EFFECT OF LAND TENURE SECURITY ON HOUSEHOLD FOOD SECURITY AND WOMEN EMPOWERMENT AMONG SMALL-HOLDER MAIZE FARMERS IN NAROK COUNTY, KENYA

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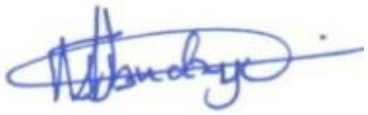
DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree.



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Recommendation

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DEDICATION

This thesis is dedicated to my dear mother, Chinyavu Mbudzya, uncle Herman Murabu, brother Angus Ngoka Mbudzya, lovely wife, Julian Mumbe Simon and son Taji Mbudzya Jabu.

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ABSTRACT

Land tenure security is key to the development of any country since it incentivizes land investments, increases maize productivity and household food security and improves women's empowerment. Despite these potential benefits of land tenure security, there is inadequate literature in Kenya, especially in areas experiencing land-related conflicts and cultural bias against women's rights, such as Narok County. This research, therefore, provides empirical evidence on (i) determinants of land tenure security, the effect of land tenure security on (ii) maize productivity, (iii) household food security, and (iv) women empowerment among small-holder maize farmers in Narok County, Kenya. A multistage sampling technique was used to obtain a sample size of 366 small-holder maize farmers. Cross-sectional primary data were then collected using semi-structured questionnaires and analysed using STATA computer software. For analysis of the four objectives, the Ordered probit model, conditional mixed process method (CMP), endogenous switching probit regression (ESR), and two-stage least square method (2SLS) were used. The findings of the study indicate that age, marital status, education level of the household head, number of years the household had stayed on the land, land fertility and size, land purchase, distance from the household to the parcel, and household size were the main determinants of land tenure security. Results also show that the sex, marital status, and education level of the household head, as well as the presence of land disputes, soil fertility, and land purchase, significantly influenced land tenure security. Findings further confirmed the relationship among land tenure security, credit access and maize productivity. Land tenure security significantly and positively influenced credit access, and the farmers with access to credit increased maize productivity by 2001.902 Kg/Ha. Furthermore, land tenure security positively and significantly affected household food security. Land tenure insecure households would have increased their food security by 38% if they were land tenure secure. In comparison, land tenure-secure households would have decreased their food security by 4% if they were land tenure insecure. Findings further suggest that possession of land rights increased women empowerment by about 0.25%. Other factors affecting women empowerment were marital status, education level gap, oxen ownership, polygamous marriage, off-farm income, group membership, and credit access. The findings of this study underscore the need for governments and other stakeholders to develop additional policies that would facilitate access to secure land rights by the rural population to increase maize productivity and food security. Further, additional policies that facilitate women's access to land rights to improve their economic, social and political power should be prioritized.

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LIST OF ABBREVIATIONS AND ACRONYMS

2SLS	Two Stage Least Square
ANGOC	Asian Non-Governmental Organization Coalition
ATT	Average Treatment for the Treated
ATU	Average Treatment for the Untreated
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
CGN	County Government of Narok
CMP	Conditional Mixed Process
COMESA	Common Markets for East and Southern Africa
EAC	East African Community
ESR	Endogenous Switching Regression
FAI	Food Access Index
FAI	Food Affordabitly Index
FAO	Food and Agriculture Organization of the United Nations
FIES	Food Insecurity Experience Scale
FII	Food Insecurity Index
FIVIMS	Food Insecurity and Vulnerability Information and Mapping System
FNI	Food and Nutrition Inventory
FSI	Food Security Index
GDI	Gender-related Development Index
GDP	Gross Domestic Product
GEM	Gender Empowerment Measure
GFSI	Global Food Security Index
GGI	Gender Gap Index
GoK	Government of Kenya
HDDS	Household Dietary Diversity Score
HDI	Human Development Index
HFCS	Household Food Consumption Score
HFIAS	Household Food Insecurity Access Scale
KES	Kenya Shillings
KFSSG	Kenya Food Security Steering Group
KNBS	Kenya National Bureau of Statistics
LTS	Land Tenure Security

MT	Metric Ton
NACOSTI	National Commission for Science Technology and Innovation
NGO	Non-Governmental Organization
NHC	National Housing Corporation
NLC	National Land Commission
NLP	National Land Policy
ODK	Open Data Kit
OLS	Ordinary Least Squares
SACCO	Saving and Credit Cooperative Society
SDG	Sustainable Development Goals
SLA	Sustainable Livelihoods Approach
SSA	Sub Saharan Africa
SUR	Seemingly Unrelated Regression
TH	Transitional Heterogeneity
TT	Treatment on the Treated
TU	Treatment on the Untreated
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
USDA	United States Department of Agriculture
WEIA	Women Empowerment Index in Agriculture
WFP	World Food Programme
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Background information

Enhancement of livelihoods among citizens is a crucial agenda for any government, especially in Sub-Saharan African (SSA) countries. Food security has been a global debate since the food and oil crises in the 1970s (Sitthisuntikul *et al.*, 2018). Lutomia *et al*. (2019) indicate that food insecurity remains the most significant socio-economic challenge in SSA and other developing countries. Globally, more than 702 million people, corresponding to about 8.9% of the total population, faced hunger in 2021. Approximately 20.2% of the African population faced hunger in 2021, compared to 9.1% and 8.6% in Asia and Latin America, respectively (FAO *et al*., 2022). Due to the rapid increase in population, it is predicted that food insecurity will continue to be a serious problem for the next 50 years, which will lead to increased demand for food. Additionally, increased land sub-divisions have decreased food production (FAO *et al*., 2022).

In Kenya, approximately 1.1 million people face acute food insecurity, which is expected to triple by the end of 2022 (WFP, 2022). The increasing food insecurity crisis can be attributed to the rapid increase in the world population, which is currently at 7.8 billion and is projected to be at 9.3 billion by 2030 (FAO, 2022). This population is putting pressure on the already limited land resources available to produce enough food to feed the growing population. Land tenure insecurity is identified as one of the significant causes of food insecurity since most resource-poor small-holder farmers are the primary food producers in third-world countries such as Kenya (Lawry *et al*., 2017).

Globally, land has been the basis for shelter, food production, and other productive activities. While it is increasingly becoming a scarce resource in urban areas, it has been known to be an essential source of wealth, social status, and power among rural families in developing countries (FAO, 2007). This stresses the need to improve land tenure security among rural households. Land tenure is a system of rights, rules, and regulations (institutions) that govern land access and use (Maxwell & Wiebe, 1999). These rights on land include rights to use, mortgage, and transfer. Three commonly known types of land tenure systems exist: private, public, and community. On the other hand, land tenure security refers to the assurance that the rights over the land will be respected and defended in case of a contestation (Doss *et al*., 2018).

In development studies and literature, land tenure security is touted as an important aspect of economic growth and development (Valkonen, 2021). Reforms in land tenure have

become a priority for governments and donors in developing and developed countries (Peters, 2009). This is because they are considered a key strategy for enhancing agricultural investments, productivity and improving food security (Ghebru & Lambrecht, 2017).

In most rural African communities, agricultural land use is based on olden days' land tenure systems (traditional or customary or community). This contrasts with the new private tenure system established by government institutions, which provides more secure rights than the former (Cotula, 2007). Land tenure security is vital in reducing poverty and gender-related gaps, enhancing agricultural productivity and women empowerment, and improving natural resource and conflict management (Bruce, 2003; Deininger, 2003; Higgins *et al.*, 2018; Lawry *et al.,* 2017). This critical role has been emphasized by its inclusion in Sustainable Development Goals (SDGs) number two (2) on ending hunger, achieving food security, and improving nutrition (Higgins *et al.,* 2018).

Previous studies by ANGOC (2017), Holden and Ghebru (2016), Kennedy-Lazar (2016), Keovilignavong and Suhardiman (2020), Miggiano *et al.* (2010), and Quizon (2017) argue that enhanced security of tenure in productive resources such as land allows for more efficient, productive, profitable, and sustainable agricultural production that leads to increased income and greater access to food. The effect of land tenure security on household food security differs with respect to whom between male and female is a key decision maker and has more land tenure rights (Chigbu *et al.,* 2019). Previous studies by Chigbu *et al.* (2019) and FAO (2007) show that women benefit socially and economically if their land rights are secure. Land tenure security by women is vital in safeguarding the fairness of elementary rights, improving household food security, and reducing poverty levels (Chigbu *et al.,* 2019; Doss *et al*., 2018; Doss *et al.,* 2015).

In Kenya, like in other SSA countries, unequal distribution of resources such as land is one of the major contributors to poverty and food insecurities, which is more prevalent in women than in men (GoK, 2021). Women in Kenya contribute to over 50% of the total agricultural labour force, yet their land ownership is about 10% (Kenya Land Alliance, 2018). The Kenyan Constitution and other laws have provided a framework for protecting women's property rights. However, despite the highlighted gains from the constitution and other laws, there are gender differences in land ownership and other properties. This has implications for the production of food crops such as maize, which is a crucial driver of food security in Narok County (Mwenzwa *et al.*, 2018).

Maize (*Zea mays)* is one of the world's major cereal crops, ranked third after rice and wheat (Mekureyaw, 2017). It is Africa's most widely cultivated cereal grain and is considered

a staple food (Nagarajan *et al.*, 2019). In Kenya, it is both a food security and the main staple food crop, accounting for approximately 40% of the cultivated area (Mekureyaw, 2017). It also contributes to about 2.4% and 12.65 % of Kenya's Gross Domestic Product (GDP) and the agricultural GDP, respectively (FAO, 2018). GoK (2021) states that small-holder farmers produce 75% of maize in Kenya. However, only 20% of the produce is sold to the market, while the rest is consumed at the household level, underscoring the crop's importance. Kenya's per capita maize consumption averages 103kg/year (Nagarajan *et al.*, 2019). In Narok County, maize is the third main crop after wheat and barley, with an average production of 200,000 MT per year (CGN, 2018). According to the Kenya Food Security Steering Group (2015), maize contributes about 70% and 15% to food and income, respectively, in Narok County.

1.2 Statement of the problem

Globally, land tenure security has been a key contributor to increased crop productivity, household food security, and improved women empowerment. It incentivizes the landholder to make investments and land improvements that can increase agricultural productivity and household food security. Land tenure security also enhances the ability of the landholder to use it as collateral to secure credit facilities from financial institutions for agricultural production and other uses. Furthermore, it improves rural women's empowerment by enhancing their household decision-making ability, and improving their financial security and bargaining power. Despite these benefits of land tenure security, there is inadequate literature, especially in Kenya, that provides empirical evidence on its effect on agricultural productivity, household food security, and women's empowerment.

Additionally, there is inadequate evidence of factors influencing land tenure security. Therefore, this study intends to bridge the identified knowledge gap by determining the effect of land tenure security on household food security and women empowerment of small-holder maize farmers in Narok County, Kenya. The novelty of this study is the linkage among land tenure security, maize productivity, household food security, and women empowerment. In addition, the study was conducted in Narok County, where cultural practices and beliefs have disadvantaged women with respect to their access to land and other productive assets.

1.3 Objectives

1.3.1 General objective

To contribute towards improvement of livelihoods of small-holder maize farmers through enhancing land tenure security, increasing maize productivity and household food security, and

improving women empowerment.

1.3.2 Specific objectives

i. To assess the determinants of land tenure security among small-holder maize farmers in Narok County, Kenya.
ii. To determine the effect of land tenure security on maize productivity among small-holder maize farmers in Narok County, Kenya.
iii. To assess the role of land tenure security on household food security among small-holder maize farmers in Narok County, Kenya.
iv. To analyse the influence of land tenure security on women empowerment among small-holder maize farmers in Narok County, Kenya

1.4 Research questions

i. What are the determinants of land tenure security among small-holder maize farmers in Narok County, Kenya?
ii. How does land tenure security affect maize productivity among small-holder maize farmers in Narok County, Kenya?
iii. How does land tenure security influence household food security among small-holder maize farmers in Narok County, Kenya?
iv. How does land tenure security influence women empowerment among small-holder maize farmers in Narok County, Kenya?

1.5 Justification of the study

By analysing the effect of land tenure security on maize productivity, household food security, and women empowerment, the findings will inform the formulation and execution of additional targeted interventions in the land, agricultural, and gender equality sectors to improve food security and women empowerment in the county and Kenya in general. Additionally, the study was conducted in Narok County, Kenya, where women's rights to productive resources may be undermined. Thus, the findings of this study will inform the formulation and amendments of policies on land, gender equality, agriculture, and economic development in the county and the nation at large. Moreover, the study contributes to the body of knowledge by measuring land tenure security using the respective rights to use and transfer land. Also, it acknowledges the different weights of the rights. This is as opposed to the conventional method of measuring it using a single measure such as possession of title deed, land tenure system, or dispute over the land. The study also uses an innovative analytical

method, namely the conditional mixed process method, to analyse the effect of land tenure security on maize productivity. This method has the ability to take care of the endogeneity and inter-relationship among the equations.

The study contributes to the achievement of Vision 2030 economic pillar of achieving economic growth of over 10% and sustaining it for over 25 years. This will be achieved by focusing more on access to secure land rights for small-holder farmers in Kenya. In addition, the study helps achieve the government's Bottom Up Economic Transformation Agenda (BETA) on food security, which is a critical ingredient in the country's realisation of economic propensity. The study also contributes to the achievement of SDGs 1 and 2 on ending poverty in all its forms everywhere, ending hunger, achieving food security and improved nutritional status, and promoting sustainable agriculture, respectively. Furthermore, the study will contribute towards the realisation of SDG number 5 on achieving gender equality and empowering all women and girls.

1.6 Scope and limitations of the study

The study focused on the small-holder farmers who had practiced maize farming for more than five (5) years in the Trans Mara East and Trans Mara West sub-counties of Narok County. The farming duration was informed by the belief that, most of the effects of farming investments, such as tree planting, are felt after five years. The study used cross-sectional data and measured agricultural productivity and land tenure security at the primary parcel level, while food security was measured at the household level. Most farm and land tenure security decisions are made at the primary parcel level; hence, such analysis provided accurate results, while most food security decisions are made at the household level. The study also focussed on the private land tenure system rather than the communal or public land tenure system. The respondents' low education levels and the need for properly kept records affected the accuracy of the estimates; hence, the study employed extensive probing to obtain the correct data. The nomadic pastoralism nature of the respondents negatively affected the data collection process; hence, prior meeting appointments with respondents were made before the data collection exercise commenced. The study's sample size in Narok County, 366 small-holder maize farmers, limits the generalisation of the study findings, conclusions, and recommendations to all small-holder maize farmers in Kenya.

1.7 Operational definition of terms

Food security is defined as when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary and food preferences for an active and healthy life (World Food Summit, 1996).

Household head- Refers to either a man or a woman who is the key decision-maker in the household concerning farm production, land-related matters, or food consumption matters.

Household- Refers to a social unit composed of one or more people who live in the same dwelling, share meals, and depend on a single person for production and consumption decisions.

Land tenure- Refers to a system of rights, rules, and regulations that govern the access and use of land.

Land tenure security refers to possessing the rights to use and transfer land or possess a land title deed.

Small-holder farmer- refers to a maize farmer who resides in Narok County and has a farm size of not more than five hectares.

Woman empowerment- The woman's ability to make independent decisions concerning agricultural production, use of resources, leadership, income use, and time allocation in the household.

Maize productivity- Refers to the amount of maize yields in kilograms produced in a unit piece of land in hectares.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter consists of the following sections: the concept of land tenure security, determinants of land tenure security, the concept of food security, determinants of food security, the relationship among land security and agricultural productivity and food security, the concept of women empowerment, access to land rights by women in Kenya, determinants of women empowerment, the relationship between land tenure security and women empowerment, theoretical framework, and conceptual framework. These sections review previous work done by other researchers on the subject matter. It helps understand the relationship among land tenure security, agricultural productivity, household food security and women empowerment.

2.2 The concept of land tenure security

Land tenure security is multi-dimensional and can be described using various terms. According to Deininger (2003), the permanence of land rights, the predictability and stability of those rights, and the certainty that others would safeguard rights constitute land tenure security. The stability of a person's or group's legal rights to land and the time for which those rights are expected to be maintained refers to land tenure security (Navarro-Castañeda *et al.,* 2021). Tenure security, as defined by Valkonen (2021), is the assurance of property rights, such as the freedom to use, control, transfer, acquire, and dispose of land.

Kamau *et al.* (2020) note that land tenure security could also be referred to as the legal protection for land use, which is the assurance that government agencies or other third parties will not infringe upon one's private property rights in the land. Tenant turnover deters residential and commercial real estate owners (Wambua *et al.,* 2018). Various methods may be used to determine the length of service. One strategy is monitoring the regularity with which land titles are challenged or altered. Clarity of land rights, or the recognition and protection of private property rights, is another essential factor to consider (Chigbu *et al.,* 2019).

Land tenure security has become an essential issue in studying economic growth due to its impact on the motivations of both people and businesses to invest in agriculture. With increased confidence in one's property rights, there is likely proportional investment growth in one's property. Increased growth in one's property would likely boost economic growth and development, given that land is a fundamental component of production. If the law better protected landowners, more individuals could invest in agriculture, benefiting the economy.

Tenure security legislation that allows more people to own land at affordable prices might help lessen conflicts over this resource.

The absence of a universally acceptable definition or metric for land tenure security complicates the matter. The legal and physical safeguards outlined in this study function together to protect land ownership. Land tenure security is defined as the degree to which an individual or group may anticipate maintaining control over land. At the same time, another definition is the legal and physical guarantee that an individual or group will continue to use and occupy the property for a fixed amount of time (Moreda, 2018). There is no single definition or measure for land tenure security, so it is challenging to define and assess.

Indicators of land tenure security exist, such as the certainty of land ownership, the flexibility of tenure systems, the transparency and honesty of leases, and the efficacy with which property rights are created and enforced. Scientists have used both subjective and objective measures in their studies. It is essential to remember the problematic nature of land tenure security while attempting to define or assess it. Land tenure security may be high in theory but low in practice if, for example, the government or other land cartels do not respect an individual's legal rights to their property.

The definition of land tenure security depends on the context since it supports a distinct set of objectives or points of view (Uwayezu & De Vries, 2018). Some studies have used research to assess how people feel about private property rights to land. Previous research (Suchá *et al.*, 2020) has shown that legal land ownership signifies economic success. According to Holden *et al.* (2013), land tenure is defined as informal or formal institutions that govern land as a property. These institutions may control the right to use, mortgage and transfer the land. The constitution recognizes three tenure systems in Kenya: private, communal or customary and public or state (Djurfeldt, 2020). The private or freehold land tenure system consists of land rights held by an individual. White settlers previously occupied this category of land and converted from community land to private land. Community land tenure system, or group ranches, is defined as rights over land held by a particular community as ancestral property. Public or, state or trust land tenure system refers to rights over the land held by the state in trust. This land includes land occupied by schools, hospitals, forests, game reserves, and national parks. With increasing population, diminishing livelihoods and pressure by the political class to formalise and privatise, community land has been sub-divided into plots held by private persons (Kyalo & Chiuri, 2010), hence the need to secure these rights to land.

Maxwell and Wiebe (1999) define land tenure security as "a bundle of rights" to carry out particular operations on the land and the protection of those rights from infringements.

These rights may be derived from statutory/legal, customary or even marriage arrangements. Holden *et al.* (2013) and Muchomba (2017), on the other hand, define land tenure security as the certainty that the individual rights over land will be recognized and protected by other people during encroachment and land grabbing by private operators, expropriation and distribution by the government. According to Cater and Olinto (2003), land tenure security is the perceived change in the likelihood of losing land. Cattaneo (2001) defines land tenure security as the expected time of residence in the piece of land before eviction.

Land tenure security has three dimensions, namely, *de jure* (legal tenure which is backed by state authority), *de facto* (tenure security which is common knowledge) and perceived tenure security (individual subjective evaluation of their tenure scenario) (Quizon, 2017; Van Gelder, 2010). The concept of land tenure security is an essential determinant of economic behaviour among property holders (Arnot *et al.*, 2011). Whether the land tenure security is legal, perceived or de facto, it influences the owners' behaviour to invest in the land (Van Gelder, 2010). Globally, there has been a debate on how best land tenure security can be improved.

Land titling/certification has been fronted to increase land tenure security (Lawry *et al.*, 2017). Land titling is defined as the possession of a legal title deed or certificate over land (Lawry *et al.*, 2017; Ma *et al.*, 2016; Owoo & Boakye-Yiadom, 2015). However, Arnot *et al.* (2011), Pinckney and Kimuyu (1994), and Place and Otsuka (2000) argue that enhancement of land rights through titling may have insignificant effects in a situation where informal and customary tenure systems provide security. Ma *et al.* (2016) and Owoo and Boakye-Yiadom (2015) suggest that land improvement practices such as tree planting and digging of wells may also improve land tenure security in rural areas. In this study, land tenure security will be defined as the possession of the rights to use the land for agricultural production and the right to transfer the land to other users.

