzling evidence from Burkina Faso. *Journal of Development Economics* 67: 373-418.

Coulibaly, D. A. 2021. An analysis of the Impact of Land Tenure Security on Agricultural Productivity in Burkina Faso. African Economic Research Consortium. 395

County Government of Narok. 2018. Narok County Integrated Development Plan (2018-2022), Nairobi: Government of Kenya.

Deininger, K. and Castagnini, R. 2006. Incidence and impact of land conflict in Uganda. *Journal of Economic Behavior and Organization* 60 (3): 321-345.

Deininger, K. and Jin, S. 2006. Tenure security and land-related investment: Evidence from Ethiopia. *European Economic Review* 50(5): 1245-1277.

Di Falco, S., Veronesi, M. and Yesuf, M. 2011. Does adaptation to climate change provide food security? A micro perspective from Ethiopia. *American Journal of Agricultural Economics* 93 (3): 829-846.

Djangmah, G. M. 2016. Comparative analysis of food security status of farming households in Eastern and Northern Regions of Ghana (Unpublished MSc Project). Department of Agricultural Economics, McGill University, Montreal; Quebec, Canada.

Djurfeldt, A. A. 2020. Gendered land rights, legal reform and social norms in the context of land fragmentation - A review of the literature for Kenya, Rwanda and Uganda. *Land Use Policy* 90: 101-115.

Espinosa-Cristia, J. F., Feregrino, J. and Isla, P. 2019. Emerging, and old, dilemmas for food security in Latin America. *Journal of Public Affairs* 19 (3):1999.

FAO, IFAD, UNICEF, WFP and WHO. 2021. The State of Food Security and Nutrition in the World 2021. Transforming food systems for food security, improved nutrition, and affordable healthy diets for all. Rome, Food Agriculture Organization of the United Nations.

Fiaz, S., Noor, M. A. and Aldosri, F. O. 2018. Achieving food security in the Kingdom of Saudi Arabia through innovation: Potential role of agricultural extension. *Journal of*

the Saudi Society of Agricultural Sciences 17 (4): 365-375.

Food and Agriculture Organization. 1996. Rome declaration on world food security and world food. Rome: Food and Agriculture Organization.

FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Transforming food systems for food security, improved nutrition and affordable healthy diets for all. Rome, Food Agriculture Organization of the United Nations.

Ghebru, H. and Holden, S. 2013. Links between tenure security and food security: Evidence from Ethiopia (No. 02/13). Centre for Land Tenure Studies Working Paper.

Ghebru, H. and Lambrecht, I. 2017. Drivers of perceived land tenure (in) security: Empirical evidence from Ghana. *Land Use Policy* 66: 293-303.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F. and Toulmin, C. 2010. Food security: the challenge of feeding 9 billion people. *Science* 327 (5967):812-818.

Government of Kenya 2021. The national agricultural research systems policy. Ministry of agriculture, livestock, fisheries and cooperatives. Nairobi, Kenya.

Habtewold, T. M. 2018. Determinants of food security in the Oromiya Region of Ethiopia. pp. 39-65. In: Economic growth and development in Ethiopia. Springer, Singapore.

Higgins, D., Balint, T., Liversage, H. and Winters, P. 2018. Investigating the impacts of increased rural land tenure security: A systematic review of the evidence. *Journal of Rural Studies* 61:34-62.

Holden, S. T. and Ghebru, H. 2016. Land tenure reforms, tenure security and food security in poor agrarian economies: Causal linkages and research gaps. *Global Food Security* 10: 21-28.

Holden, S. T. and Otsuka, K. 2014. The roles of land tenure reforms and land markets in the context of population growth and land use intensification in Africa. *Food Policy* 48: 88-97.

Holden, S. T., Otsuka, K. and Deininger, K. 2013. Land tenure reforms, poverty and natural resource management: conceptual framework. pp. 1-26. In: Land Tenure Reform in Asia and Africa. Palgrave Macmillan, London.