2.2.1 Land tenure security in Kenya

According to Daniel *et al.* (2022), land ownership issues in Kenya have persisted since the country's colonial times partly because the British colonial administration privatised property previously held in common. Land disputes between the British and Kenyan administrations were settled after Kenya gained independence in 1963. The Constitution of Kenya, which dates back to 1963, guarantees property ownership to all adult residents. However, not everyone shared these advantages since the British government and a few groups of wealthy Kenyans kept legal possession of the vast bulky of the country's land (Kim *et al.*,

2019).

According to Schürmann *et al.* (2020), Kenya's government has enacted various laws and regulations to guarantee the security of land ownership to its citizens. Property rights were expanded to all Kenyans in 2012 as part of the government's commitment to upholding the Constitution's promise from 2010. The National Housing Corporation's (NHC) homeownership scheme is just one of several government-run initiatives to ensure ownership to secure land rights. Some progress has been made, but land tenure instability is still an issue in Kenya.

While the Kenyan government has made some progress in establishing stable land ownership, this endeavour has failed. To tackle the issue of land reform, a new National Land Policy was established in 2003. Although this strategy was never implemented, land insecurity remains a severe issue in Kenya. The government of Kenya launched a National Land Policy (NLP) in 2003 as a first attempt to deal with the issue of constantly changing land ownership (Kibugi, 2021). The NLP proposed registering all land titles and controlling real estate transactions to modernize the land tenure system (Nyakweba, 2019). The NLP also advocated creating a land commission to investigate and settle land issues. Lack of political will and opposition from vital interests prevented the NLP from being implemented.

According to Wambua *et al.* (2018), economic growth and helping people lift themselves out of poverty depend on individuals investing in and taking control of the structures and property in their community. Land scarcity, if put to agricultural and industrial use, might harm the economy; the dangers of investing in real estate rise when the title to a piece of property is unclear. The region's economic and social status might suffer (Djurfeldt, 2020).

Tlale (2018) states that protecting people's property rights is crucial to any culture's progress. Instability and even violence might break out if people do not trust that their possessions are safe. The government of Kenya has to move fast to guarantee that all citizens have clear property titles. Low-income people will have easier access to agricultural land if the rules governing land ownership and usage are simplified and brought up to date and land reform is implemented. Fixing Kenya's economic and social challenges would only be possible by addressing land tenure insecurity.

According to Rugadya (2020), landowners with tenure security know that neither the state nor any other landowner can force them out of their property. The safety of land ownership is a common problem in developing countries, especially in Africa, even though it is vital for economic growth and poverty reduction. Tenure security is an issue that has been studied extensively in Kenya. There has been a lot of back and forth in the government over whether

or not property owners should be afforded certain protections. As a result, laws that would have afforded certain protections have often been authorised and then revoked.

Since no individual shall be dispossessed of property without due process of law, Kenya's Constitution guarantees tenure security (Wanjira & Muriuki, 2020). It is unclear how the provision in the Constitution authorising government property acquisitions for public purposes will be applied. Kenya's central government has tried several times, with little success, to ensure lasting stability in land ownership. The Land Bill, presented by the government in 1998 to better protect landowners, was never passed (Gannon *et al.*, 2022). The government's Property Reform Bill was initially introduced in 2002. However, it was never enacted. This bill would have made it legal to take private property for public use if it had been passed.

The Land Bill was drafted to protect landowners against expropriation and give the government greater control over property use. If the bill had been passed, it would have paved the way for the benefit of eminent domains to purchase land for public use and for establishing property banks to be used in future development projects. It would have allowed the government to seize private property for public use as long as the owners were compensated fairly. As a result of landowners' legitimate concern that the Bill would give the government too much authority, the legislation remained law.

The Property Reform Bill intends, among other things, to safeguard the transfer of property ownership from one generation to the next. The Bill would have allowed the government to take private property for public safety. Landowners opposed the measure because they feared the government would take their land without paying. In September 2009, Parliament passed the Land Act to safeguard property owners. Kenyans may now make title deed applications to establish a legal claim to their property. Landowners must be compensated fairly and equitably if their property is taken for a public purpose under the Act.

While the Land Act is an improvement, it remains to be seen whether its goal of giving landowners more peace of mind is achieved. It has been said that the Act is ambiguous, which is why its opponents oppose it. An important step forward for Kenya was the passage of the Land Act in 2009. Those findings were just published by academics (Lydiah *et al.,* 2019). Providing landowners the option to acquire a certificate of ownership in their name offers them a sense of safety. The mechanism for enforcing this regulation, however, remains to be determined. Some people have expressed concern about the Act because it lacks information about its implementation.

2.2.2 Land laws in Kenya

Kenya's land laws can be traced back to pre-colonial, colonial and post-colonial period, which were characterized by significant activities that shaped the land governance in the country. Before colonialism, land was governed by informal rules or customary laws where land belonged to the community. Land access rights were open to all community members, and land use was based on what was acceptable to the community through its leaders (Kanyinga, 1998).

In the early 1890s, the establishment of the Protectorate marked the end of land governance by customary laws. The Crown Land Ordinance of 1915 was imposed to assist the colonialist in acquiring and owning land deemed suitable for their settlement. After the land acquisition for settlement, the English Property Laws were enacted to govern land ownership and use. The English Property law marked the beginning of individual land ownership in Kenya (Wanjala, 2000). It also ushered in the white settler to practice agriculture in the Protectorate. In order to consolidate the acquired land, the Transfer of Property Act of India was put in place by the colonial government. This law provided avenues for land transfers such as leases and mortgages. This was followed by the enactment of the Registration of Titles Ordinance (now Cap 281 of Kenya) in 1920 to enhance land tenure security (Ogendo, 1976).

At independence in 1963, the Registered Land Act (Cap 300) and Land Adjudication Act (Cap 284) were enacted to provide a post-independence law that governed land formally under customary law. The Land Adjudication Act was amended in 1968 to cater to pastoralists and nomadic communities in areas where individual land ownership yielded little success. The group rights were registered under the Land (Group Representative) Act (Cap 287) to help cater for the pastoralists and nomadic way of life (Wanjala, 2000). Establishing the Magistrates Jurisdiction Amendment Act of 1981, which gave the power to hear and determine land ownership cases, was one of the significant post-independence laws. Another notable post-independence land policy was the establishment of land settlement schemes to settle the landless people displaced during the colonial government (Leach, 1998).

The Constitution 2010 provides the foundation of Kenyan laws and policies governing land. The 2010 Kenyan constitution recognises three types of tenure systems: private, communal or customary and public or state (Djurfeldt, 2020). The private or freehold land tenure system consists of land rights held by an individual. White settlers previously occupied this category of land and converted from community land to private land. The community land tenure system, or group ranches, is defined as rights over land held by a particular community as ancestral property. Public or state or trust land tenure system refers to rights over the land

held by the state in trust. Public land includes land occupied by schools, hospitals, forests, game reserves and national parks. Increasing population, diminishing livelihoods and pressure by the political class to formalise and privatise land have led to community land being sub-divided into plots held by private persons (Willy & Chiuri, 2010), hence the need to secure these rights to land. Land ownership in Narok County is categorised into three (3): community land, trust land, and private land. Private land forms the largest category, with more than 50% of the households possessing land title deeds (CGN, 2018). Under the constitution of 2010, Kenya enacted the Land Act of 2012 to guide land registration. Today, approximately 30% of Kenya's total land area is registered with over 5 million title deeds (Jeppesen & Hassan, 2022).

2.2.3 Determinants of land tenure security

A growing body of literature explores the elements contributing to stable land rights. The security of land ownership depends on several factors, but legal safeguards for property rights present a critical aspect of the factors. If property rights are clearly defined and preserved, landowners in that country are more likely to have secure tenure. The economy's health is also a significant consideration. As a nation's economy grows and its people get wealthier, so does its capacity to protect land rights and provide secure tenure.

Some factors include land concentration, the power of traditional institutions, the availability of communal land, and the nature of the land tenure system. Landowners are more likely to have the security of tenure in countries with a robust system of private property rights (Bambio & Agha, 2018). In addition, countries with customary solid structures tend to have more secure tenure. However, as communal land is not always adequately protected by the state, its use may weaken tenure security. Finally, the concentration of land ownership is a significant issue in determining tenure rights. Tenure problems arise when a few individuals possess a disproportionate quantity of land. This situation is in countries with many grounds concentrated in a small area (Dachaga & de Vries, 2021).

The most critical aspects of land tenure security include the legislative framework, economic development, land tenure system, communal land, the strength of traditional institutions, and land concentration. We claim that individuals have "land tenure security" when they have the social and legal certainty that their land rights will not be taken away without reasonable cause (Valkonen, 2021). Gaining public trust is crucial to promote environmentally sound land management practices. Before land ownership may be considered secure, several conditions must be met. One may classify them into three major groups: legislative, statutory and institutional.

Supportive legislative frameworks and institutional mechanisms contribute to the stability of land tenure. The legal structure governing land rights significantly impacts tenants' ability to enjoy the security of tenure (Ingirankabo & Ertsen, 2020). Land tenure is more secure in countries where customary law handles property rights instead of statutory law. Governments are more inclined to change or eliminate conventional legal norms with good cause. Equally important is having a just court system to protect property rights. When citizens believe their country's judicial system will uphold their rights, they are likelier to believe that courts will be just in matters of property (Kamau *et al.,* 2020).

Tenure security is also determined by the institutional frameworks that regulate ownership rights. In countries with more tenure security, private individuals, families, or clans are more likely to possess land outright than the central government (Gebreeyosus *et al.,* 2020). The state will be less likely to forcibly transfer land rights of individuals, families, and communities with a financial interest in preserving them. The possessions of a group can only be safeguarded to a certain degree by the closeness of its members. In the event of an invasion, individuals are more likely to help one another if they have a strong sense of community (Rashid, 2021).

The land's current market value significantly impacts the security of a person's tenure. More permanent land ownership is typical in economically advantageous rather than less advantageous areas. If the land has value, people will be more inclined to take precautions to preserve it. Back-up funds for land purchases are also essential (Paltasingh, 2018). Communities and individuals in countries with limited economic opportunities are more inclined to put money into land claims.

Land ownership has long been seen as a critical component of development strategy. The question of what factors contribute to secure land ownership has been the subject of much research, focusing on the state's role. Owning property has long been recognised as a powerful tool for combating poverty and fostering economic growth. More money may be invested in the economy and infrastructure if property titles are in order (Lawin & Tamini, 2019). This improves their odds of getting money and other resources and realising economies of scale.

The recognition and protection of land tenure rights depend on a solid legal and institutional framework. Several nations have recently adjusted their property ownership structures to ensure their citizens' better safety (Sarmiento *et al.,* 2020). Due to these reforms, customary land rights are now recognised by law, and more progressive practices in land management have been implemented. Factors like the stability of customary institutions also have a role in determining the safety of land tenure. Securing land ownership in rural areas is

primarily dependent on shared institutions. They may provide individuals not shielded by the law with a feeling of security.

2.3 Concept of food security

There have been difficulties in defining the term food security; researchers and other stakeholders have defined and used it differently in the past (Kassie *et al.,* 2014; Maxwell & Wiebe, 1999). Food security is a complex term that cannot be summed up in a singular sound bite. Based on people's upbringing and life experiences, individuals are likely to interpret food security differently. It may mean how cheaply, how easily, or how nutritious food may be obtained for different people (Kassie *et al.,* 2014).

According to FAO (1996), food security is defined as a state 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 an active and healthy life. This definition captures four critical aspects of food security: availability, access, utilisation and stability (FAO, 2013). Food availability addresses the supply side of food security, which is determined by the level of food production, stock levels and net trade. This aspect is based on access to resources such as land, production technologies, and environmental and market conditions, among other factors. On the other hand, food access is determined by the social, economic and physical access to food. Food utilisation can be described as how the body uses the available nutrients, while food stability is the state of being food secure at all times (FAO, 2019). Despite its breadth, the FAO's definition does not clarify how to ensure that all people have consistent access to nutritious food (McCarthy *et al.,* 2018).

The single most important indicator of food security is consumption; however, data on such an indicator is complex to gather. While there is now a greater quantity of data on household income, the quality of that data has declined. The most common and subjective method of gauging food insecurity is polling the affected population (Amare *et al.,* 2021). The most accurate way to measure food insecurity is via consumption statistics, yet these data are hard to acquire. Household income data is easier to get, but its accuracy is doubtful. A poll that probes respondents' self-assurance in making healthy food decisions is one of the most convenient yet demanding gauges.

The most significant predictor of food security is consumption statistics. While data on personal income is more accessible, its reliability is less admired (Gil *et al.,* 2019). Self-report surveys are the most time-efficient method for gauging consumers' opinions of food security, but they also tend to be the least reliable. When all people in a society have access to and can

produce all the food they need for good health and active engagement in society and the economy, then that society is said to have achieved food security (Cole *et al.*, 2018). Numerous factors that impact people's ability to produce, purchase, or otherwise get food include the production, distribution, and trade of food; access to land, water, and other natural resources; and socio-economic, political, and environmental situations.

The World Food Summit of 1996 emphasised the need to ensure a reliable supply of healthy food that meets people's tastes and dietary requirements for individuals to participate fully in society, get an education, and find gainful employment (Cafiero *et al.*, 2018). This word captures the complexity of the problem of ensuring enough food to eat. Both the food's nutritional value and its security as a source of nourishment are crucial. Food insecurity, or the absence of ready access to sufficient amounts of nutritionally sound foods, was initially included in the definition of food security. Several things may lead to people not having enough food to eat, including poverty, conflict, harsh weather, and natural disasters.

Another aspect of food security is malnutrition. The prevalence of malnutrition may be approximated by the percentage of the population that is chronically malnourished. Indicators such as stunting and the majority of overweight and obese children are used to assess the level of physical underdevelopment among children under five years old (WHO, 2021). Young children under five are measured for height and weight to determine the wasting rate. The FAO food security indicator was developed to assess food insecurity on a global, national, and even local level. The Global Food Security Index (GFSI) is at the global level. The Global Food Security Index evaluates the food safety situation in 113 nations annually (GFSI). Food quality, safety, availability, and accessibility are some aspects considered when compiling the index. GFSI offers helpful statistics for evaluating food safety by considering various parameters. However, it is not a perfect predictor of food security. GFSI is limited in its ability to assess the many variables contributing to food insecurity worldwide fully. Despite its severe flaws, the GFSI is widely used to measure people's confidence in their ability to get healthy food. While the GFSI performs a great deal of study on food safety, it does not examine every possible scenario. Despite its flaws, the index is an attempt to quantify a pressing global problem (Harris *et al.*, 2020).

The United Nations Food and Agriculture Organization (FAO) developed the Food Security Index (FSI) to assess a nation's level of food security in relation to its food production, distribution, and cost. The Food Security Index (FSI) considers the accessibility, affordability, and availability of food (Rembold *et al.*, 2019). The FSI may be used as a gauge of a country's food security measures. This metric considers stock market activity, the volume of imports,

and manufactured product output. One measure of a country's productivity is the proportion of its food supply grown inside its borders. The percentage of food that a nation needs to acquire from elsewhere is known as the import index. It is an indicator of a country's capacity to meet its food demands in its stock market.

The food access index (FAI) is one way to evaluate people's buying ability. It may be broken down into the following categories: quantity of food consumed, diversity in diet, and lack of access to adequate nutrition. Typical daily food intake is categorised in the food consumption index. A family is assigned a dietary diversity index based on the variety of foods ingested regularly. On the other hand, researchers created the food insecurity index (FII) to measure people's vulnerability to hunger. The food affordability index (FAI) measures how much of a household's monthly income goes on food and serves as a proxy for economic health. Food prices, spending, and subsidies comprise the index's three subcategories. The food affordability index can tell you whether food costs are going up or down. The food expenditure index records Americans' average amount each week on food. That percentage of a country's population receives financial assistance from the government to buy food, as determined by the Food Subsidy Index (De-la-Torre, 2020).

The University of Maryland created a scale to measure food insecurity at home called the household food insecurity access scale (HFIAS). The HFIAS uses the answers to nine questions to determine a family's food security. "Is there enough food to eat?" and "Does anybody in the home need to go hungry?" may help ease concerns like "Are we going to be hungry?". The HFIAS has many benefits as opposed to other indicators of food security. As a first step, it may show the likelihood of hunger in a household. It is also based on a reliable metric, the Food Security Survey Module, which is included in the National Household Food Acquisition and Purchase Survey, which was developed by the United States Department of Agriculture (USDA). Additionally, HFIAS is updated annually to keep it up-to-date and valid.

Another way to quantify how often and for how long people go without food is using the food insecurity experience scale (FIES). The food insecurity experiences scale is a 6-item questionnaire to assess food insecurity. The questions in this measure probe a wide variety of issues, including whether or not the respondent has gone hungry, whether or not they have been able to eat the foods they desire to ingest, and whether or not they can afford the meals that they need to eat. The FIES is much more efficient than the FSI, the GFSI, and the HFIAS since it is a good indicator of whether or not you are starving.

The United States Government Agency for Agriculture and Food (USDA) developed the Food and Nutrition Inventory (FNI) to measure the uncertainty in the food supply chains.

There are 19 total questions on the Food and Nutrition Security Inventory (FNI). Food insecurity, easy access to healthcare, and the availability of nutritious food choices are just a few of the many issues explored in this inquiry. Compared to the FSI, GFSI, HFIAS, and FIES, FINI was designed to assist people in assessing their food and nutritional insecurity.

The food insecurity and nutrition database provides worldwide data on hunger and malnutrition. Both the FAO and the WFP were founded in 1945 by the United Nations. Each country's progress toward achieving food and nutritional security is measured against a set of 80 indicators known as the index. Production, consumption, pricing, availability, and nutritional value are all accounted for in these figures (Lydiah *et al.,* 2019). The index outperforms the FSI, GFSI, HFIAS, FIES, and FINI in many crucial respects. It shows how unstable the world's food supply is. Furthermore, it uses a reliable data source, the food security information system maintained by the World Food Programme (WFP).

Global food insecurity and vulnerability may be assessed using the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) created by the United Nations Environment Programme (UNEP) and the United Nations Food and Agriculture Organization. The Food Insecurity and Vulnerability Information Mapping System (FIVIMS) database and associated maps provide a graphical representation of these issues. The FIVIMS database is an extensive repository of information on various fields, such as agriculture, nutrition, economics, and public health. There are several valuable metrics to choose from, including the FSI, GFSI, HFIAS, FIES, FINI, and INDEX; however, the FIVIMS is the gold standard. It is a perfect example of how precarious the global food supply is. Second, it was built with the help of the UNEP/FAO Food Insecurity and Vulnerability Information and Mapping System.

2.3.1 Determinants of food security

The determinants of food security can be classified into climatic-related, land-related and socio-economic characteristics. Climate variability affects rainfall patterns, which, in turn, affects agricultural yields. As a result of reduced yield, food security decreases (Chandra *et al.,* 2017). The age of the household head determines the household food security status. Iram and Butt (2004) and Welderufael (2015) argued that older household heads are more likely to be experienced in farming matters. In addition, they tend to have more land rights than younger ones (Omotayo *et al.,* 2018). However, Mannaf and Uddin (2014) found that an increase in age by one year reduced the probability of being food secure by 0.73. Younger people are more exposed and have better access to the latest information on relevant agricultural technologies to increase food production. Maharjan and Joshi (2011) argued that older persons are less

receptive to new ideas and technologies meant to improve food security.

The gender of the household head also affects the household's food security status. In relation to climate-related studies, female-headed households are more vulnerable to climate change and, hence, more likely to be food insecure due to less resource base and relatively low resilience to food insecurities (Chandra *et al.,* 2017). Habtewold (2018) notes that since agricultural activities, especially in developing countries, are physical and labour-intensive, female-headed households tend to provide less labour and thus may not be able to produce enough food for their families.

The education level of the household head is also a key determinant of food security. Better-educated household heads are more likely to adopt agricultural productivity-increasing technologies such as soil conservation (Muche *et al.,* 2014). Furthermore, they can be innovative and access more information easier than less educated ones. This information may be necessary for food production decisions (Awoke *et al.,* 2022; Echebiri *et al.,* 2017). Habtewold (2018) noted that educated farmers might also be able to obtain, process and utilise information easier than uneducated ones. Additionally, they may be more willing to accept technical advice from extension agents, increasing their food production. Mohammed and Mohammed (2021) also argue that educated household heads may diversify their household income and become more resilient towards food insecurities.

The household size also determines household food security. Household size refers to the number of people who live and eat within the household for at least six months (Muche *et al.,* 2014). Research by Mohammed and Mohammed (2021) showed that as the household size increases, it exerts pressure on food consumption, reducing food security. On the contrary, larger household sizes made up of economically active members can be a source of agricultural labour, increasing household food production (Abu & Soom, 2016; Kakota *et al.,* 2015). Another factor determining the level of household food security is land size – the more land available for crop production, the more food secure a household is. Land provides space for the cultivation of food crops and livestock grazing (Abebaw & Betru, 2019). Additionally, rural land is considered a symbol of wealth; therefore, more land is associated with a high level of food security. Land can also be leased in exchange for money or sharecropping, thus contributing to income diversification and the improvement of food security (Maharjan & Joshi, 2011).

The ownership of an ox also influences household food security. In most SSA countries, agriculture is labour intensive; thus, oxen, especially in the rural areas, are used to provide agricultural labour for cultivation, weeding, and transportation of agricultural produce and

inputs, among other activities to improve food production (Abebaw & Betru, 2019; Omotayo *et al.*, 2018). Furthermore, they can be hired to provide an alternative source of income for the household. This could improve food security status. Off-farm income also determines household food security status (Awoke *et al.*, 2022; Muche *et al.*, 2014). Off-farm income includes income from non-agricultural sources such as formal employment or other non-agricultural businesses. An increase in off-farm income increases the amount of household disposable income, which can be used to invest in food production technologies, hence increasing food security. In addition, the income can be used to purchase other varieties of food products, improving food diversity (Kakota *et al.*, 2015).

Another factor influencing household food security is access to credit. A household with access to credit can invest in farm activities such as purchasing fertilisers and pesticides to produce more food, boosting household food security. Furthermore, income from the credit facility can be invested in off-farm activities such as purchasing a motorcycle and increasing and diversifying income to improve household food security (Awoke *et al.*, 2022). A household head's marital status also determines the household's food security. Marriage is meant to assist couples socially and economically; married people pool their resources together to help them during food insecurities (Habtewold, 2019). Marriage can also help reduce costs as consumption is done in a single unit instead of in separate ways (Echebiri *et al.*, 2017). The saved costs can be used to purchase food for the household. However, Kakota *et al.* (2015) argue that since marriage brings two people/families together, consumption increases and may reduce household food security status due to sharing costs.

Access to extension services also determines household food security. Extension services such as updates on new technology and pest and disease control methods are critical in agricultural production. Access to such services helps farmers to increase their farm production, hence boosting food security. Extension services such as access to credit facilities enable farmers to invest in modern farm technologies to boost food production (Kakota *et al.*, 2015; Mohammed & Mohammed, 2021). Access to the input and output market is another key factor influencing household food security. Lesser distance to the market may imply easy access to inputs, which incentivises producers to produce more food (Muche *et al.*, 2014). Furthermore, it signifies access to infrastructure such as roads, which may create opportunities for off-farm income and boost food purchasing power (Chandra *et al.*, 2017).

2.3.2 Maize farming in Kenya

Maize (Zea mays) is one of the most important cereal crops in Africa, covering 40 million hectares and producing about 81 million tonnes (FAOSTAT, 2019). In Kenya, maize is not only a significant contributor to food security and nutrition, with 90% of the population consuming it as a staple food (Ochieng *et al*., 2017), but it is also a source of employment and income for millions of subsistence farmers. Currently, maize is cultivated on 2.196 million hectares of land in the country, engaging more than 3 million small-holder farmers and with an annual production of 3.897 million tonnes (FAOSTAT, 2019). Maize production in the country is mainly in the hands of small-holder farmers who depend on agriculture for income and have limited resources to invest in practices. Current levels of maize grain productivity are as low as 1 ton/Ha against a potential of 6–8 ton/ Ha (Kiboi *et al*., 2019). The major maize-producing counties in Kenya are Trans Nzoia, Uasin Gishu, Kakamega, Nakuru, Embu, Nyeri, Narok, Kirinyaga, Taita-Taveta and Kwale. Kenya's per capita maize consumption is estimated at 103 kg/person/year (CIMMYT, 2021), with the 2020 annual maize demand being 52.8 million bags.

However, on average, maize production has shown a decline over the years. The 2017 annual production was 37 million bags of maize, which fell below the annual domestic demand of 55 million bags (KNBS, 2019). This yield gap is primarily caused by widespread soil fertility degradation in croplands arising from the removal of nutrients by crop production without satisfactory replenishment and generally poor management (Tittonell *et al*., 2008; Mucheru-Muna *et al*., 2010). Erratic rainfall increased frequency of drought, lack of soil water conservation practices, and low adoption of improved germplasm further contribute to low maize yield levels (Mucheru-Muna *et al*., 2014; Ngetich *et al*., 2014). This situation is expected to worsen over the next decade as the population in Kenya is rapidly growing (Rowell *et al*., 2015). Scaling practices improving plant nutrition and soil water retention are of crucial importance to breaking this vicious cycle of low maize production and productivity.

2.3.3 Relationship among land tenure security, agricultural productivity and food security

A growing body of evidence suggests that land tenure security is linked to higher agricultural productivity. The United Nations' SDGs number 1, 2, 3, 5, 10 and 12 have played a role in this change by focusing on problems such as increasing farm output and guaranteeing secure land tenure (Higgins *et al.*, 2018). For example, increased property rights and access to agricultural funding have enhanced rice output in Tanzania. More substantial property holdings

allow for more access to agricultural financing, leading to improved rice production (Rashid, 2021).

Previous studies have shown a correlation among stable property rights, monetary freedom, and abundant harvests. There was also a correlation between a family's access to finance and agricultural output, and credit availability was also a predictor of long-term land ownership (Wang *et al.,* 2018). To get the most benefits from one's labour, as shown by this research, having a clear legal title to one's land is essential. More availability of public amenities like healthcare, and education and increased protections for privately owned property like housing are likely to be at the root of this correlation (Voronkova *et al.,* 2018). Kenya's high agricultural output is often credited to the country's relatively secure land ownership structure.

To address these concerns, the Kenyan government enacted the Land Act of 2012 to strengthen property rights in the country (Ramankutty *et al.,* 2018). The Act requires registration of all land and the formalisation of all existing unofficial landholdings. The Act was passed to standardise and equalise land distribution and was supported by most Kenyan farmers. Despite this, the Act's implementation has been slow, and substantial obstacles remain in guaranteeing its efficient enforcement. Evidence suggests that protecting farmers' property rights may increase crop yields. According to the research by Mwenzwa *et al.* (2018), there is a connection among increased agricultural output, decreased input costs, and stable land ownership.

No matter how public or private it is, the economic, social, and political conditions in which a land tenure system is implemented significantly impact how well it functions (Kubitza *et al.,* 2018). Land ownership stability is crucial for fostering economic growth and agricultural output. The precise process by which well-defined rights over lands boost agricultural output is context-dependent and murky (Fuglie, 2018). Evidence suggests that productivity increases when people have secure ownership of land. In such a scenario, farmers are encouraged to boost agricultural production by investments in infrastructure and methods/technologies that enhance the quality of their land (Ntihinyurwa *et al.,* 2019).

Additionally, Ali *et al.* (2011), Holden and Ghebru (2016), Lambin and Meyfroidt (2011), and Ling *et al.* (2019) argue that land tenure security increases land conservation practices and agricultural productivity. The relationship between land tenure security and land investment is more pronounced since it favours access to credit, purchase of inputs and enhances the investment in land improvement practices such as tree planting, construction of gabions, among others (Besley *et al.,* 2012; Higgins *et al.,* 2018). Land tenure security also

reduces land ownership disputes, paving the way for technical development and economic expansion (Ajefu & Abiona, 2020; Benjaminsen *et al.,* 2009; Higgins *et al.,* 2018; Mwenzwa *et al.,* 2018). Farmers are cautious about investing in expanding their property since there is no assurance that they will be able to maintain current yields.

Long-term agricultural success depends on secure land ownership. Long-term farm investments, like irrigation systems and soil preservation, can become possible with the assurance of owning one's property right. Farmers who are uncertain about their land rights but wish to boost productivity in the near term may be tempted to resort to over-farming, which damages the soil and reduces yield but increases productivity in a short time (Zuo *et al.,* 2018). Greater agricultural productivity is strongly correlated with more secure property rights. Farmers in Ethiopia who had a strong sense of ownership over their property benefitted the most from efforts to preserve water and soil, according to the country's researchers. Farmers in Tanzania were more inclined to plant trees and boost their revenue when they felt secure in their property rights (Rashid, 2021).

The correlation between stable land ownership and increased crop production has been the subject of several explanations. To begin with, farmers are more inclined to improve their land if they feel secure (Stehfest *et al.,* 2019). Secondly, when farmers are confident in their ownership rights, they are more inclined to use environmentally sound farming techniques. Lastly, when farmers have secure land rights, they may use their land as collateral to borrow money for essential agricultural machinery and other structures.

Researchers have identified a link between secure land ownership and higher crop yields in several analyses. If farmers know they will eventually own the land, they are more willing to undertake long-term investments like irrigation and soil protection (Meinzen-Dick *et al.,* 2019). Much analysis has been done on the correlation between stable land ownership and increased crop yields. More secure land ownership will undoubtedly boost agricultural output in Kenya. Carter and Olinto (2003) indicate that the potential benefits of land tenure security (LTS) on productivity and food security may be available for properly positioned farmers with respect to market opportunities such as input, output and land markets. Benjaminsen *et al.* (2009) and Holden and Ghebru (2016) note that corruption and inefficiencies leading to high costs in land titling as a way of improving LTS may disadvantage the poor and favour the rich (Benjaminsen *et al.,* 2009). Other studies, such as Migot-Adholla *et al.* (1994) and Pinckney and Kimuyu (1994), found no significant effect of land titling on agricultural productivity.

2.4 The concept of empowerment

The concept of empowerment has been associated with several definitions, which vary depending on the circumstances under which it is used (Van den *et al.,* 2013). Additionally, the methods of measuring and tracking the changes are not well established due to their multidimensional nature and the need to operationalise them at different levels (Sharaunga *et al.,* 2019). There is a diversity in the definition of women's empowerment based on the emphasis, agenda, and terminologies used (Narayan, 2005). Some terminologies used in the definition of empowerment include choice, power, control options, and agency (Van den *et al.,* 2013). Empowerment is sometimes conceptualised as an outcome, a process, a means to an end, an outcome or a capacity, or a matter of getting power or agency (Kabeer, 2001; Njoh & Ananga, 2016). Most of these concepts refer to women's decision-making ability, which affects important individual and family outcomes.

Alkire *et al.* (2013) argue that empowerment can be viewed as personal. This is because one tends to have one's definition of empowerment based on one's life experiences, cultural beliefs, and the environment. However, in the literature, there are three commonly used definitions. Empowerment can be defined as expanding the assets and capabilities of the disadvantaged members of society to enable them to participate in negotiations with influence, control and hold accountable institutions that affect their lives (Narayan, 2002). This definition emphasises four elements of empowerment: access to information, inclusion and participation, accountability and local organisation's capacity. Kabeer (1999), on the other hand, defines empowerment as the process of enhancing people's ability to make strategic life choices, especially when these abilities are denied to them. This definition brings out three dimensions, namely, resources (access and future claims to physical, human and social resources, agency (process of decision-making, negotiations, manipulation and deceptions) and achievements (outcomes).

Batliwala (2007) in his work on women empowerment in organisations, defined women empowerment as challenging existing power and gaining control over resources. Based on this definition, women empowerment is about challenging patriarchal ideas, which help transform societal structures and institutions to allow women access to and control resources. The definition also emphasises that if society is to achieve empowerment, then a comprehensive approach is necessary. Batiwala's approach recognises that societal changes will not be sustainable if interventions focus on a few people. This is because the patriarchal powers will isolate them.

Kabeer (1999), in his study, defines empowerment as enhancement in an individual's

capacity to make decisions about critical aspects of their lives in a situation where their ability has been constrained. These critical life decisions may be the choice of livelihood, whether to marry or not, who to marry, and how many children to have, among other decisions. According to her definition, there are three aspects of empowerment, namely resources, agency and achievements, which depend on each other. Kabeer argues that how individuals obtain the resources is as important as the resources themselves when dealing with the issue of empowerment. As per Kabeer's (2001) argument, resources include physical resources, capabilities of a person and what they can help others achieve, while agency is the purpose or internal motivation that an individual brings to the activity. Kabeer further notes that there is a difference in the choices of men and women living in the same society, which is a crucial manifestation of gender inequality. There are three levels under which empowerment may be achieved: the individual, the intermediate level of institutions, and the deeper level of class and gender (Kabeer, 2001).

Alsop *et al.* (2006) and Kabeer (1999) define empowerment as the capacity of an individual or a group to make effective choices and change the choices to desired actions and outcomes. This definition has two components that are the component of the agency, which is defined as how a person can act on behalf of what they value and have reason to value, and the component of the institutional environment, which allows people to apply the agency successfully (Alkire, 2008; Ibrahim & Alkire, 2007). This definition is broader since it encompasses the relationship between people and institutions and how they affect each other. The three definitions focus on group choices since individual choices may be limited, especially in cultural societies where community and mutuality are highly valued. Dery (2016) suggests that women access to secure land rights can be an empowerment avenue. Kishor (2000) notes that women can gain empowerment from assets or resources that can improve their livelihood, life choices, and sense of security for themselves and society. The concept of empowerment, therefore, is useful in explaining women's behaviour concerning land tenure security, which influences agricultural productivity and food security of households.

2.4.1 Measurement of women empowerment

According to Asaolu *et al.* (2018) and Ewerling *et al.* (2017), it is challenging to measure empowerment because empowerment cannot be observed and may be a proxy for another phenomenon; it is also inherent. It can sometimes be universal, while at other times, it can be specific in nature. Empowerment can also be observed at an individual or collective level; thus, its determinants can arise from either level. Empowerment can also be applied as

an economic, psychological, socio-cultural and political measure. Finally, measuring empowerment depends on the element of measure (self or others) and how the measurement is done, either qualitatively or quantitatively.

The measurement of women empowerment has a long history due to its diverse definition. In 1990, the United Nations Development Programme (UNDP) developed indices to measure human development as per the Amartya Sens capability approach (Ewerling *et al.,* 2020). In order to capture the gender issue in the Human Development Index (HDI) measure, the Gender-related Development Index (GDI) and the Gender Empowerment Measure (GEM) were added (Kazembe, 2020). The GDI and GEM were developed by Anand and Sen (1995) and introduced by the Human Development Report in 1995. Both the GDI and GEM are used to measure the well-being of citizens in countries; however, GDI can take care of the issues of gender inequality in measuring overall human development.

On the other hand, GEM is used to measure whether there is equality in holding both political and economic power between men and women in a particular society (Schüler, 2006). The GDI and GEM were developed to bring more attention to gender discrimination and equality worldwide. The two measures (GDI and GEM) were, however, faulted for being unable to measure gender inequality in both developed and developing countries adequately. Additionally, GDI was prone to misinterpretation and attracted little attention from researchers (Schüler, 2006). The Gender Gap Index (GGI) is a metric that measures the magnitude and scope of gender-based inequalities and how these elements can be tracked over time (Hausmann *et al.,* 2012). GGI can be used to track the gender inequality of a country and compare it with others of the same level.

Tandon (2016) suggests the need to devise a concise way to measure women empowerment. Sharaunga *et al*. (2018) suggest the sustainable livelihoods approach (SLA). This approach explains how individuals make a living by engaging in economic activities. The main objective of the sustainable livelihood approach is to find more effective ways by which organisations or governments can support communities and individuals with more sustainable and meaningful interventions than having ready-made methods of interventions (De Haan & Zoomers, 2005).

The use of SLA has the following advantages. Firstly, it presents an appropriate tool to understand the relationships among resources and people and strategies used in livelihood interventions and desired livelihood outcomes. Secondly, it is a suitable approach when analysing gender issues with a cultural background because both play a role in transforming society (Lakwo, 2006). Thirdly, since the approach to the different aspects of women

empowerment.

The mentioned measures of women empowerment have methodological weaknesses in that they all use aggregated data; thus, it is difficult to break down into socio-economic and cultural groups such as age, income levels, region, and race, among others. The measures also do not take care of the control over resources or the issues of agency, especially in the agricultural sector, where the labour force provided by women is approximately 43% in developing countries. (Alkire *et al.,* 2013).

Njuki *et al.* (2022) used two indirect measures as a proxy for women's economic empowerment: participation in the labour force by women measured, economic participation, the ability to strengthen job-searching behaviour, and the likelihood of women escaping employment. Economic opportunity was measured by wage work and the ability of women to escape from vulnerable employment, low-paying jobs, and if they had overcome segregation in their workplaces.

The Women Empowerment in Agriculture Index (WEAI), another measure of women empowerment, is a multidimensional index that provides information on the achievement of an individual in different domains (Alkire *et al.,* 2013). It can be decomposed into region, race, age, and gender, among other socioeconomic and cultural aspects. WEAI has five domains: production, resources, income, leadership and time. In each domain, some indicators help measure a respondent's performance. WEAI also introduces the Gender Parity Index (GPI), which helps identify intra-household gender inequalities. The indicators used in WEAI are uniquely chosen, and the survey questions can be tailor-made to meet the local setting. WEAI can be used to measure women empowerment in rural areas irrespective of whether they are farmers or not. WEAI is an improvement of works by Alsop *et al.* (2006), Ibrahim and Alkire (2007), Narayan *et al.* (2009), and Narayan (2005), who proposed domain-based measures to measure women empowerment in agriculture.

2.4.2 Access to land rights by women in Kenya

Kenya's quest for enhancement of the security of land tenure started way before independence. Kenya introduced land reforms by initiating a land registration and titling programme in the agricultural-rich areas following the Swynerton Plan of 1954 (Kijima & Tabetando, 2020). Isinta and Flitner (2018) note that laws on equality in the acquisition and ownership of property, including land across gender, existed prior to the 2010 constitution. For instance, the Law of Succession Act 12 was passed in 1981, explicitly providing equal property inheritance rights for both women and men. The Kenyan Constitution 2010 eliminates all forms

of gender discrimination in acquiring and using property such as land. Other Kenyan laws, such as the Matrimonial Property Act of 2012, the National Land Commission (NLC) Act of 2012, and the Land Registration Act of 2012, strive to achieve gender equality and equity in ownership of productive resources. Furthermore, under Article 2 of the 2010 Kenyan constitution, both regional and international laws, such Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) treaty in 1979, the Beijing Platform for Action 1959, Common Markets for East and Southern Africa (COMESA)'s gender policy of 2002 and East Africa Community (EAC) Treaty of 2000 which advocate for gender equality in ownership of resources are recognised as part of the laws of Kenya (National Council for Law, 2010).

Arguments exist that the coexistence of formal and customary laws in Kenya contributes to women's land ownership challenges (Kameri, 2005; Musangi, 2017). These authors further argue that the discriminative aspects of customary law that tend to disenfranchise women have remained both within households and at the community level. In addition, land-related conflicts involving women have persistently increased in households and, thus, failed to secure women's land rights, especially in rural areas in Kenya (Musangi, 2017).

Like the rest of the developing countries, men in Kenya are more likely to own land than women. Women still face several obstacles to executive roles in industry and government (Djurfeldt, 2020). Due to these aspects, females have higher rates of experiencing violence, being homeless, and relying on government assistance than males (Simotwo, 2019). In recent years, Kenya has seen increased initiatives to assist women in securing property rights (Castillejo & Domingo, 2022). The Community Land Act of 2012, which allows married couples to own and pass on natural land jointly, is one such policy that guarantees women equal rights. Other initiatives to aid women in acquiring land include the Women's Land Rights Programmed and advocacy efforts such as StandUp4WomenLand (Auya, 2022).

Research by Po and Hickey (2018) shows that approximately 14% of Kenyan women are landowners. This could be attributed to patriarchal norms, financial restrictions, and a lack of vigilance in protecting property rights (Massay, 2019). More has to be done before Kenyan women have the same access to property as men. To increase the number of women who own land and raise public knowledge of women's property rights, it is essential to expand existing programs, establish new ones, and make changes to law and policy (Andersson *et al.*, 2018). As a woman in Kenya, securing property ownership presents substantial obstacles. In many cultures, women are not allowed to purchase property without the consent of a male relative,

husband, or father. Women may experience monetary hardship, a loss of personal freedom, or even physical harm in their quest for land rights.

There are more hurdles for women to overcome than for men when purchasing land in Kenya. The first is the widespread belief that everyone is entitled to a piece of Earth. This is reflected by Kenya's legal traditions and modern practices (Ananda *et al.,* 2020). The land is usually significant to dominant nations. This hinders women's ability to acquire land even if they are financially stable. Finally, women's legal rights to property ownership are seldom defended because of their lack of political and social influence (Davison, 2019). This might be because individuals have a lower socioeconomic standing or are not part of the elite groups possessing large tracts of land.