Ibrahim, H. Y., Adeola, S. S. and Ibrahim, H. I. 2016. Determinants of food insecurity among farming households in Katsina state, North Western Nigeria: An ordinal logit regression approach. *Journal of Agricultural Sciences* 61 (3): 291–301.

Kariuki, P. M., Njoka, J. T., Saitabau, L. C. and Saitabau, H. S. 2016. Forest Governance, Livelihoods and Resilience: The Case of Loita Forest (Entime e Naimina enkiyio), Narok County, Kenya. Swirtz: Springer International Publishing Switzerland 2016. OI 10.1007/978-3-319-19405-9_6

Kassie, M., Jaleta, M. and Mattei, A. 2014. Evaluating the impact of improved maize varieties on food security in Rural Tanzania: Evidence from a continuous treatment approach. *Food Security* 6 (2): 217-230.

Kassie, M., Zikhali, P., Pender, J. and Kohlin, G. 2016. The economics of sustainable land management practices in the Ethiopian highlands. *Journal of Agricultural Economics* 61: 605–27.

Kennedy, G., Razes, M., Ballard, T. and Dop, M. C. 2010. Measurement of dietary diversity for monitoring the impact of food based approaches. In International symposium on food and nutrition security, Rome.

Kennedy-Lazar, M. 2016. Linking Food and Land Tenure Security in the Lao PDR. Vientiane: Global Association for People and the Environment.

Kenya National Bureau of Statistics. 2019. Kenya Population and Housing Census 2019. Nairobi: Government of Kenya.

Keovilignavong, O. and Suhardiman, D. 2020. Linking land tenure security with food security: Unpacking farm households' perceptions and

strategies in the rural uplands of Laos. *Land Use Policy* 90: 1-11.

Lawry, S., Samii, C., Hall, R., Leopold, A., Hornby, D. and Mtero, F. 2017. The impact of land property rights interventions on investment and agricultural productivity in developing countries: a systematic review. *Journal of Development Effectiveness* 9 (1): 61-81. doi:10.1080/19439342.2016.1160947

Lee, G. H., and Trost, R. P. 1978. Estimation of some limited dependent variable models with application to housing demand. *Journal of Econometrics* 8 (3): 357-382.

Linkow, B. 2016. Causes and consequences of perceived land tenure insecurity: Survey evidence from Burkina Faso. *Land Economics* 92(2): 308-327.

Lovo, S. 2016. Tenure insecurity and investment in soil conservation. Evidence from Malawi. *World Development* 78: 219-230.

Lutomia, C. K., Obare, G. A., Kariuki, I. M. and Muricho, G. S. 2019. Determinants of gender differences in household food security perceptions in the Western and Eastern regions of Kenya. *Cogent Food and Agriculture* 5 (1): 1694755. doi.org/10.1080/23311932.2019.1694755

Maddala, G. S. 1986. Limited-dependent and qualitative variables in econometrics (No. 3). Cambridge university press.

Maddala, G. S. and Nelson, F. D. 1975. Specification errors in limited dependent variable models (No. w0096). National Bureau of Economic Research.

Mallick, D. and Rafi, M. 2010. Are female-headed households more food insecure? Evidence from Bangladesh. *World Development* 38 (4): 593-605.

Maxwell, D. and Wiebe, K. 1999. Land Tenure and food security: A review of concept, evidence and methods. *Journal of Development and Change* 30 (1999): 825-849.

Mekureyaw, M. F. 2017. Maize Lethal Necrosis Disease an Emerging Problem for Maize Production in Eastern Africa. *Journal of Plant Physiology and Pathology* 5 (4): 2-8. doi:10.4172/2329-955X.1000170

Mendola, M. and Simtowe, F. 2015. The welfare impact of land redistribution: Evidence from a quasi-experimental initiative in Malawi. *World Development* 72: 53-69. doi:dx.doi.org/10.1016/j.worlddev.2015.02.010

Migot-Adholla, S. E., Place, F. and Oluoch-Kosura, W. 1994. Security of tenure and land productivity in Kenya. Iowa: Hunt Publishing Company.