Women discrimination against the right to own property in Kenya could have a devastating impact on the economy. A woman must depend on her male relatives if she cannot farm. Usually, her husband or father provides for her family (Akinola, 2018). Because of how fragile their financial status is, they are an easy target. Moreover, women may not believe in themselves if they cannot buy their homes. Females in urban areas often depend on their male breadwinners for emotional and financial assistance (Daniel *et al.,* 2022). This might make it more challenging for certain people to make life-altering decisions or to escape potentially harmful situations. Antonio *et al.* (2019) noted that a lack of land rights might be a contributor to the increasing violence against women in some areas of the world. Additionally, the possibility of women gaining legal authority over men's possessions might spark violence (Antonio *et al.,* 2019).

There are several ways to enhance women ownership of land in Kenya. First, Schürmann *et al.* (2020) suggest that specific changes to the law need to be made to ensure equal access to land is guaranteed by the law of the land. Equal rights for women to own and inherit property in Kenya are necessary. It is also essential to alter the collective consciousness of the people at large. It might have far-reaching consequences if women in Kenya are denied access to land. The fighting efforts to defend and expand women's rights to land and other forms of property should be enhanced. Successful strategies in other countries include women-only land trusts and quotas for the representation of women in political leadership positions (Chigbu, 2020). Unequal property ownership opportunities for men and women are challenging to resolve. Kenyan women need more robust legal safeguards before they may inherit property or have equal economic opportunities (Onyalo, 2019). Therefore, securing women's land rights is a necessary part of the realisation of the fifth SDG, which is achieving gender equality and empowering all women and girls, as well as goals 1 and 2 of ending poverty and hunger.

2.4.3 Determinants of women empowerment

Literature on what influences the level of women empowerment, especially in the developing world, is still emerging. Assad *et al.* (2014), Bushra and Wajiha (2015), and Sharma and Bansal (2017) indicate that women's level of education, number of people in the household, income from employment, age, assets value, and poverty status are some of the factor influencing the level of women empowerment. Assad *et al.* (2014), when using decision-making ability as a measure of women's empowerment, found out that being a public wage worker in Egpyt enhances women decision-making ability. Additionally, women who took leadership in the absence of their husbands were more empowered than those who were taking a leadership role in the presence of their husbands. On matters of education level, Assad *et al.* (2014) in their study revealed that higher education positively influenced women decision-making ability but negatively influenced their mobility index. Mowla (2009), while using labour market outcomes to measure women empowerment, indicated that increasing the level of education for women is not enough; however, they will benefit more by increasing its quality. On the other hand, Sell and Minot (2018) found out that the type of family, whether the woman is married to a polygamous or monogamous family, influenced the woman's level of empowerment.

2.4.4 Relationship between land tenure security and women empowerment

The subject of women's empowerment and protecting their property rights has recently received attention among policymakers and researchers in developing countries (Higgins *et al.*, 2018). Women's economic and social status rises when they own property. Doss *et al.* (2018) argue that land rights in African societies vary by sex, with women usually getting user rights through men. Women's land tenure security based on patrilineal descent depends on their relationships with their husbands, fathers or brothers (Djurfeldt, 2020; Kingwill, 2016; Peters, 2019). Land tenure insecurity among female-led households results from informal barriers associated with limited access to land resources allocated by communities and inheritance from families (Doss *et al.*, 2018). Informal barriers may also play a role in that women may not be able to exercise their rights of land due to lack of sufficient information, lack of legal knowledge, financial challenges, and weak implementation of laws, among other reasons (Deininger *et al.*, 2011; Quisumbing *et al.*, 2021). Improving women's land tenure security through sole or joint ownership means enhancing their control over property or assets such as land for income generation (Doss *et al.*, 2014; Ghebru & Holden, 2013). This, in turn, improves their bargaining power in decision-making at the household and community levels (Han *et al.*,

2019).

The possession of security of tenure on land by rural women also increases their access to economic, social and political power, which is critical for their empowerment. In addition, they tend to have a stronger fallback position than landless women (Agarwal, 1997). Chigbu (2019) and Widerquist (2013) note that women have to work for someone as peasant farmers to meet their needs due to landlessness among women. Doss *et al.* (2014) argue that women possession of the right to land improves their financial security, influencing and promoting their empowerment. Hare *et al.* (2007) also note that land lost in China through mobility by women was a vital reason for their loss of family status and bargaining power. At the same time, Menon *et al.* (2014) suggest that possession of title deeds by women increases the child's health and education. Bezabih *et al.* (2016), Holden *et al.* (2011), and Mishra and Sam (2016) argue that individual or joint ownership of land by women is a recipe for improved empowerment through agricultural production. Improving women's LTS through titling improved agricultural productivity, household food security, nutrition and participation in land rental markets (Ali *et al.,* 2014a; Ghebru & Holden, 2013; Holden *et al.*, 2011). However, Maxwell and Wiebe (1999) note that enhancing the security of tenure on land may disadvantage the resource-poor and vulnerable segments of the population, particularly women.

Persistent gender disparity in our society's economic and social institutions disproportionately negatively impacts women (Kabeer, 2001). Women's financial independence and agency are stunted in many parts of the world because they do not have the same property rights as men. Devereux *et al.* (2011) note that land tenure security is necessary for women to be financially independent. There is a clear correlation between women's economic and social position and their degree of engagement in political and economic decision-making at all levels, from the household to the country to the world (Meinzen-Dick *et al.,* 2019). If women can benefit economically from access to land, they may take care of it. Better than their male counterparts. Women who own property are more likely to save for retirement and their children's education than males. One of the most effective methods for governments to help women climb the corporate ladder is ensuring land-tenure security for landowners (Chigbu *et al.,* 2019). If land rights legislation and efforts can provide women with more economic and political influence, they may be able to contribute to reducing poverty and advancing gender equality.

Protecting women's rights has given rural women a significant say in their economic future. Women's economic and social position rises When they are granted the same property

rights as men (Schleifer & Sun, 2020). Previous research suggests that poverty alleviation and progress toward gender equality may result from measures to increase land tenure security (Webster *et al.,* 2019). Improvements in health, education, and economic standing have all resulted from women's empowerment. For gender equality to be realised, women must be afforded the opportunities and burdens of property ownership.

Women who achieve financial autonomy must be guaranteed the right to property ownership. When a woman buys her own house, she increases her independence, sense of duty, and probability of becoming involved in local politics (Tseng *et al.,* 2021). Finding stable employment and establishing financial stability should also be less of a challenge for them. Women's economic and political empowerment may be enhanced if property ownership rights are granted. Many rural women are unwilling to leave their homes, which they see as a source of wealth (Galiè *et al.,* 2019). When women face institutional barriers to gaining financial independence, such as limited access to savings accounts and loans, the value of property ownership may rise.

When women own land, they have a greater sense of security and independence in their communities (Diiro *et al.,* 2018). In certain cultures, owning land is a mark of social rank and a public expression of allegiance to one's society. A woman in a patriarchal society may experience a boost in her sense of autonomy and self-worth if she can own property in her name. When women are granted equal protection under the law to possess property, they may find an advantage in the business sector (Sen, 2019). Gaining property rights is a crucial step in achieving economic equality for women. If women put their money back into the house, it may help the family.

The final piece of the puzzle in guaranteeing women's rights might be protecting their ability to own property. Women's rights are not always upheld to the same degree as men's, and they are frequently treated with less respect. If women's property rights were protected by law, they would feel more secure from discrimination and abuse, and their voices would be more prominent in public discourse (Larson *et al.,* 2019). Women have historically played a vital role as land caretakers in their communities, and as a result, women often possess the most comprehensive understanding of ecological processes in their areas. Several environmental catastrophes, such as deforestation, soil erosion, and water pollution, may be averted or at least lessened with the help of this new knowledge. Without the legal right to own, transfer, and inherit property, women would never be able to realise their full potential. Therefore, kids are given both material and emotional stability. It may help the green movement and the movement for women's rights.

2.5 Theoretical framework

The study is based on several theories explaining the hypothesized effect of land tenure security on agricultural productivity, household food security and women empowerment. These theories are property rights theory, utility maximization theory, and production theory.

2.5.1 Property rights theory

This theory describes the relationship between property rights and land tenure security. In 1960, renowned economist Ronald Coase released the first version of the theory of property rights (Auya, 2022). Coase theorizes that a society's economic resources are distributed in accordance with its institutions that regulate property rights. His study shows that establishing and defending property rights allows the market to reallocate resources efficiently (Ayonga, 2021). Demsetz argued that, for fair distribution of resources, clearly established property rights must be strictly enforced (Bambio & Agha, 2018). As reported by Bambio and Agha (2018) he also discovered that the allocation of resources by the market is not always optimal, calling for action on the part of the government.

Property rights are institutions (formal or informal) that define or provide a scope of privileges granted to individuals for specific resources or assets, such as land (Coase, 1960). These rights include rights to use and obtain income from others and to exclude others from using assets such as land. In a wider view, property rights can be described as a "bundle of rights", including the right to access and withdrawal, exclusion, management and alienation rights (Schlager & Ostrom, 1992). Formal property rights are legal, allocated, recognized, or supported by government authorities and enforced by the country's laws. The rights are categorized into four (4), namely, private, common, state and open access property rights. Private rights assign individual rights to physical objects and are viewed as absolute and relative since they ensure the transferability of rights to better use of the asset by others (Furubotn & Richter, 2010).

The classical property rights theory argues that sustainable natural resource management is only possible with individual property rights since it ensures tenure security (Seogo & Zahonogo, 2019). Demsetz (1967) and Hardin (1968) note that individual property rights are rational when deciding on private ownership. Arnold (2002), Peters (2004), and Radin (1982) state that individual property rights are considered an innovation towards the agricultural sector's structural transformation. Thus, land tenure security, which provides individual rights over the land, grants the owner the rights to use, transfer, mortgage, and exclude other people from using the land. The theory of property rights holds that the security

of land tenure is the foundation of agricultural sector growth (Seogo & Zahonogo, 2021).

Coase laid the groundwork, and Alchian expanded on it by showing that property rights impact market efficiency. He argued that when property rights are ambiguous, markets allocate resources inefficiently (Bendzko *et al.,* 2019). Several issues conflict with the concept of individual property rights. Opponents of the idea argue that it ignores or minimizes the state's role in policing markets and redistributing wealth. Despite its widespread acceptance, the theory has been criticized for its inability to explain the role of institutions in the economy adequately.

2.5.2 Utility maximization theory

The study is based on the utility maximization theory, which states that a household's decision to participate in a particular activity is based on whether they will maximize their expected utility by employing their resource endowments, such as land and labour (Mbudzya *et al.,* 2017). Therefore, the household's decision to possess a title deed is based on the expected utility (increased maize productivity, food security and women empowerment). Therefore, it is assumed that households will possess a title deed if the expected utility is more significant than if they do not possess the title deed. The acquisition of title deed decision, therefore, occurs when;

$U^*(T) > U^*(NT)$ where $U^*(T)$ denotes expected utility with a title deed while $U^*(NT)$ denotes expected utility without a title deed. The probability that the household will select an alternative j conditional on their choice set I_i; this is the probability that the perceived utility of the alternative j is greater than that of all the other available alternatives as expressed in equation 1;

$$p^i(j/I_i) = \Pr[U_J^i > U_k^i \forall k \neq j, k \notin, I^i] \quad (1)$$

The perceived utility U_{ij} can be expressed as the sum of two terms: a systematic utility and a random residual. The systematic utility V_{ij} represents the mean (expected value) utility perceived by all decision makers having the same choice context (alternatives and attributes) as a decision maker i. The random residual ε_{ij} is the (unknown) deviation of the utility perceived by the user i from this mean value; it captures the combined effects of the various factors that introduce uncertainty into choice modelling. This theory was used by Mbudzya (2017) and Wabwile (2016) on agricultural land rental market participation in Kwale County and improved sweet potato varieties adoption in Bungoma County, respectively.

2.5.3 Theory of Production- Cobb Douglas production function

The theory explains the relationship between inputs and outputs. It exists in both linear and non-linear forms. The nonlinear production function was estimated by Cobb and Douglas (1928) and has been used extensively in the estimation of productivity and production over the years. The theory was estimated by Cobb and Douglas (1928) and has been used extensively in the estimation of productivity and production over the years. A popular functional version of the Cobb-Douglas production function may be used to estimate the aggregate production function of a farm and gain insight into the forces that shape its growth. The theory assumes a perfect linear relationship between input and output (Uwineza *et al.*, 2021). It is a form production function representing a relationship between output and inputs in a particular firm or farm as expressed in equation 2. It takes the following form;

$$Q = A(t)L^{\beta 1}K^{\beta 2} \quad (2)$$

In linear form, it takes the form as expressed in equation 3;

$$LnQ = \alpha + \delta T + \beta_1 L + \beta_2 K + \varepsilon \quad (3)$$

Where Q, L and K are vectors of output, labour and capital, respectively, δ is the time variable, α is a constant, $\beta 1$, $\beta 2$ are elasticities and ε is the error term. This theory is critical in explaining the production behaviour of firms. In specific ways, the production function of Cobb and Douglas may be reduced to the form $Y = A + K + L$.

Where Y the output A is the total factor productivity, K the capital stock L is the amount of labour input, and the symbols signify the capital-output elasticity and the labour-output elasticity, respectively (Akinola, 2018). For the function to have constant returns to scale, these values must be positive and fulfil + = 1. Agricultural productivity is determined by labour, capital and other factors such as age, farm size and input use.

Cobb-Douglas production function has economic applications (Singirankabo & Ertsen, 2020). It broadens the rule of diminishing returns, which states that increased use of a particular input will first lead to an increase in output and eventually decrease. If the exponents for both capital and labour investment are lower than 1, it is referred to as a decreasing return to scale. In the case where the exponents are more than 1, it is referred to as an increasing return to scale, while if they are equal to one, it is called a constant return to scale. Furthermore, continuous returns to scale are assured if the Cobb-Douglas production function is homogenous to the first degree (Amare *et al.*, 2021). The output increases if the same amount elevates each input. By taking the logarithms of both sides, the Cobb-Douglas production function may be transformed into a linear form. When all the pieces are obtained, standard regression techniques may be

used to achieve a more exact estimate (Ananda *et al.*, 2020).

An extensive empirical investigation of economic development has used the Cobb-Douglas production function. The linearity of this function makes it ideal for use in the estimate. The model has been thoroughly tested using vast economic data collection with encouraging findings. Opponents of parts have risen in number in recent years, assisted by the fallacy of continuous returns to scale (Djurfeldt & Sircar, 2018). Economists still utilize it to this day in their studies of growth drivers. The Cobb-Douglas hypothesis argues that a linear connection exists between inputs and outputs for any given production function. Cobb and Douglas's (1928) economic development theory can increase our knowledge of the past and our capacity to anticipate the future.

This theory supports the study of economics as it highlights the significant differences between succeeding and failing economies (Ansah *et al.*, 2019). To the degree that a country's resources (land, labour, and money) are higher, so too will its production (such as commodities and services). This, therefore, generates a gain in productivity and a widening of the economy as a whole. Despite its universal usage in economics, the Cobb-Douglas model has been critiqued for being extremely basic (Antonio *et al.*, 2019).

2.5.4 Empowerment theory

This theory views women's access to secure land rights as an empowerment avenue. Land tenure security is a general occurrence, especially in the local context. However, in development settings, the questions of who possesses the piece of land, the purpose, and the level of access and negotiation of access to a particular piece of land determine the welfare of the household and community in general (Dery, 2016). According to development theorists and feminist scholars Kabeer (1999) and Malhotra and Schuler (2005), women's access to and control of land are far more than just issues of human rights. Still, they affect the development of a nation. The authors further disagreed that access to land among rural women is empowering; instead, it should be combined with many other factors, such as access to education and financial resources. Kabeer (1999) defines empowerment as an individual's capability to do what can influence his or her welfare. According to the author, empowerment can be divided into three (3) interrelated dimensions: empowerment as an agent, which implies the ability to take part in actions, as a resource and as an outcome (whether decisions made cater for the person's interest). Melesse (2021) noted that women empowerment is, therefore, the expansion of women's asset base and their capabilities in order to be able to make decisions on life choices. Kishor (2000) also noted that individuals can gain empowerment from assets

or resources that can improve their livelihood, life choices, and sense of security for women and society in general.

People's right to make their own life choices is at the heart of the emancipatory theory, often known as the self-determination theory (Doss & Meinzen-Dick, 2020). It is often believed that people have little agency when confronted with structural, institutional, or economic barriers, but research suggests this is not always the case. Examples of people and groups that overcame tremendous odds demonstrate the concept's viability (Eder *et al.,* 2021). It has also been used to investigate what allows some people and places to take advantage of opportune situations (Fuglie, 2018). He says that when all of Maslow's requirements are met, a person reaches a thriving condition he calls autonomy. According to Maslow, one must meet one's physiological needs before cultivating a positive self-concept and reaching one's maximum potential.

When people do not have access to resources that would allow them to meet their higher-order needs on Maslow's hierarchy, their potential for development is stunted, as proposed by the empowerment hypothesis (Galiè *et al.,* 2019). These concepts highlight the benefits and drawbacks of providing individuals with opportunities to improve their social and economic standing. Microfinancing, community development, and vocation training are some economic and social activities linked to the empowerment paradigm (Gannon *et al.,* 2022). Some critics of the empowerment theory have noted that it fails to account for differences in socioeconomic status, sexual orientation, and race (Gao *et al.,* 2019). Although not without its detractors, this idea provides a helpful prism to examine the knotty interplay between individual agencies and authoritative structures.

One of the most fundamental aspects of empowerment is the opportunity to formulate norms and policies that directly affect one's life. Individuals using empowerment-based programs must have faith in their judgment (George *et al.,* 2019). The empowerment thesis draws heavily on humanism, a worldview many social workers hold. Self-determination and independence are honoured. Feminism's emphasis on women's liberation has shaped social work's empowerment movement (Gil *et al.,* 2019).

Land reforms may have far-reaching consequences on food security and women's autonomy among low-income farmers. Those who are less reliant on others are better able to take advantage of opportunities presented to them. The implications of understanding the relationship between land access and food security are profound (Khumalo & Sibanda, 2019). The disparity between men and women regarding financial security and political power is nothing new. The greater the number of women who held property, the greater the likelihood

of food security and the greater the empowerment of women. This illustrates that allowing women farmers equal property rights is a viable strategy for boosting global food production (Kibugi, 2021).

2.6 Conceptual framework

Figure 1 illustrates the linkage between land tenure security, maize productivity, household food security and women empowerment. The demographic, institutional, and land-related characteristics influence land tenure security, maize productivity, household food security, and women's empowerment. At the same time, maize productivity, household food security, and women's empowerment influence land tenure security, hence a reverse relationship. Land tenure security affects maize productivity through land improvements, credit access, and complementary inputs. Overall, land tenure security, maize productivity, household food security, and women's empowerment are expected to improve the livelihoods of small-holder maize farmers in Narok County, Kenya.

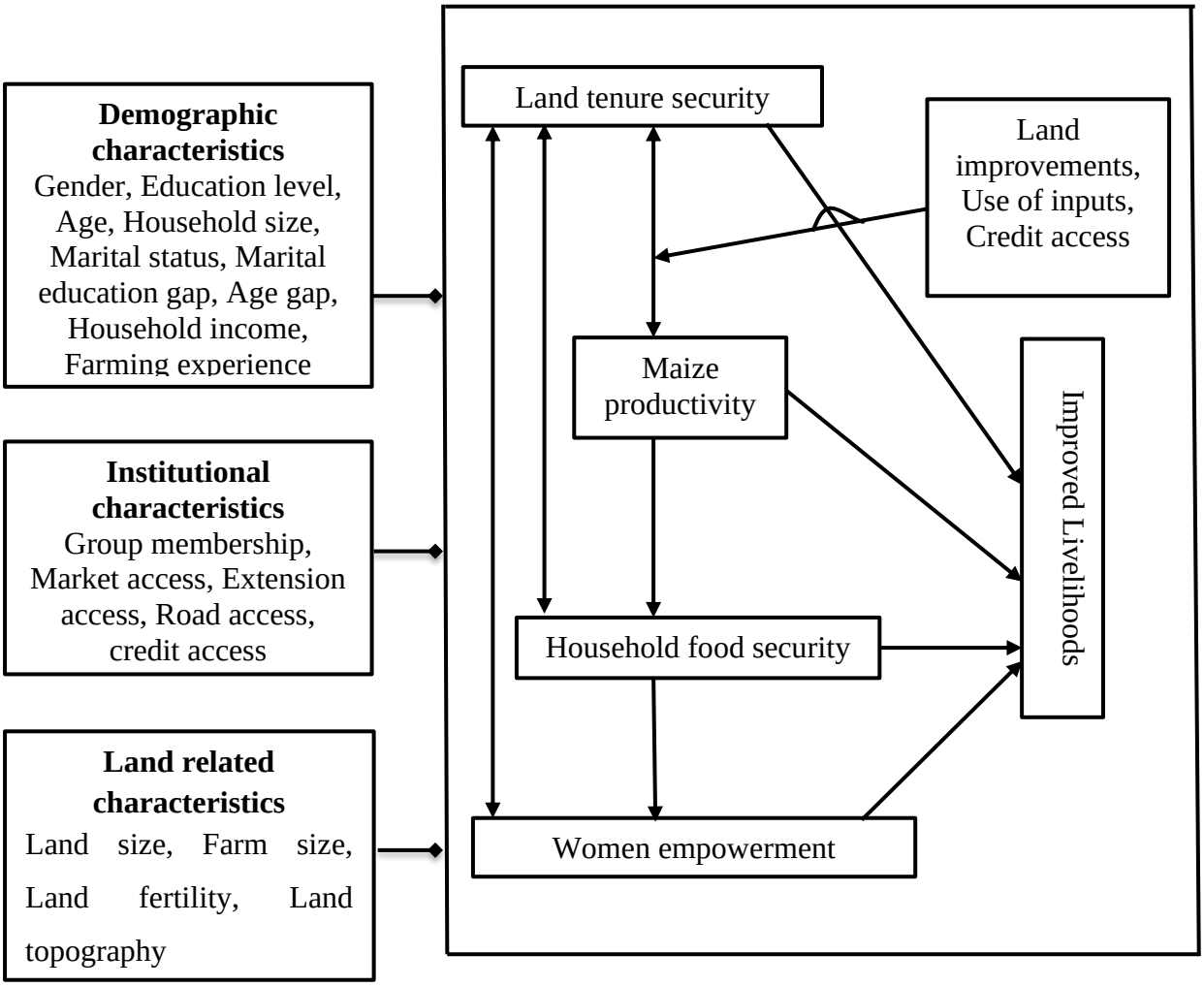

Figure 1: Conceptual framework on the linkage among land tenure security, maize productivity, household food security and women empowerment

CHAPTER THREE

DETERMINANTS OF LAND TENURE SECURITY AMONG SMALL-HOLDER FARMERS IN RURAL KENYA: AN ORDERED PROBIT ANALYSIS

Abstract

Land tenure security is key to achieving rural transformation, diversification, increased agricultural production, and environmental sustainability. However, its determinants are still unclear, especially in Sub-Saharan Africa (SSA). This study evaluated the determinants of land tenure security using an ordered probit model. Using pre-tested semi-structured questionnaires, data were collected from 366 respondents using a multistage sampling procedure. Findings suggest that household heads in the high land tenure security category were older, more educated, owned relatively larger land sizes, and had higher maize productivity with relatively smaller household sizes than the household heads in the low and medium land tenure security categories. Additionally, age, marital status, education level of the household head, number of years the household had stayed on the land, land fertility, land acquisition through purchase, size of land, distance from the household to the parcel, and household size were the main determinants of land tenure security. Pro-youth policies should be enacted to enhance land tenure security. Moreover, laws that protect marital property rights should be put in place to ease the land purchase procedure by reducing transaction costs and weeding out corruption.

3.1 Introduction

The last 50 years have seen the subject of land tenure reforms gain importance in the priority lists of governments and other development partners (Place, 2009). Today, land reforms and, in particular, land tenure security is considered one of the main ways to increase agricultural productivity and food security among nations (Ghebru & Lambrecht, 2017). It is one of the key contributors to a country's growth, development, social cohesion, and poverty alleviation, among other development indicators (Ayamga *et al.,* 2015; Valkonen, 2021).

Land tenure security has also received attention in national and global development agendas. Among them are Kenya's Vision 2030, Sustainable Development Goals (SDG), and the United Nations, Paris Agreement. The Kenyan constitution introduced the National Land Policy to constitutionally recognise land matters, tenure system issues, land use management, and land administration. As a result of the policy, several land laws were legislated to protect the tenure rights of the citizens. These laws include the Government Land Act (Cap 280) of 1982, revised in 2010; Land Titles Act (282) of 1982, revised in 2010, Registration of Titles Act (281) of 1982, revised in 2010, Trust Land Act (Cap 288) of 2010 revised in 2012, and Registered Land Act (Cap 300) of 1989 revised in 2010 (Kieyah & Nyaga, 2010).

Before colonisation, the communal land tenure system was the most commonly used in Kenya. Land tenure insecurity in Kenya started just after Kenya became a British colony when the land was converted to crown land (Kieyah & Nyaga, 2010). Local owners were forcefully displaced from their land and reallocated to the white settlements (Wakoko, 2014). After independence in 1963, all the land was under the presidency to undertake the resettlement of its citizens. However, the process was marred by corruption from politicians and local leaders (Khamisi, 2018).

The Kenyan constitution recognises three types of tenure systems, namely, private (land rights held by an individual), communal or customary (land owned by a particular community as ancestral property), and public or state (the land occupied by schools, hospitals, forests, game reserves national parks) (Djurfeldt, 2020; FAO, 2017). Due to the increasing population, diminishing livelihoods, and pressure by the political class to formalise and privatise land rights, the community land has been sub-divided into plots held by private persons (Kyalo & Chiuri, 2010). The highlighted challenges informed the need to enhance land tenure security of farming communities to increase productivity, forming the basis for this study.

Holden *et al.* (2013) and Muchomba (2017) define land tenure security as the confidence that the individual rights over land will be recognised and protected by other people during an invasion by private investors, expropriation, and distribution by the government.

Land tenure security has three dimensions: *de jure* (tenure sanctioned by government power), *de facto* (tenure security, which is common knowledge), and perceived tenure security (individual subjective evaluation of their tenure scenario) (Quizon, 2017; Van Gelder, 2010). If land tenure security is realised through clearly enforced rights, it can provide an incentive for investments, ease access to credit, and transfer of land, reducing poverty and spurring economic development (Bambio & Agha, 2018; Place, 2009; Valkonen, 2021). Land tenure security increases the participation of women in decision-making, thus giving them a voice in the decision-making processes (Muchomba, 2017; Mwesigye *et al.,* 2017). Furthermore, it protects women's land from dispossession, especially in a patriarchal society (Owoo & Boakye-yiadom, 2015). Land tenure security is considered a key ingredient in environmental protection and safeguarding natural resources (Robinson *et al.*, 2018). In previous studies, Besley (1995) argues that land tenure security improves agricultural investment, hence increasing agricultural productivity.

Neo-classical theories have fronted the individualisation of land tenure rights as a necessary condition for economic growth and development. There is a perception that the privatisation of land rights can efficiently protect land interests. It is against this backdrop that many studies have restrictively defined land tenure security using procedures from the formal land market, such as land titling. Land titling is defined as possessing a legal title deed or certificate over land (Lawry *et al.,* 2017; Ma *et al.,* 2016; Owoo & Boakye-Yiadom, 2015).

While acknowledging the significance of formal land documentation such as a title deed, the question of what measure should be used in areas that largely use the customary land tenure system should not be overlooked. The use of land titling as a proxy for land tenure security may have an insignificant effect in situations where informal and customary tenure systems exist (Arnot *et al.,* 2011; Place & Otsuka, 2002). This study suggests that using several rights (rights to use and rights to transfer land) possessed by an individual may be an appropriate indicator for land tenure security. Therefore, this study argues that the more rights an individual possesses over a certain parcel of land, the higher the land tenure security. Additionally, even though few studies have looked at the drivers of land tenure security (Ayamga *et al.,* 2015; Ghebru and Lambrecht, 2017; Linkow, 2016), they have yet to analyse land tenure security as a categorical variable derived from the possession Therefore, this study attempts to address the knowledge above gap by examining the drivers of land tenure security in Kenya. This study adds to the body of knowledge by analysing the land tenure security variable as a categorical variable derived from the possession of different rights over land.

This paper is organised as follows: the first section provides a brief background of the

study, the works of previous authors, and the research gap to be addressed. In the second section, the methodology used in the study is discussed, along with a background of the study area and sampling procedure. The third section contains a discussion of the descriptive and econometric results. Finally, the fourth section presents the conclusion and recommendations of this paper.

3.2 Methodology

3.2.1 Study area and sampling procedure

The study was conducted in Transmara East and Transmara West sub-counties, which are among the six sub-counties of Narok County, Kenya (Figure 2). The county lies between latitudes 0^0 50' and 1^0 50' and longitudes $35^0$28' and 36^0 25'. The county has a population of about 1,057,873 persons (529,042 males and 528,805 females), making a gender ratio of approximately 1:1 (KNBS, 2019). In the two sub-counties of interest, the average farm size is 5 acres for the small-holder farmers and 20 acres for the large-scale farmers (CGN, 2018). Land ownership in Narok County is categorised into three (3): community, trust, and private land.

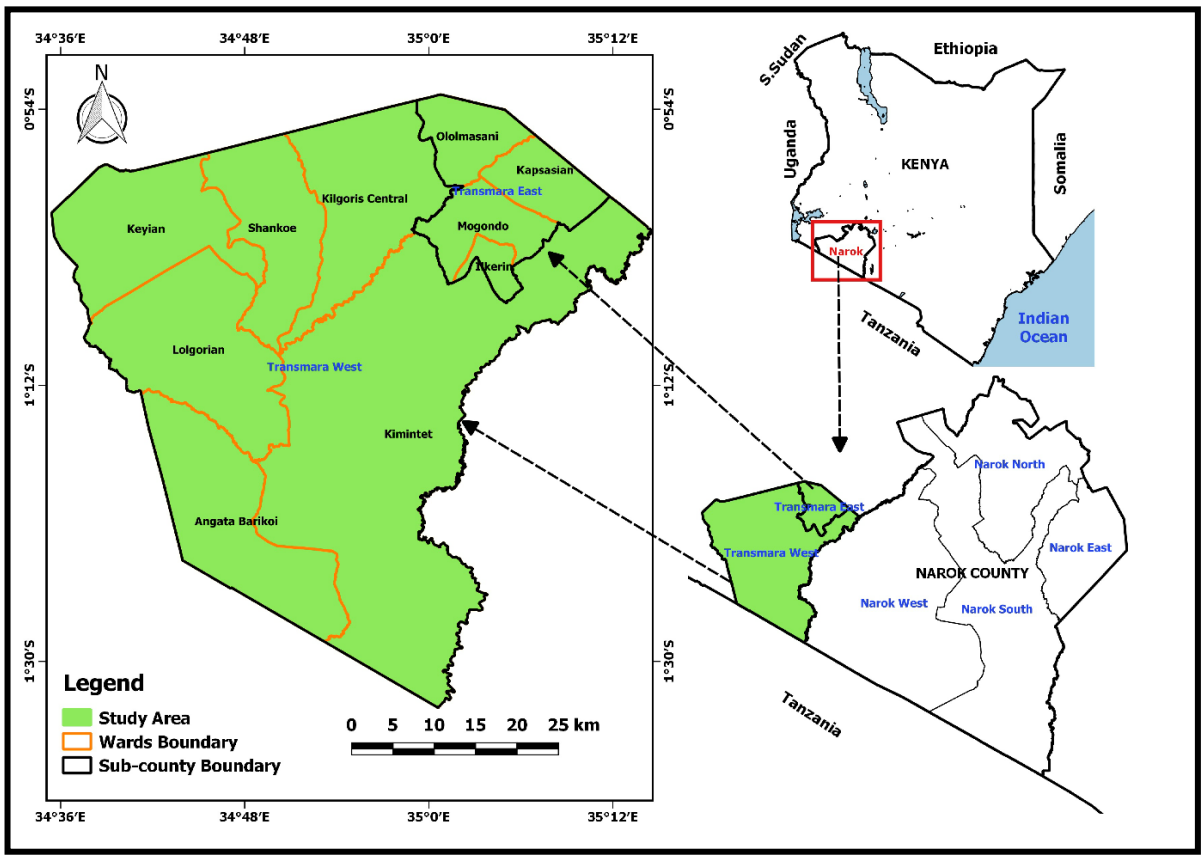

Figure 2: Map of the study area

Source: World Atlas (2019)

The study used a statistical formula by Fleiss *et al.* (2013) and adapted by Bolarinwa (2020) to obtain a sample size of 366 respondents. The sample size per sub-county was calculated based on the population size of small-holder maize farmers in the sub-county. This resulted in 187 and 179 respondents in Transmara West and Transmara East sub-counties, respectively. The study used a multistage sampling procedure to choose the study respondents.

The first stage involved the purposive selection of Narok County due to the frequent land-related conflicts experienced in the area (Kariuki *et al.,* 2016). Transmara East and Transmara West were purposively selected in the second stage because they are the main small-holder maize-producing counties with similar climatic conditions but different socio-economic, institutional, and land-related characteristics (CGN, 2018). The third stage involved the purposive selection of 2 wards in each sub-county, the main maize producers (Mogondo, Ololmasani, Kilgoris Central, and Angata Barikoi). The last stage used systematic random sampling to select the respondents from a list of small-holder maize farmers obtained from the ward agricultural office of the county government of Narok.

Data collection and analysis

Data collection on socio-economic, institutional, and land-related characteristics was done using semi-structured questionnaires installed in Open Data Kit (ODK) data collection software. The data were then coded and analysed using Stata 15 computer statistical software (StataCorp, 2014).

3.2.2 Analytical framework

Measurement of the land tenure security variable

This study used land tenure security as the dependent variable, while independent variables included socio-economic, institutional, and land-related factors. Land tenure security can be measured in different ways. For instance, Carter and Olinto (2003) measured land tenure security (LTS) using the land tenure system associated with the land, that is, private, communal, or public. However, according to Cattaneo (2001), the years the household is expected to reside on the land before eviction can also be used to measure LTS. On the other hand, Holden and Yohannes (2002) used a binary variable that is 1 representing secure land rights and 0 insecure land rights, while Place and Otsuka (2002), in their study, measured LTS using the method of acquiring the land. Place and Otsuka (2002), however, acknowledge that the measure is not explicit enough to capture all the aspects. Rao *et al.* (2016) used the probability of eviction to measure land tenure security, while Owoo and Boakye-Yiadom

(2015) and Ma *et al.* (2016) used a title deed or land certificate ownership to measure land tenure security. This measure is backed by the finding that there is a strong correlation between possession of a legal title and land tenure security (Brasselle *et al.*, 2002). However, possession of a title deed may not necessarily mean having the security of tenure over land (Place & Otsuka, 2000). Illegal squatters in government land have relatively secure land tenure since they face a lower probability of evictions, yet they lack legal title over the land (Rao *et al.*, 2016). Arnot *et al.* (2011) state that when governments are unstable, possessing a legal title may not mean anything.

Due to these inefficiencies in the singular measures of land tenure security, this study adopted (Brasselle *et al*., 2002) definition of land tenure security, which is a composite measure consisting of various rights over the land. According to Brasselle *et al.* (2002), the 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. In order to apply this definition, ten different types of rights were defined based on the two broad categories (right to use and right to transfer). Unlike Place *et al.* (1994), who assigned equal weight to all the rights, this study adopted Brasselle *et al.* (2002) approach that appreciates the different weights each right possesses.

In this approach, households were asked whether they have permanent, transitory (temporary), or none of the user rights. In adapting to Brasselle's approach, the user rights cover the following: (i) choice of crop to grow, (ii) land fallowing and cultivation at the end of the fallow period, (iii) making land developments, (iv) disposal of crop produce, (v) prevention of people's livestock from grazing on the land. Additionally, respondents were asked if they required any approval to enjoy the following rights of land transfer: (vi) give land along customary lines, (vii) transfer land as an inheritance, (viii) lease land in exchange for cash, (ix) sell land, and (x) mortgage the land. All these elements capture the existing concerns relating to the land LTS that may affect the investment. Three (3) categories, low LTS, medium LTS, and high LTS, were derived from the data to distinguish the different levels of land tenure security, making the LTS a categorical variable. This approach eases the interpretation of results and simultaneously captures the different roles of LTS alternatives for rural dwellers (Ajefu & Abiona, 2020; Brasselle *et al.*, 2002). The study also adopted with amendments the categorisation criterion of the land tenure variable(s) as used by Brasselle *et al.* (2002).

Table 1 presents the frequency distribution results of the respondents' various land rights (to use and transfer) in the study area. Results indicated that, among the sampled households, choice of crops to grow, land development, and the right to prevent grazing were

the most common rights; hence, they were difficult to use to create categories. Furthermore, few respondents held less than one right (permanent or transitory). The most prevalent right in the transfer rights was the inheritance right, followed by the right to lease land, the right to give land along customary lines, the right to sell the land, and lastly, the right to mortgage. Since the user rights (ii and iv) and the transfer rights exhibited sufficient variations in the results, they were used to create three (3) categories, namely categories 1, 2 and 3, which represent low LTS, medium LTS and high LTS, respectively.

Category 1 (Low LTS) if they did not hold any transfer rights and didn't hold more than two user rights (whether permanent or transitory) or did not hold the latter two rights (or one of them) or had at least two permanent or transitory user rights in addition to rights (i), (iii), and (v). Category 2 (Medium LTS) if apart from the rights of inheritance and to give land along the customary line, they held the right to lease land (with or without approval) and at least two permanent user rights in addition to rights (i), (iii) and, (v). Category 3 (High LTS) if apart from the rights to inherit, to give land along the customary line, to rent or lease land, to sell land, they had a mortgage right on the land (with or without approval) and at least two permanent rights of use in addition to rights (i), (iii) and, (v).

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

Type land right	**%**	**Type of land right**	**%**
(i) Choice of the crop to grow		(vi) Give land along 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) Lan 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	39.34
Temporary right	12.84	Without Approval	28.96
Permanent right	79.78	With Approval	31.69
Total	100.00	(366 respondents)	100.00

The categorical nature of the dependent variable (land tenure security) necessitates the use of the ordered probit model, which estimates the parameters of the underlying distribution as opposed to the response itself (Daykin & Moffatt, 2002). The model can analyse ordinal multinomial dependant variables. There is a latent continuous metric underlying the ordinal responses (Wollni *et al.,* 2010). The structural form of the model is as presented in Equation 4;

$$Y^{*} = \alpha + \beta X + \varepsilon \quad (4)$$

where Y^{*} denotes the variable that indicates the level of land tenure security, which is in an ordinal form coded as 1, 2, 3, … K. X is a vector of the various explanatory variables

(demographic, institutional, and land-related factors) and ε represents the error term or the unobserved factors that may determine land tenure security. Intervals are as shown in equation 5;

$$\begin{bmatrix} Y_i = 0 \text{ if } Y^* \le \delta_i \\ 1 \text{ if } \delta_1 < Y^* \le \delta_2 \\ 2 \text{ if } \delta_2 < Y^* \le \delta_3 \end{bmatrix} \quad (5)$$

where δ the threshold or cut-off parameter to be estimated β β lacks intercept terms as it is normalised to zero to allow the parameters to be "free" parameters (Daykin & Moffat, 2002). As suggested by Daykin and Moffat (2002) and Wollni *et al.* (2010), it is assumed that ε it is normally distributed, and the probabilities of the observed ordinal responses are given by equation 6;

$$\begin{bmatrix} prob(Y=0) = P(Y^* \le \delta_1) = P(\beta' X + \varepsilon_i \le \delta_1) = \phi(\delta_1 - \beta' X) \\ prob(Y=1) = \phi(\delta_2 - \beta' X) - \phi(\delta_1 - \beta' X) \\ prob(Y=2) = \phi(\delta_3 - \beta' X) - \phi(\delta_2 - \beta' X) \end{bmatrix} \quad (6)$$

Where ϕ is the standard normal cumulative distribution function. The log-likelihood function is used to estimate parameters δ and β, as expressed in equation 7;

$$L = \sum_{i=1}^{n} \sum_{y=1}^{i} \log(\phi(\delta_i - \beta' X) - \phi(\delta_1 - \beta' X)) \quad (7)$$

Since the coefficients from the ordered probit do not provide precise interpretation, marginal effects were obtained (Mallick & Rafi, 2002). Authors such as Al Mamun (2018), Bezabih *et al.* (2011), Dokken (2015), and Mallick and Rafi (2010) used ordered probit to obtain unbiased and consistent results in their research. The socio-economic, institutional, and land-related characteristics used as explanatory variables in this study were adapted from (Ali *et al.*, 2011; Ghebru *et al.*, 2016; Holden & Ghebru, 2016; Lambin & Meyfroidt, 2011; Linkow, 2016; Lovo, 2016). These variables include age, sex, education level, and marital status of the key decision-maker on farming matters, land size, adult equivalent, land concentration, years of cultivation, fertility of the land, market access, road access, leadership, land acquisition, land dispute, and group membership as presented in table 2.