Mohammed, S. and Mohammed, A. 2021. Determinants of Food Security: The Case of Kurmuk District in Benishangul Gumuz Regional State, Western Ethiopia. *International Journal of Natural Resource Ecology and Management* 6 (1):16-26.

Moreda, T. 2018. Contesting conventional wisdom on the links between land tenure security and land degradation: Evidence from Ethiopia. *Land Use Policy* 77: 75-83.

Nagarajan, L., Naseem, A. and Pray, C. 2019. Contribution of policy change on maize varietal development and yields in Kenya. *Journal of Agribusiness and Emerging Economies* 9 (1):4-21. doi:https://doi.org/10.1108/JADEE-01-2018-0013

Ogunniyi, A., Omonona, B., Abioye, O., and Olagunju, K. 2018. Impact of irrigation technology use on crop yield, crop income and household food security in Nigeria: A treatment effect approach.*AIMS Agriculture and Food* 3 (2): 154–171.

Oluwatayo, I. B. and Ojo, A. O. 2019. Effect of access to ICT on food insecurity among farming households in Nigeria. *The Journal of Developing Areas* 53 (2): 155–168.

Payne, H. E., Gray, B., Davis, S. F., Hine, C. A., Das, A., Kabra, M. and Crookston, B. T. 2016. Factors associated with food insecurity among women and children in rural Rajasthan, India. *Journal of Gender, Agriculture and Food Security (Agri-Gender)* 1 (302-2016-4757): 23-39.

Pinckney, T. C. and Kimuyu, P. K. 1994. Land tenure reform in East Africa: Good, bad or unimportant? *Journal of African Economies* 3 (1):1-28.

Place, F. 2009. Land tenure and agricultural

productivity in Africa: A comparative analysis of the economics literature and recent policy strategies and reforms. *World Development* 37 (8): 1326-1336.

Santpoort, R. 2020. The drivers of maize area expansion in Sub-Saharan Africa. How policies to boost maize production overlook the interests of smallholder farmers. *Land* 9 (3): 68-81.

Sitko, N. J., Chamberlin, J. and Hichaambwa, M. 2014. Does smallholder land titling facilitate agricultural growth? An analysis of the determinants and effects of smallholder land titling in Zambia. *World Development* 64: 791-802.

Stata Corp 2014. Stata statistical software: release 15. Stata Corporation. LP, College Station, Texas, United States of America.

Tibesigwa, B., and Visser, M. 2016. Assessing gender inequality in food security among small-holder farm households in urban and rural South Africa. *World Development* 88: 33-49.

Tiwasing, P., Dawson, P. and Garrod, G. 2018. Food security of rice-farming households in Thailand: A logit analysis. *The Journal of Developing Areas* 52 (1): 85–98. doi:10.1353/jda.2018.0006

Valkonen, A. 2021. Examining sources of land tenure (in) security. A focus on authority relations, state politics, social dynamics and belonging. *Land Use Policy* 101: 105191.

Wekesa, B. M., Ayuya, O. I. and Lagat, J. K. 2018. Effect of climate smart agricultural practices on household food security in smallholder production systems: micro level evidence from Kenya. *Agriculture and Food Security* 7 (80): 1-14. doi.org/10.1186/s40066-018-0230-0

World Food Programme 2022. Global Report on Food Crisis. Retrieved on May 29th 2022. https://www.wfp.org/publications/global-report-food-crises-2022

Yahaya, I., Pokharel, K. P., Alidu, A. F. and Yamoah, F. A. 2018. Sustainable agricultural intensification practices and rural food security: The case of North-western Ghana. *British Food Journal* 120 (2): 468–482.