Table 2: Description and measurement of variables used in the ordered probit model

Variable name	Description and measurements of variables	Type of variable
Dependent variable		
Land tenure security	Level of land tenure security	Categorial-1 =low , 2= medium , 3=high
Independent variables		
Age	Age of the household head in years	Continuous
Education level	Years of schooling by the household head	Continuous
Household size	Number of people in the household	Continuous
Land stay	Number of years household had stayed on the land	Continuous
Land size	Total land size in hectres	Continuous
Parcel access	Time taken from the house to the parcel in minutes	Continuous
Maize productivity	Productivity of maize (Kg/Ha)	Continuous
Household income	Total household income in Kenya Shillings	Continuous
Sex	Sex of the household head	Dummy-1=male, 0=female
Marital status	Marital status of the household head	Dummy-1=married, 0=not married
Community leadership	Whether the household head is or was a community leader	Dummy-1=yes, 0=no
Land concentration	Whether the land is concentrated in one area	Dummy-1=yes, 0=no
Land acquisition	Method of land acquisition	Dummy-1=purchase, 0=not purchase
Land dispute	Whether there is a dispute concerning the land	Dummy-1=yes, 0=no
Land fertility	Fertility of land	Dummy-1=fertile, 0=not fertile

Land topography	Topography of the land	Dummy-1=hilly, 0=flat

3.3 Results and discussion

3.3.1 Descriptive and inferential statistics

Table 3 presents descriptive and inferential results of continuous variables used to analyse the determinants of land tenure security. The results show that, overall, the mean age of the household heads was 43.63 years. The pairwise correlation results indicate that there was a significant negative correlation between low land tenure security and the age of the household head at a 1% significance level. In addition, the results indicate that there was a significant positive correlation between high land tenure security and the age of the household head, underscoring the importance of experience, knowledge, and skills in securing land, which is associated with older people.

Overall, the average years of schooling of the sampled household heads was 9.47. The correlation results show a significant negative correlation between education level and low land tenure security. On the other hand, there was a significant positive relationship between education level and high land tenure security. As suggested by Rao *et al.* (2020), better-educated individuals tend to be more updated with information; hence, they can secure their land more quickly and easier than their less-educated counterparts.

The overall mean household size for the sampled household was 4.54, with pairwise correlation results indicating a positive significant correlation between household size and low land tenure security at 1%. Furthermore, the correlation results show a significant negative correlation between household size and high land tenure security at a 5% level. The household size determines household resource utilisation, and therefore, households with more members are more likely to allocate resources to pressing needs such as educating children and purchasing food rather than investing in securing land rights (Djurfeldt, 2020).

Table 3: Descriptive and inferential statistics of continuous variables used in the ordered probit model

Variable name	Description of variables	Overall sample	Low land tenure security	Medium land tenure security	High land tenure security
Continuous variables			**Pairwise correlation**		
Age	Age of the household head in years	43.63 (11.92)	-0.17***	-0.04	0.19***
Education level	Years of schooling of the household head	9.47(4.04)	-0.14**	-0.05	0.16***
Household size	Number of people in the household	4.54(1.75)	0.16***	-0.02	-0.14**
Land stay	Number of years household had stayed on the land	16.59 (11.69)	-0.15***	-0.003	0.15**
Land size	Total land size in hectares	1.65(1.49)	-0.18***	-0.03	0.19***
Parcel access	Time taken from the house to the parcel in minutes	3.69 (3.03)	-0.24***	-0.002	0.23***
Maize productivity	Productivity of maize (Kg/Ha)	2484.31 (1249.00)	-0.11***	0.04	0.09**
Household income	Total household income in Kenya shillings	256,598.90 (205029.8)	-0.07	-0.01	0.08

Standard deviations in parenthesis

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

Overall, the mean number of years a household had stayed on the parcel of land was 16.59 years. Pairwise correlation results indicate a significant negative correlation between low land tenure security and the stay period at a 1% significance level. On the other hand, a significant positive relationship between high land tenure security and stay period was recorded at a 5% level. This finding suggests that households who stayed on the land for longer periods tend to be more secure in land tenure than those who stayed for shorter periods. The more a household stays in a particular parcel of land, the more they tend to carry out investments such as planting trees, thus increasing their land tenure security. Joel and Bergaly (2020) note that carrying out investments on a piece of land is a function of the duration a person has owned it, which influences land tenure security.

Overall, the average land size for the sampled respondents was 1.65 hectares. In addition, there was a statistically significant positive correlation at a 1% significance level between low land tenure security and land size. Furthermore, there was a significant positive relationship between high land tenure security and land size. Having more land provides an incentive for one to secure it so as to protect it from land grabbers (Ghebru & Lambrecht, 2017).

The average walking time from the homestead to the parcel of land was 3.69 minutes, indicating that the parcels were relatively nearer to the homesteads. The results further indicate a significant negative relationship at a 1% significance level between low land tenure security and the walking time to the parcel of land. On the other hand, results indicate a significant positive correlation between high land tenure security and the walking time to the parcel of land from the homestead at a 1% significance level. The more time it takes to reach the parcel, the further the distance; hence, the incentive to secure the land rights is to prevent private developers from grabbing it. Nearer parcels of land are usually more secure; hence, owners tend to be less motivated to secure them (Djurfeldt, 2020).

The average maize productivity for the sampled household was 2484.31kg/Ha. The pairwise correlation results indicate that there was a negative correlation between low land tenure security and maize productivity. There was also a significant positive correlation between high land tenure security and maize productivity. Land tenure security tends to incentivise farmers to invest in productivity-enhancing technologies such as irrigation and the use of fertilisers. Consistent with Rashid (2021) findings, land ownership documents could be used as collateral to secure credit facilities, which may be used to invest in new farming technologies, thus increasing productivity.

Table 4 presents the results of the descriptive and inferential statistics of the categorical

variables used in the study. In general, the findings indicate that the majority of the respondents were males (54.10%). Moreover, with respect to the three categories of land tenure security, there was a statistically significant relationship at a 1% significance level between land tenure security and the gender of the household head. In the medium and high land tenure security categories, most household heads were males at 54.17% and 62.87%, respectively. In contrast, women were the majority in the low land tenure security category (58.57%). In most rural communities, the patriarchal system is rampant; hence, men have better access to resources and information, making it easier to secure their land than their female counterparts.

The majority (77.60%) of the study respondents did not acquire their land through purchase, which indicates the underdevelopment of the land markets in the study area. Regarding the three categories of land tenure security, most respondents acquired their land through purchase, with chi-square results showing a statistically significant relationship between the method of land acquisition and land tenure security at a 1% significance level. Land acquisition through purchase in Kenya follows a well-laid-down procedure. Hence, owners, especially in rural areas, are most likely secure compared to those who have acquired land through other means, such as inheritance leasing, among other ways (Valkonen, 2021).

The majority (71.86%) of the respondents reported that their land was fertile. With respect to the three categories of land tenure security, most of the respondents had fertile land at 63.57%, 79.17% and 76.73% for the low, medium and high land tenure security categories, respectively. Land fertility was significantly related to land tenure security at a 5% significance level as per chi-square results. The fertility of the land is an essential aspect in determining the value of the land. Fertile parcels of land are deemed productive, and hence, owners are incentivised to secure their rights over such parcels of land. On the other hand, less fertile lands are less valued due to their low productivity and, thus, less incentive to secure land rights.

Table 4: Descriptive and inferential statistics of categorical variables used in the ordered probit model

Variable Name	**Description of variables**	**Response**	**Overall sample (%)**	**Low land tenure security (%)**	**Medium land tenure security (%)**	**High land tenure security (%)**	χ^2
Land tenure security	% of respondents as per the land tenure security category			38.25	6.56	55.19	
Sex	Sex of the household head	Male	54.10	41.43	54.17	62.87	15.31***
		Female	45.90	58.57	45.83	37.13	
Marital status	Marital status of the household head	Married	64.75	65.71	62.50	64.36	0.12
		Not married	35.25	34.29	37.50	35.64	
Community leadership	Whether the household head is or was a community leader	Yes	15.57	13.57	8.33	17.82	2.16
		No	84.43	86.43	91.67	82.18	
Land concentration	Whether the land is concentrated in one area	Yes	97.81	99.29	100.00	96.53	3.50
		No	2.19	0.71	0.00	3.47	
Land acquisition	Method of land acquisition	Purchase	77.60	12.86	12.50	30.20	15.75***
		No purchase	22.40	87.14	87.50	69.80	
Land dispute	Whether there is a dispute concerning	Yes	10.38	9.29	16.67	10.40	1.20

	the land	No	89.62	90.71	83.33	89.60	
Land fertility	Fertility of land	High	71.86	63.57	79.17	76.73	7.76**
		Low	28.14	36.43	20.83	23.27	
Land topography	Topography of the land	Hilly	36.61	32.86	37.50	39.11	1.40
		Flat	63.39	67.14	62.50	60.89	

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

3.3.2 Determinants of land tenure security

The ordered probit model chi-square results (Table 5**)** of 122.48 with 16 degrees of freedom and a p-value of 0.000 shows that it is significant at a 1% significance level. Thus, the independent variables included in the model sufficiently explain the variations in the dependent variable. The model threshold parameters α_1 α_2 are significant at 5% and 10%, respectively, underscoring the reliability of the model results. Due to the problem of interpretation of ordered probit results, Wollni *et al.* (2010) and Mallick and Rafi (2002) suggest post-estimation marginal effects of the ordered probit model to ease the estimation of the model.

Sex, marital status, years of schooling of the household head, land acquisition, land fertility, period the household had stayed on the land, land size, parcel access, and household size are statistically significant at different significance levels. Male-headed households reduce the probability of the household having low and medium land tenure security by 45.5% and 1.9%, respectively. However, it increased the probability of having high land tenure security by 47.3%. The study area is a patriarchal community; men are regarded as the custodians of the family property, such as land and therefore possess more rights than women. Similarly, Whitehead and Tsikata (2003) found that women, especially in customary land tenure systems, face difficulties in possessing land rights. Moreover, due to women's weaker position concerning socio-economic status in the community, they tend to behave insecurely in land tenure matters (Ghebru & Lambrecht, 2017).

Marriage reduces the likelihood of having high land tenure security by 44.5%, while it increases the likelihood of having low and medium land tenure security by 40.7% and 3.8%, respectively. Married people are more likely to have children, and therefore, they may allocate the land to their young ones, making it difficult for them to be trusted by the community. This finding is contrary to research by Ghebru and Lambrecht (2017) and Valkonen (2021), who noted that marriage helps household heads attain a high level of social and economic status and thus secure their land easily as compared to unmarried household heads.

Although the results show that advancement in education decreases the probability of households having low and medium land tenure security by 1.7% and 0.1%, respectively, it increases the probability of having high land tenure security by 1.8%. Higher levels of education expose an individual to opportunities that can be used to secure land. Formal education enables one to get timely, updated, and correct information on land-related policies that may improve land tenure security (Rao *et al.*, 2020; Rashid, 2021).

The method of land acquisition was statistically significant at a 1% significance level

in all categories of land tenure security. Acquisition of land through purchase increases the likelihood of households.

Table 5: Ordered Probit results on the determinants of land tenure security

Variables	**Coefficients**	**Marginal effects (dy/dx)**		
		Low land tenure security	**Medium land tenure security**	**High land tenure security**
Sex	1.271***(0.250)	-0.453***	-0.019***	0.473***
Marital status	-1.251***(0.260)	0.407***	0.038***	-0.445***
Age	0.007 (0.009)	-0.003	-0.000	0.003
Education level	0.0461**(0.023)	-0.017**	-0.001*	0.018**
Land concentration	-0.840 (0.787)	0.244	0.037	-0.281
Land acquisition	0.821***(0.193)	-0.268***	-0.029***	0.297***
Land dispute	-0.108 (0.233)	0.041	0.002	-0.043
Land fertility	0.387** (0.171)	-0.147**	-0.006**	0.153**
Land stay	0.019** (0.009)	-0.007**	-0.000*	0.007**
Land size	0.130** (0.063)	-0.048**	-0.003*	0.051**
Parcel access	0.117***(0.032)	-0.043***	-0.003**	0.046***
Maize productivity	-1.640 (0.000)	6.090	3.750	-6.461
Household size	-0.110** (0.043)	0.041**	0.003**	-0.043**
Community leadership	-0.275 (0.221)	0.105	0.004*	-0.109
Land topography	-0.021 (0.155)	0.008	0.000	-0.008
Household income	1.471 (3.801)	-5.440	-3.341	5.771
α_1	0.318** (0.918)			
α_2	0. (0.918)			
No. of observations	366			
LR chi2(16)	122.48			
Prob>chi2	0.000			
PseudoR2	0.191			

Standard errors in parenthesis

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

to be high land tenure security by 29.7%. In contrast, it reduces the probability of having low and medium land tenure security by 26.8% and 2.9%, respectively. Land purchase in Kenya follows a formal process, and therefore, holders tend to have more secure rights than those who acquire land through other means, such as inheritance. In areas where land markets are relatively developed, land acquired through purchase tends to be more tenure secure since the purchase process mainly involves government institutions (Djurfeldt, 2020).

Ownership of fertile land increases the probability of having higher land tenure security by 15.3% as opposed to those in low and medium land tenure security categories at 14.7% and 0.6%, respectively. Due to the expected benefits derived from fertile lands, such as high productivity, holders tend to protect the land from illegal exploration and grabbing. Fertile lands usually attract a higher value in either formal or informal land markets. This motivates owners to secure their properties for fear of losing the land (Coulibary, 2021). On the contrary, Joel and Bergaly (2020) found that fertile land requires fewer investments for optimal production and, hence, less incentive to secure the land.

The longer a household stays in the land increases the probability of being in the high land tenure security category by 0.7% while reducing the probability of being in the low land tenure security category by 0.7%. The longer someone stays in a parcel of land, the more likely they make short- and long-term investments in the land. The investments may increase the tenure security of the land. Similarly, Brasselle *et al.* (2002) and Joel and Bergaly (2020) found a positive relationship between land investments and improvements such as planting trees, fences, soil conservation structures, and land tenure security.

An increase in land size by a hectare increases the likelihood of a household being in the high land tenure security category by 5.1%. In comparison, it reduces the likelihood of being in the low and medium land tenure security categories by 4.8% and 0.3%, respectively. Households with large tracks of land are more likely to be influential and, therefore, able to control the governing land system in the community. This finding is consistent with the findings by Ayamga *et al.* (2015), who noted that the perception of being land tenure secure could result from abundant land. However, Alemu (1999) and Ghebru and Lambrecht (2017) argue that households with large pieces of land may find it challenging to manage and protect them from encroachment.

The more time (minutes) spent walking from the homestead to the land parcel increases the probability of a household's security land tenure by 4.6%. The more minutes, the more the parcel is exposed to land grabbers and illegal explorations; therefore, it incentivises securing the land to protect it. A plot of land relatively far from one's homestead is more likely to be

reallocated to other users, hence the motivation to secure the land (Sitko *et al.*, 2014).

Households with more members are less likely to belong to the high land tenure security category land by 4.3%. Household members in most rural households are the providers of agricultural labour; therefore, the availability of sufficient manpower reduces the amount of idle land, demotivating securing the land. This conflicts with the finding by Rashid (2021), who argued that large households motivate land tenure security due to the increased demand for land.

3.4 Conclusion and recommendations

The study sought to determine land tenure security drivers using the ordered probit regression model. Findings indicate that high land tenure security household heads were older, better educated, owned relatively larger land sizes, and had higher maize productivity with relatively smaller household sizes than in low and medium land tenure security households. In addition, age, marital status, years of schooling of the household head, period the household had stayed on the land, land fertility, method of land acquisition, size of land, distance from the homestead to the parcel, and household size were the main determinants of land tenure security. The study findings have implications for the relevant policies on strengthening land tenure security in rural areas.

In order to improve land tenure security for households, more pro-youth and women's policies should be developed to increase the community's social status. Additional laws that protect marital land should be enacted to enhance tenure security among married people. Acquisition of land through purchase can potentially increase households' land tenure security. Therefore, the government and other stakeholders should focus on developing additional policies geared towards easing the land purchase process, reducing transaction costs, and weeding out corruption. Moreover, effective implementation of the existing laws and policies should also be encouraged.

CHAPTER FOUR

EFFECT OF LAND TENURE SECURITY ON MAIZE PRODUCTIVITY AMONG SMALL-HOLDER MAIZE FARMERS IN NAROK COUNTY, KENYA: A CONDITIONAL MIXED PROCESSES ANALYSIS

Abstract

Land tenure security among rural households is integral to achieving high agricultural productivity. However, there is limited information on the nexus among land tenure security, credit access and agricultural productivity. This research investigates the effects of land tenure security on maize productivity through credit access. Using pre-tested semi-structured questionnaires, cross-sectional primary data were collected from randomly selected 366 small-holder maize farmers in Trans-Mara East and Trans-Mara West sub-counties of Narok County. Descriptive statistics and a conditional mixed process (CMP) model were used to analyse the data. Results show that 46.99% of the households interviewed had land title deeds. Farmers with land title deeds were more educated, had larger land and farm sizes productive parcels, and obtained higher gross margins than those without land title deeds. Moreover, most household heads with secure land tenure were married and had community leadership positions. Furthermore, land tenure security was significantly influenced by the sex, marital status, and education level of the household head, as well as the presence of land disputes, soil fertility, and land purchase. This study confirmed the relationship among land tenure security, credit access and maize productivity. Land tenure security significantly and positively influenced credit access, while farmers with access to credit increased maize productivity by 2001.902 Kg/Ha. Findings call for efforts by stakeholders to enact additional policies that could promote cost-friendly access to secure land tenure through the acquisition of land title deeds. Additionally, the government must encourage the development and strengthening of land and credit markets to stimulate agricultural productivity.

4.1 Introduction

The United Nations Sustainable Development Goals (SDGs) 1 and 2 of 2015 envision that, by 2030, the world will be free of hunger and any forms of food insecurity and malnutrition (CEPAL, 2018). However, over five years after their adoption by member states, approximately 768 million people worldwide are still food insecure, with more than three-quarters coming from Africa, Asia, and Latin America (FAO *et al.*, 2021). This can be attributed to the mismatch between the focus of agricultural reforms and the intended recipients– the rural dwellers. Agricultural sector growth in Sub-Saharan Africa (SSA) is estimated to be eleven times more effective in reducing poverty than other sectors, underscoring the sector's critical role (Nagarajan *et al.*, 2019). In Kenya, the agricultural sector contributes about 26% of the Gross Domestic Product (GDP), employing more than 40% of the total population and more than 70% of the rural population (FAO, 2022). The sector is envisioned to increase the country's annual growth rate by 10% by 2030 (GoK, 2021).

The maize farming sub-sector plays a vital role in the agricultural sector's contribution. Maize (Zea mays) is one of the major cereal crops in the world, ranked third after rice and wheat (Mekureyaw, 2017). It is Africa's most widely cultivated cereal grain and is a staple food in most parts of Africa (Nagarajan *et al.*, 2019). Kenya is considered a food security and the main staple food crop (Nagarajan *et al.*, 2019). It accounts for approximately 40% of the cultivated area with an estimated annual production of 3 million MT and a national average productivity of 2 MT per hectare (GoK, 2021). FAO (2022) indicates that about 75% of the maize production in Kenya is from small-holder farmers. However, approximately 20% of the maize produced by small-holder farmers is sold, while the rest is consumed at the household level, underpinning the crop's importance to the country's food security status. Low maize productivity remains a challenge that curtails the growth of the agricultural sector and the corresponding contribution to the country's GDP in general (GoK, 2021). The increase in the Kenyan population, currently standing at slightly above 50 million (KNBS, 2019), and the corresponding limited land area of approximately 582.650km^2 is one of the reasons for the increased pressure on productive resources such as agricultural land (KNBS, 2019). This makes it a potential source of land tenure insecurity in Kenya (GoK, 2021). Land tenure insecurity is one of the key contributors to conflict, low land investments, and low maize productivity (Mekureyaw, 2017).

Access to secure land tenure is considered a key driver of rural development and poverty reduction (Higgins *et al.*, 2018). Policymakers worldwide have prioritised securing their citizens' land tenure (Singirankabo & Ertsen, 2020). This study measures land tenure

security by possessing a land title deed. Possession of a land title deed has been considered one of the main ways of ensuring that rights to one's land is formally recognised and protected by the state. The International Federation of Surveyors defines land titling or registration as the official process of recording lawfully recognised rights to land (Barrows & Roth, 1990). This is usually accompanied by a formal and legal document given to the owner(s) as proof of ownership and registration. The document indicates the rights held on a particular piece of land as provided by law.

Before independence, Kenya operated with a mixture of private and customary land laws, which were considered impediments to increasing agricultural production (Kieyah & Nyaga, 2010). Pre-independence, the Swynnerton Plan was published to intensify changing land tenure systems from customary to private through land registration (Swynnerton, 1955). The government enacted the Registered Land Act of 2012 to ensure access to secure land rights, which reclassified land into three categories: private, public, and trust.

The 2010 Kenyan constitution recognises three types of tenure systems: private, communal or customary and public or state (Djurfeldt, 2020). The private or freehold land tenure system consists of land rights held by an individual. This category of land was previously occupied by white settlers and converted from community land to private land. The community land tenure system, or group ranches, is rights over land a particular community holds as ancestral property. Public or state or trust land tenure system refers to rights over the land held by the state in trust. Public land includes land occupied by schools, hospitals, forests, game reserves and national parks. Increasing population, diminishing livelihoods and pressure by the political class to formalise and privatise land have led to community land being sub-divided into plots held by private persons (Willy & Chiuri, 2010), hence the need to secure these rights to land. Land ownership in Narok County is categorised into three (3): community land, trust land, and private land. Private land forms the largest category, with more than 50% of the households possessing land title deeds (CGN, 2018).

Under the constitution of 2010, Kenya enacted the Land Act of 2012 to guide land registration. Today, approximately 30% of Kenya's total land area is registered with over 5 million title deeds (Jeppesen & Hassan, 2022). These various legislations aim to promote the security of land tenure, which can be used as collateral for credit access from financial institutions. The credit obtained could be used to invest in adopting modern agricultural technologies, hence increasing productivity (Kieyah & Nyaga, 2010). This study defines access to credit as whether a farmer can apply for credit in a formal credit source. According to the CGN (2018), there are 15 national commercial bank branches, eight microfinance institutions,

and 15 savings and credit cooperative societies (SACCOs) in Narok County. The credit facility is one of these institutions' major financial services/products.

Traditionally, land tenure security and agricultural productivity have been researched separately; hence, the linkage between the two is a relatively new subject area (Atwood, 1990; Chigbu *et al.*, 2019). A previous study by Hanstad (1997) argues that possessing individual and secure land tenure is key to increasing agricultural production, poverty reduction, and economic growth. Land tenure security also positively affects access to credit and farming investments (Jacoby *et al.*, 2002; Sossou & Mbaye, 2018). Moreover, Bambio and Agha (2018), Nkomoki *et al.* (2018), and Paltasingh (2018) argue that the security of land tenure, whether land title or customary, significantly increases the adoption rate of agricultural technologies, encourages enterprise diversification and use of complementary inputs as well as promoting agricultural investments. Land tenure insecurity demotivates households from investing in the land for fear of eviction, as evidenced by Deininger *et al.* (2011), Linkow (2016), and Lovo (2016). Other studies by Ali *et al.* (2011), Holden and Ghebru (2016), and Lambin and Meyfroidt (2011) suggest that land tenure security increases land conservation practices and agricultural productivity.

Migot-Adholla *et al.* (1994) and Pinckney and Kimuyu (1994), on the other hand, found no significant effect of land titling on agricultural productivity due to the underdevelopment of credit markets. Land tenure security has no significant impact on agricultural land investments, access to credit, and crop yield (Matchaya, 2010; Migot-Adholla *et al.*, 1991; Jacoby & Minten, 2007; Place & Hazell, 1993). Much of the research concurs that land tenure security stimulates investments; however, the reverse is also true, as found in research by Brasselle *et al.* (2002) and Moreda (2018).

Although previous studies have attempted to investigate the effect of land tenure security on agricultural productivity, there is still limited literature linking land tenure security, access to credit, and agricultural productivity in Kenya and other SSA countries. The available literature has resulted in inconclusive findings, while the results vary by crop enterprise, country, and even the measurement of land tenure security variable. Most of the literature on this subject, such as by Bangwayo-Skeete *et al.* (2010), Field *et al.* (2006), Kohansal *et al.* (2008), Newman *et al.* (2015), and Sheuya and Burra (2016), have studied only two components that are either land tenure security and maize productivity or land tenure security and credit access and productivity, thus breaking the conditional link among land tenure security, access to credit and maize productivity. Analysing the linkage between land tenure security and agricultural investments without considering whether access to credit is caused by

land tenure security may result in erroneous findings (Joel & Bergaly, 2020; Rashid, 2021). This paper, therefore, attempts to bridge this knowledge gap and contribute to the body of knowledge by analysing the effect of land tenure security on maize productivity through credit access in Kenya. This paper also uses an innovative econometric model (Conditional Mixed Process) to address the endogeneity problem that exists in this study.

Additionally, the research was carried out in an area prone to land-related conflicts, providing a unique feature to this study. The rest of the paper is organised as follows: Section 2 provides the theoretical framework, while Section 3 presents the methodology, which includes a brief on the study area, sampling procedure and analytical method used in the study. Section 4 provides descriptive statistics, model results and discussions on the effect of land tenure security on maize productivity. Section 5 provides the conclusion and policy recommendations based on the findings. Section 7 presents the study's limitations and recommendations for further research.

4.1.1 Theoretical framework

The study is based on the property rights theory and the production theory, which explain the hypothesised nexus between land tenure security, credit access, and maize productivity.

Theory of property rights

This theory describes the relationship between property rights and land tenure security. Property rights are institutions (formal or informal) that define or provide a scope of privileges granted to individuals for certain resources or assets, such as land (Coase, 1960). These rights include rights to use, obtain income from and exclude others from using the assets such as land. In a wider view, property rights can be described as a “bundle of rights”, including the right to access and withdrawal, exclusion, management and alienation rights (Schlager & Ostrom, 1992). Formal property rights are legally allocated, recognised, or supported by government authorities and enforced by the country's laws (Furubotn & Richter, 2008). These rights are categorised into 4, namely: private, common, state, and open access property rights. Private rights assign individual rights to physical objects and are viewed as absolute and relative since they ensure the transferability of rights to better use of the asset by others (Furubotn & Richter, 2008).

The classical property rights theory argues that sustainable natural resource management is only possible with individual property rights since it ensures tenure security

(Seogo & Zahonogo, 2019). Demsetz (1967) and Hardin (1968) note that individual property rights are rational when deciding on private ownership. Radin (1982) and Arnold (2002) state that individual property rights are an innovation towards the agricultural sector's structural transformation. Thus, land tenure security, which provides individual rights over the land, grants the owner the rights to use, transfer, mortgage, and exclude other people from using the land. The theory of property rights holds that the security of land tenure is the foundation of economic growth (Seogo & Zahonogo, 2019).

The theory of production -Cobb Douglas production function

The theory explains the relationship between inputs and outputs. It exists in both linear and non-linear forms. The non-linear production function was estimated by Cobb and Douglas in 1928 and has been used extensively to estimate productivity and production over the years. It is a form production function (equation 8) representing a relationship between output and inputs in a particular firm or farm. It takes the following form;

$$Q = A(t)L^{\beta 1}K^{\beta 2} \tag{8}$$

In linear form, it takes the form as expressed in equation 9;

$$LnQ = \alpha + \delta T + \beta_1 L + \beta_2 K + \varepsilon \tag{9}$$

Where Q, L and K are vectors of output, labour and capital, respectively, δ is the time variable, α is a constant $\beta 1$, $\beta 2$ are elasticities and ε is the error term. This theory is key in explaining the production behaviour of firms. The labour, capital and other factors such as age, farm size and input use determine maize productivity.

4.1.2 Heterogeneity analysis

Previous studies on the relationship among land tenure security, credit access and agricultural productivity reveal various findings. A recent study in Benin found that enhanced security of land tenure in the initial stages of land formalisation has a positive effect on the decision to invest and, hence, an increase in agricultural productivity (Sossou & Mbaye, 2018). Ali *et al.* (2017) also argue that improved land rights may increase land-related investments and land tenure security. Improved land tenure security increases transparency, giving financial institutions confidence while accessing credit facilities. The accessed credit could be used in agricultural investment, increasing agricultural productivity (Barrows & Roth, 1990; Han *et al.,* 2019). However, research in Kenya shows that land tenure security did not significantly affect maize yields due to the underdeveloped credit markets, especially in the rural areas. The study questioned the rationale of the government's ambitious land registration and titling

program (Delville, 2010). Moreover, Pender *et al.* (2006) noted a negative relationship between land tenure security and agricultural productivity.

4.2 Methodology

4.2.1 Study area, sample size determination, and sampling procedure

The study is based on cross-sectional data collected in September 2021 from 366 randomly selected small-holder maize farmers in Narok County, Kenya. According to the CGN (2018), Narok County is one of the 47 counties in Kenya, and it borders the Republic of Tanzania to the south, Bomet, Migori, Nyamira, and Kisii counties to the west, and Nakuru and Kajiado counties to the north and east, respectively. Narok county, which is home to about 1,057,873 persons, is divided into six (6) sub-counties (Narok North, Narok South, Trans Mara East, Trans Mara West, Narok East, and Narok West), with Narok town being the county headquarters (KNBS, 2019). The county is mainly occupied by the Maasai community, one of the plain nilotes of Kenya (Wambua *et al.*, 2018).

Based on the altitude and physical features, the county is divided into four (4) agro-climatic zones: humid, sub-humid, semi-humid, arid, and semi-arid, with temperatures ranging from 12° to 28° (CGN, 2018). The county has two rainfall seasons; long rains are experienced from February to June, while short rains are between August and November. The estimated annual average rainfall is between 500mm and 2500mm. The county's main economic activities include crop farming, pastoralism, tourism, and trade. Maize, beans, and sugarcane are the main crops grown in the county. Other horticultural crops, such as tomatoes, potatoes, and cabbages, are mainly grown under irrigation. Maize is considered a food and cash crop in Narok County since it can be consumed and sold to earn income (CGN, 2018).

The study followed a comparative cross-sectional study design to determine the effect of land tenure security on maize productivity, as used by Charan and Biswas (2013), Motbainor *et al.* (2016), and Bolarinwa (2020). The study used a sample size determination formular by Fleiss (1981) adapted by Bolarinwa (2020), as presented in equation 10. This is due to the study's comparability nature, which required the outcome variables to be compared between two groups (insecure land tenure and secure land tenure).

$$n = \frac{\left[Z_{\alpha}\sqrt{2P(1-P)} + Z_{1-\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)}\right]^2}{(p_1-p_2)^2} * 2 \tag{10}$$

where; n represent the total sample size, Z_{α} is the significance level or p-value or the chance of getting a false positive conclusion estimated at 1% (2.58), $Z_{1-\beta}$ is the power or the chance

of getting a false negative conclusion estimated at 90% (1.28), P is the average probability of the exposure, p_1 (40%) is the prevalence for high maize productivity on the control (insecure land tenure households) while p_2 (60%) is the prevalence of high maize productivity on the treatment (secure land tenure households).

$p = \frac{p_1 + p_2}{2} = p = \frac{0.4 + 0.6}{2} = 0.5$ therefore,

$$n = \frac{\left[2.58\sqrt{2 \times 0.5(1-0.5)} + 1.28\sqrt{0.4(1-0.4) + 0.6(1-0.6)}\right]^2}{(0.4-0.6)^2} * 2 \quad (11)$$

$n = 366$ therefore, the total sample size was 366 respondents.

The study used proportionate to the size formular to obtain the sample size per ward, as shown in equation 12. According to the County Government of Narok (2018), maize farmers account for approximately 70% of the households in the two sub-counties. There are 28,890 households in the four wards of Trans Mara East and Trans Mara West sub-counties (G.o.K, 2019), thus 20,233 maize farmers.

$$W = \frac{P}{N} \times S \quad (12)$$

where; W is the sample size per ward, P =number of maize farming households in the ward, N = total number of maize farming households in the four wards and S = Total sample size. The sample size per ward is presented in Table 6.

Table 6: Sample size distribution

Sub-county	**Wards**	**Number of maize farming households**	**Sample size**
Trans Mara West	Keyian	7515	136
	Ongata Barikoi	4199	76
Sub total		11714	212
Trans Mara East	Magondo	2763	50
	Ololmasan	5746	104
Sub total		8, 509	154
Grand Total		20,223	366

A multistage sampling procedure was employed to select the study respondents. First, Narok County was purposively selected because it is one of the highest maize producers in Kenya, ranked at position five after Trans Nzoia, Uasin Gishu, Bungoma, and Kakamega

counties (GoK, 2021). The predominant community (Maasai) also suffered land-related conflicts even before independence. Blewett *et al.* (1995) and Kariuki *et al.* (2016) argue that, historically, the Maasai were economically, socially, culturally, and politically marginalised due to their nomadic pastoralist nature. This was attributed to their inability to fit into the Western development pathways advocated by the colonial government, hence losing their ancestral land. The second stage involved the selection of Transmara East and Transmara West sub-counties since they are the highest maize producers in the county (CGN, 2018). Based on the proportionate to the size of small holder maize farmers, formular 179 and 187 small-holder farmers were sampled in Transmara East and Transmara West, respectively.

The third stage involved the choice of 4 wards (Mogondo, Ololmasani, Angata Barikoi, and Kilgoris Central) in the two sub-counties of Narok County because they were the largest maize producers in their respective sub-counties. Based on the number of small-holder maize farmers in the selected wards, 88 respondents were selected in Mogondo, while 92, 64, and 122 respondents were selected in Ololmasani, Angata Barikoi, and Kilgoris Central, respectively. The last stage was a systematic random sampling of small-holder maize producers from a list provided by the county agricultural office. The choice of the study area offers diversity concerning climatic conditions and socio-economic, institutional, and land-related characteristics.

Before the data collection exercise began, a research permit was obtained from the National Commission for Science Technology and Innovation (NACOSTI). The data were collected using a semi-structured questionnaire, with households being the unit of analysis. The data were later coded and analysed using Stata 15 computer software to obtain descriptive, inferential, and econometric results (Stata Corp, 2014).

4.2.2 Econometric model and estimation

The study analyses the relationship between land tenure security, credit access and maize productivity. This article defines a land tenure secure farmer as one whose name is registered in the title deed of the land on which they farm. On the other hand, credit access is defined as farmers' ability to apply for credit. Maize productivity, the dependent variable, refers to the quantity of output produced using given units of inputs such as labour and land (Holden & Ghebru, 2016). When using all the inputs, it is referred to as total productivity, while using part of the inputs is called partial productivity. Due to the problems of data inadequacy caused by poor record-keeping, this paper defines productivity as maize output in kilograms per unit of land in hectares in the 2020 production as used by Dlamini and Masuku (2011), Joel and

Bergaly (2020), and Sarma and Rahman (2020). Therefore, land tenure security, denoted as LTS, is a dummy variable, where the codes (0,1) were employed, with 1 indicating a farmer who is land tenure secure while 0, land tenure insecure, credit access, denoted as CRT, is also a dummy variable,1 representing a farmer who can take credit and 0 cannot take credit and productivity denoted as PDT is a continuous variable. A household head in this study is defined as a household member responsible for making critical decisions on farm production and land-related matters.

As conceptualised in this study and used by Feder *et al.* (1988) and Place (2009), several important linkages exist among land tenure security, credit access and maize productivity. Firstly, possessing a title deed on the land increases the land's ability to be used as collateral to acquire credit facilities. Therefore, the acquired credit facility could be used to purchase complementary inputs such as fertilizer, certified seeds, pesticides, and hired labour to increase maize productivity. Furthermore, credit is expected to reduce liquidity challenges, hence motivating farmers to make investments in the farm through the adoption of modern technologies, increasing maize productivity (Dabara *et al.,* 2009; Feder *et al.,*1988; Mishra & Sam, 2016; Narayanan & Chakraborty, 2019). The investments made on the land due to the credit acquired may increase the land value and hence its improvement in the security of land tenure. Thus, access to credit leads to land tenure security and vice versa. This scenario, therefore, results in reverse causality, a source of endogeneity (Brasselle *et al.,* 2002; Joel & Bergaly, 2020).

Farmers with well-structured project proposals may be better able to access credit than those possessing title deeds. In most SSA countries, older farmers may have a higher ability to get/access credit than younger ones due to their perceived higher repayment ability due to accumulated resources over the years. This, therefore, presents a sample selection bias problem. Furthermore, unobservable factors may affect maize productivity (Di Falco *et al.,* 2011; Rashid, 2021). Better motivated farmers and the ability of farmers to better manage the farm may influence farm performance, yet such factors are difficult to measure; hence, they are omitted in this study. These omitted variables are a source of endogeneity in this study.

Empirically, the relationship among land tenure security, credit access, and productivity can be estimated as follows;

$$LTS_i = \alpha_0 + \alpha_1 X_{i1} + \varepsilon_{1i} \tag{13}$$

$$CRT_i = \beta_0 + \beta_i X_{i2} + \delta LTS_i + \varepsilon_{2i} \tag{14}$$

$$PDT_i = \gamma_0 + \gamma_i X_{i3} + \eta CRT_i + \varepsilon_{3i} \tag{15}$$

Where X_{i1} denotes a vector of explanatory variables influencing land tenure security. These variables are sex, marital status, age, education level of the household head, household size, method of land acquisition, land dispute, fertility of land, land topography, number of years the household had stayed on the land, total land size, whether the household head has any community leadership position, access to the parcel of land, and whether the land is concentrated at one place as presented in table 7. X_{i2} represents a vector of independent variables that affect access to credit. As explained in Table 7, these variables include sex, age, education level of the household head, possession of a title deed, total land size, group membership, total household income, access to the market, and gross maize margin. X_{i3} On the other hand, it denotes a vector of variables affecting maize productivity, such as the household head's sex, education level, age, ownership of an ox, size of the parcel of land under maize, possession of a title deed, number of contacts with an extension agent, group membership, access to credit, use of certified seeds, fertilizer, and pesticides. The parameters δ represent the predicted value of land tenure security on credit access and the value of credit access on productivity, respectively. ε_{1i} ε_{2i}, and ε_{3i} are the error terms and α β γ δ η represent the parameters to be estimated in the equations.

Equation 13 estimates the determinants of land tenure security in Kenya using a binary probit. Equation 14 also has a binary dependent variable, and it examines the determinants of credit access with a predicted value from equation 13. Equation 15 analyses the effect of credit access on maize productivity and uses the predicted variable derived from equation 14. Equations 13, 14, and 15 are recursive; equations 13 and 14 have binary dependent variables, while equation 15 has continuous dependent variables. Since there are two equations with an endogenous variable from the first equation inserted into the second equation as an exogenous variable, a multi-equation model may be appropriate to deal with the possible correlation among the equations.

Additionally, inserting the predicted variable helps deal with the endogeneity problem. However, the predicted variables can still cause bias. This paper, therefore, uses the conditional mixed process (CMP) model developed by Roodman (2007; 2011) and used by Dlamini and Masuku (2011), Joel and Bergaly (2020), and Rashid (2021). The model helps in accounting for the following: adapting to a system of apparently independent variables (Seemingly Unrelated Regression) (SUR), instrumental variables, a system of simultaneous equations, and differences like the dependent variables. It also considers the cross relationships among the model's equations. Following the CMP format, equations 13, 14, and 15 are expressed as in

equations 16, 17, and 18;

$$y_1^* = \theta_1 + \varepsilon_1 \tag{16}$$

$$y_2^* = \theta_2 + \varepsilon_2 \tag{17}$$

$$y_3^* = \theta_3 + \varepsilon_3 \tag{18}$$

where $\theta_1 = \beta_1 X, \theta_2 = \beta_2 X + \delta y_1, \theta_3 = \beta_3 X + \eta y_2$

$$y = g(y^*) = (1\{y_1^* > 0\}, y_2^*, 1\{y_3^* > 0\}) \tag{19}$$

$$\varepsilon = (\varepsilon_1, \varepsilon_2, \varepsilon_3)' N(0, \sum) \text{ and } \sum = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{bmatrix} \tag{20}$$

where y_1^*, y_2^* and y_3^* represents latent factors of land tenure security, credit access, and maize productivity. X represents a vector of explanatory variables influencing land tenure security, credit access, and maize productivity, and ρ_{12} represents the correlation among the residual errors of land tenure security and credit access, ρ_{13} represents the correlation among the residual terms of land tenure security and maize productivity, and ρ_{23} represents the correlation between credit access and maize productivity.

With the assumption that $y_i = (0, y_{i2}, 0)'$ it is observable, then a corresponding log-likelihood function can be expressed in equation 18;

$$L_i(\beta_1, \beta_2, \beta_3, \delta, \eta, \sum; y_i | x_i)$$

$$= \int_{-\infty}^{-\theta_1} \int_{-\infty}^{-\theta_2} \int_{-\infty}^{-\theta_3} \phi_j \{(\varepsilon_1, y_{i2} - \theta_{12}, \varepsilon_3)'; \sum\} d\varepsilon_1 d\varepsilon_2 d\varepsilon_3 \tag{21}$$

The choice of the independent variables was informed by studies by Dlamini and Masuku (2011), Joel and Bergaly (2020), and Rashid (2021). Endogeneity was tested using the Durbin-Wu- Hausman test (Durbin, 1954; Hausman, 1978). Table 7 presents the description and measurement of the variables used in this study.

Table 7: Description and measurement of variables used in the Conditional Mixed Process model

Variable name	**Description and measurements of variables**	**Type of variable**
Dependent variable		
Land tenure security	**Possession of a land title deed**	**Dummy-1=yes, 0=no**
Independent variables		
Age	Age of the household head in years	Continuous
Education level	Years of schooling of the household head	Continuous
Household size	Number of people in the household	Continuous
Land period stay	Number of years household had stayed on the land	Continuous
Land size	Total land size in hectares	Continuous
Farm size	Size of land under maize cultivation in Ha	Continuous
Parcel access	Time taken from the house to the parcel in minutes	Continuous
Market access	Walking time from the homestead to the nearest market in minutes	Continuous
Extension contacts	Number of contacts the respondent had with an extension agent	Continuous
Maize productivity	Productivity of maize (Kg/Ha)	Continuous
Household income	Total household income in Kenya shillings	Continuous
Maize gross margin	Maize gross margin in Kenya shillings	Continuous
Sex	Sex of the household head	Dummy-1=male, 0=female
Marital status	Marital status of the household head	Dummy-1=married, 0=not married
Community leadership	Whether the household head is or was a community leader	Dummy-1=yes, 0=no
Land concentration	Whether the land is concentrated in one area	Dummy-1=yes, 0=no
Land acquisition	Method of land acquisition	Dummy-1=purchase,

		0=No purchase
Land dispute	Whether there is a dispute concerning the land	Dummy-1=yes, 0=no
Land fertility	Fertility of land	Dummy-1=high, 0 =low
Land topography	Topography of the land	Dummy-1=hilly, 0=flat
Use of certified seeds	Whether certified seeds were used in maize production last season	Dummy-1=yes, 0=no
Use of inorganic fertilizer	Whether inorganic fertilizer was used in maize production last season	Dummy-1=yes, 0=no
Use of pesticides	Whether pesticides were used in maize production last season	Dummy-1=yes, 0=no
Credit access	Whether the household head can take credit	Dummy-1=yes, 0=no
Group membership	Whether the household head is a member of at least one group	Dummy-1=yes, 0=no
Oxen ownership	Whether the household head owns at least an ox	Dummy-1=yes, 0=no

4.3 Results and discussion

This section contains discussions on the descriptive, inferential and econometric results of the study.

4.3.1 Descriptive and inferential statistics

Table 8 presents descriptive and inferential statistics results of the continuous variables used in the study. According to the t-statistics results, the land tenure secure households were significantly more educated than the land tenure insecure households at a 1% level. The mean years of schooling for land tenure secure households was 10.56, while that of land tenure insecure households was 8.51. These results imply that education helps land owners be aware of the available land market and development opportunities and hence are incentivised to secure their land to fetch better prices and keep it for future development. Additionally, more educated landowners are more likely to be aware of the various ways to secure their land (Rashid, 2021).

The average land size for land tenure secure households was 1.83 hectares, while for the land tenure insecure households was 1.49 hectares. In addition, the t-test results suggest that there was a significant difference between the land size of the land tenure secure

households and the land tenure insecure households at a 5% significance level. The results imply that land tenure secure households had significantly more land than land tenure insecure households. In rural areas, land is a symbol of wealth; thus, households with more land are considered wealthier than those with less land. This suggests that, in order to secure their wealth, they are more likely to secure their land first before any other valuable asset (Saqib *et al.,* 2016). Furthermore, wealthier landowners are more informed on the benefits of having secure land rights, which could influence their land tenure security. Households with more land are also more likely to benefit from economies of scale of production and, therefore, an incentive to secure their land.

Results also show that land tenure secure households allocated significantly more land allocated to maize production than land tenure insecure households at a 1% level. The mean land size under maize production for the households with secure land tenure was 1 hectare, while for the households with insecure land tenure was 0.77 hectares. Security of land tenure incentivises land owners to use the land as security to access credit facilities that could be used to invest in the land and hence allocate more land to maize farming than those with insecure land tenure.

The average walking time between the homestead and the parcel of land for land tenure secure households was 3.86 minutes, while for land tenure insecure households was 3.53 minutes. Furthermore, *t* statistics results suggest that land tenure secure households walked significantly fewer minutes from their homestead to the parcel of land than land tenure insecure households at a 5% significance level. The farther the parcel of land is from the household, the more exposed it is to land grabbers; hence, this gives the incentive to land owners to secure the land.

The study findings revealed that land tenure secure households, on average, had approximately two (2) contacts with extension service agents, while land tenure insecure households had about one (1) contact. Land tenure secure households had significantly more contacts with an extension agent than land tenure insecure households at a 1% significance level. Extension services are critical in improving agricultural productivity. Certainty of land tenure security is more likely to encourage farmers to invest in extension services to increase their productivity. Additionally, land tenure secure households may have access to additional resources which can be used to invest in extension services (Rashid, 2021).

Results also show that the average maize productivity for land tenure secure households was 2686.36, while for land tenure insecure households was 2305.19. The t-statistic results also suggest that land tenure secure households significantly produce more maize per unit of land

than land tenure insecure households at a 1% significance level. Coulibaly (2021) notes that land tenure security incentivises land owners to invest in technologies such as manuring, mulching or soil erosion prevention measures such as planting of trees and construction of gabions, among other technologies. These technologies can increase maize productivity.

The average annual household income for land tenure secure households (KES 303,047.10) was significantly more than that of land tenure insecure households (KES 215,418.00) at a 1% significance level. Wealthier households are more likely to have access to information on how to secure their land tenure. Wealthier households can easily afford to cater for any transaction costs needed to secure land tenure rights. On the other hand, the mean maize gross margin for land tenure secure households was KES 30,984.47 per Ha while for the land tenure insecure households was KES 20,226.78 per Ha. The t-statistics results show that land tenure secure households had significantly higher maize gross margin than land tenure insecure households at a 1% significance level. A higher gross margin translates to more income for the household, hence more wealth.

Table 8: Descriptive and inferential statistics of continuous variables used in the Conditional Mixed Process model

Variable name	Description of variables	Overall sample	Land tenure security status		Significance
			Insecure	Secure	
Continuous variables			Mean		t-statistic
Age	Age of the household head in years	43.63(11.92)	42.82 (12.43)	44.55 (11.28)	-1.38
Education level	Years of schooling of the household head	9.47(4.04)	8.51 (3.69)	10.56 (4.14)	-5.00***
Household size	Number of people in the household	4.54(1.75)	4.55 (1.73)	4.53 (1.78)	0.09
Land stay	Number of years household had stayed on the land	16.59(11.69)	16.27 (11.80)	16.93 (11.59)	-0.54
Land size	Total land size in hectares	1.65(1.48)	1.49 (1.38)	1.83 (1.58)	-2.22**
Farm size	Size of land under maize cultivation in hectares	0.88(0.87)	0.77 (0.67)	1.00 (0.86)	-2.59***
Parcel access	Walking time from the homestead to the parcel in minutes	3.69(3.03)	3.53 (2.98)	3.86 (3.08)	-2.26**
Market access	Walking time from the homestead to the nearest market in minutes	38.63(30.20)	39.10 (30.71)	38.11 (29.70)	0.31

Extension contacts	Number of contacts the respondent had with an extension agent	1.32(1.28)	1.07 (0.84)	1.60 (1.51)	-3.98***
Maize productivity	Maize productivity (Kgs/Ha)	2484.31(1248.98)	2305.19 (1211.95)	2686.36 (1262.72)	-2.94***
Household income	Total household income in Kenya shillings	256598.90 (205029.80)	215418 (179213.60)	303047.10 (222227.30)	-4.17***
Maize gross margin	Maize gross margin in Kenya shillings	25282.31 (15507.99)	20226.78 (13939.53)	30984.47 (15242.47)	-7.05***

Standard deviations in parenthesis

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

According to the results in Table 9, in terms of the marital status of the household head, 70.35% of household heads in the land tenure secure category were married, compared to 59.79% of the land tenure insecure households. Additionally, chi-square results suggest a significant relationship between the marital status of the household head and land tenure security at a 5% significance level. In most rural areas in Africa, a household's land tenure security depends on the household head's marital status (Deere *et al.,* 2013). Married household heads are more likely to have secure land tenures than unmarried ones.

In terms of community leadership, results show that more (19.19%) household heads in land tenure secure households were community leaders compared to 12.37% of land tenure insecure households. The relationship between community leadership and land tenure security was also significant at a 10% level. Community leadership included current and former positions such as village elder, assistant chief, chief, any political position, and church elders, among other positions. In rural areas, such leadership positions provide a platform for the holder to make decisions concerning the land tenure security of the community. This may include decisions on land adjudications, the formation of land management committees and land dispute cases. Furthermore, Giovarelli and Scalise (2016) note that holders of such positions may have accumulated the necessary social capital that could be used to influence land tenure security decisions.

Approximately 29.07% of the households heads in the land tenure secure category acquired land through purchase compared to 16.49 % in the land tenure insecure households category. Chi-square results also show that there was a significant relationship at a 1% significance level between the method of land acquisition and land tenure security. Land purchase in Kenya follows a legal process. Therefore, persons who acquire land through such a method are more likely to be land tenure secure than those who acquire land through other methods, such as leasing and inheritance.

Regarding land disputes, 7.56% of the households under the land tenure secure category had land disputes compared to 12.86% of households in the land tenure insecure category. Land disputes were significantly related to the household's land tenure security status at a 10% significance level. A land title deed is a legally recognised document that gives the owner all the rights over the land; hence, land owners with title deeds are more likely to secure land tenure, hence fewer disputes. On the other hand, more households (88.95%) under the land tenure secure category reported that their land was fertile as compared to 59.70% of the households under the land tenure insecure category. Land fertility was significantly related to land tenure security at a 1% level. Fertile land indicates that it can produce more than infertile

land. It is, therefore, expected that holders of fertile land will secure their right over the land to prevent it from grabbing. In addition, fertile land attracts high prices in the land market, and hence, owners are incentivised to secure land tenure (Coulibaly, 2022).

More households (95.35%) used certified seeds in the land tenure secure category compared to 90.72% of the land tenure insecure households. Chi-square results also show that using certified seeds was significantly related to land tenure security. Land tenure security, that is, possession of a title deed, gives an incentive to the land owner to invest in technologies geared towards increasing land productivity. Furthermore, land tenure security gives the owners certainty that they will have the land until harvest; thus, they can invest in modern production techniques, such as using certified seeds to boost production (Traore, 2012).

Regarding access to credit, 51.74% of the households under the land tenure secure category had access to credit compared to 39.69% of land tenure insecure households. There was a significant relationship between land tenure security and access to credit at a 5% significance level. A land title deed can be used as collateral to access credit in formal financial institutions such as banks, micro-finance institutions and saving and credit cooperatives (SACCOs) (Higgins *et al.,* 2018). This is possible in areas where the credit market is fairly developed. However, even in areas where informal credit is more widespread, a land title deed can act as an assurance that the loan repayment will be made.

The results showed that there was a significant relationship between ownership of an ox and land tenure security status. Under the land tenure secure category, 22.67% of the households owned at least an ox, while 13.34% of the households under land tenure insecure households owned an ox. Additionally, there was a significant relationship between ownership of an ox and land tenure security status. In most rural areas, especially in the study area, an ox is an important source of labour on the farm (Habtewold, 2018). Therefore, since land tenure secure households are more certain of their land tenure rights, they are incentivised to invest in the land. Ownership of an ox is an advantage to them since it reduces labour costs and thus increases profits.

Table 9: Descriptive and inferential statistics of categorical variables used in the CMP model

Variable name	Description of variables	Response	Overall sample (%)	Land tenure security category		χ^2
				Insecure (%)	Secure(%)	
Title deed possession	% of respondents with a land title deed			53.01	46.99	
Sex	Sex of the household head	Male	54.10	51.55	56.98	1.08
		Female	45.90	48.45	43.02	
Marital status	Marital status of the household head	Married	64.75	59.79	70.35	4.45**
		Unmarried	35.25	40.21	29.65	
Community leadership	Whether the household head is or was a community leader	Yes	15.57	12.37	19.19	3.22*
		No	84.43	87.63	80.81	
Land concentration	Whether the land is concentrated in one area	Yes	97.81	98.45	97.09	0.79
		No	2.19	1.55	2.91	
Land acquisition	Method of land acquisition	Purchase	22.40	16.49	29.07	8.30***
		No purchase	77.60	83.51	70.93	
Land dispute	Whether there is a dispute concerning the land	Yes	10.38	12.89	7.56	2.78*
		No	89.62	87.11	92.44	
Land fertility	Fertility of land	High	71.86	56.70	88.95	46.90***
		Low	28.14	43.30	11.05	
Land	Topography of	Hilly	36.61	32.99	40.70	2.33

topography	the land	Flat	63.39	67.01	59.30	
Use of certified seeds	Whether certified seeds were used in maize production last season	Yes	92.90	90.72	95.35	2.96*
		No	7.10	9.28	4.65	
Use of inorganic fertiliser	Whether inorganic fertiliser was used in maize production last season	Yes	57.65	60.00	56.52	0.43
		No	42.35	40.00	43.48	
Use of pesticides	Whether pesticides were used in maize production last season	Yes	10.11	10.27	11.18	0.07
		No	89.89	89.73	88.82	
Credit access	Whether the household head can take credit	Yes	45.36	39.69	51.74	5.34**
		No	54.64	60.31	48.26	
Group membership	Whether the household head is a member of at least one group	Yes	74.59	73.20	76.16	0.42
		No	25.41	26.80	23.84	
Oxen ownership	Whether the household head owns at least an ox	Yes	17.76	13.34	22.67	5.37**
		No	82.24	86.60	77.33	

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

4.3.2 Effect of land tenure security on maize productivity through credit access

Table 10 summarises the effects of land tenure security on maize productivity through

access to credit. The results are in three stages. Stage 1 provides the determinants of land tenure security. Stage 2 presents the effect of land tenure security on credit access, while stage 3 shows the effect of credit access on maize productivity. The model fit results, such as the likelihood-ratio test (-3335.930), indicate that it is statistically significant at a 1% level; thus, the model correctly explains the relationship between land tenure security and maize productivity. The Durbin-Wu-Hausman test (4.932) for endogeneity was significant at a 10% level, indicating the presence of endogeneity in the analysis and thus justifying the use of the CMP model.

Determinants of land tenure security

According to Table 10 model 1 results, male household heads are more likely to be land tenure secure than female household heads. It is relatively easier for a man to get a title deed than a woman because they are considered superior to women in most rural African communities; hence, they can easily initiate the land registration process to obtain a title deed for their land. Similarly, Joel and Bergaly (2020) suggest that in traditional societies, women are seen as fragile and can be easily swayed to give the land to another person; thus, denying them the security of land tenure is considered a way of protecting the land from grabbing.

Marriage increases the probability of having secure land tenure. Obtaining a title deed by married people is often considered a means of securing their children's future. Higgins *et al.* (2018) argue that for fear of disputed inheritance and lengthy legal battles in case parents die, married people tend to secure their land through registration. Education level was also found to influence land tenure security. More educated household heads are likely to be more land tenure secure than less educated household heads. Education helps one acquire information on land, financial markets and land policies on registration, making them more likely to acquire a title deed. Similarly, educated landholders can easily understand the need to acquire a title deed (Kusiluka & Chiwambo, 2018). They can also easily marshal all the available resources towards securing their land (Rashid, 2021).

Land disputes reduce the likelihood of securing the land. Disputed parcels only qualify for land adjudication once the dispute is resolved. Similarly, land with disputes attracts low prices in the land market, making it less likely to be secure (Ngango & Hong, 2021). Land purchase positively and significantly influences land tenure security.

Table 10: Conditional mixed processes model results

Variable	Model 1 Land tenure security		Model 2 Credit access		Model 3 Productivity	
	Coefficients		Coefficients		Coefficients	
Title deed possession			0.849***	(0.235)		
Credit access					2001.902 ***	(150.963)
Socio-economic characteristics						
Sex	0.485**	(0.207)	-0.079	(0.137)	11.923	(198.930)
Marital status	0.403**	(0.204)				
Age	0.008	(0.008)	-0.008	(0.006)	8.266	(8.440)
Education level	0.078***	(0.021)	0.048**	(0.0190)	46.780*	(28.449)
Household size	-0.037	(0.036)				
Household income			-2.422	(2.251)		
Land related characteristics						
Land dispute	-0.471**	(0.235)				
Land acquisition	0.360**	(0.155)				
Land fertility	0.897***	(0.170)				
Land topography	0.167	(0.139)				
Land stay	0.012	(0.008)				
Land size	0.048	(0.051)	0.065*	(0.038)		
Parcel access	0.029	(0.021)				
Land concentration	-0.586	(0.467)				
Plot size					-222.303**	(94.189)
Institutional characteristics						
Community leadership	0.040	(0.187)				
Group membership			0.022	(0.145)	1.493	(187.966)
Market access			-0.002	(0.001)		
Oxen ownership					230.030	(169.391)
Extension contacts					76.988	(47.833)
Productivity related factors						
Maize gross margin			1.711***	(2.181)		
Use of certified seeds					476.887**	(217.960)

Use of inorganic fertiliser		-228.483**	(117.082)
Use of pesticides		-5.582	(198.918)
Diagnostic and model fit			
Durbin-Wu-Hausman test	4.932*		
Number of observations	366.000		
LR chi2(35)	246.110		
Prob>chi2	0.0000		
Log-likelihood	-3335.930		

Standard errors in parenthesis

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

Acquisition of land through purchase increases the probability of securing land. The land purchasing procedure in Kenya is a legal process protected by law; thus, purchasing land is deemed a legal way of protecting one's land from illegal exploration. In areas with developed land markets, the purchase of land guarantees security for the land since the process is detailed and involves legal procedures (Rashid, 2021). Land fertility was also found to be influencing land tenure security. Households with fertile land are more likely to secure it due to its perceived high value. Coulibaly (2021) notes that land fertility increases its value in the land markets, thus becoming a target to land grabbers hence more likely to secure it.

Effect of land tenure security on credit access

Table 10 model 2 results show that possession of a title deed (land tenure security), years of schooling, total land size, and maize gross margin significantly affected credit access. Land tenure security positively affects the ability to access credit. This implies that possession of a land title deed enables holders to use it as collateral to access credit from formal financial institutions. Land tenure security provides an incentive for the development of land markets, hence enabling farmers to use the land as collateral to access credit facilities (Higgins *et al.*, 2018; Joel & Bergaly, 2020; Rashid, 2021). However, Delville (2010) argues that corruption and lack of transparency in public administration may render the title deed worthless to be used as collateral. In addition, land tenure security may not spur credit access in areas where formal

lending is underdeveloped (Field *et al.,* 2006; Fort, 2007).

More educated household heads increase the probability of having the ability to access credit. Education exposes an individual to information on credit availability and how to access it. Temesgen *et al*. (2018) suggest that educated persons have a higher degree of literacy in finance, available technologies, innovations, risk evaluation strategies, production, and marketing, enabling them to respond to market signals more easily than uneducated persons. Moreover, education improves credit availability awareness, which helps in financial decision-making (Mitra *et al.,* 2018; Patriciah & Wario, 2016).

Land size also positively and significantly increases the likelihood of having the ability to access credit facilities. The land is usually taken as a measure of wealth in most communities; households with more land are deemed wealthier and thus can easily access credit due to their better repayment ability. Large land size may act as a sign of high social status and hence can facilitate access to credit even in informal credit sources (Chandio *et al.,* 2018; Saqib *et al.,* 2016).

High maize gross margin also positively and significantly increases the likelihood of having the ability to access credit. Formal lenders could use income obtained from maize production as collateral to access credit; hence, a higher gross margin may translate into a higher ability to access credit. Joel and Bergaly (2020) argue that revenues from the sale of crop production can be used to pay off loans granted to the farmers if they default.

Effect of credit access on maize productivity

According to the results in Table 10 model 3, land tenure security, credit access, years of schooling of the household head, and use of certified seeds significantly and positively affect maize productivity, whereas parcel size and use of inorganic fertiliser significantly and negatively affect maize productivity. Being the main explanatory variable, access to credit increases farmers' maize productivity by about 2001.902 Kg/Ha. Agricultural credit facilities can purchase complementary inputs such as fertiliser and certified seeds, increasing maize productivity in the short run. In the long run (Rashid, 2021; Traore, 2012) argue that farmers can use credit to invest in soil and water conservation methods. Additionally, credit can help adopt new technology and facilitate the performance of other production factors, such as land, hence increasing productivity (Ali *et al.,* 2014b; Chandio *et al.,* 2018; Sekyi *et al.,* 2017; Zhao & Barry, 2014).

Maize productivity was reduced by approximately 222.203 Kg/Ha, with farm size increasing by a hectare. Farmers with smaller farms do not enjoy economies of scale, hence

lower productivity than larger ones. Similarly, (Akudugu, 2016: Ekbom, 1998 : Sekyi *et al.,* 2017) argue that relatively smaller farms sometimes intensify production to maintain their household welfare, whereas their counterparts pursue more extensive methods. However, this finding contradicts Akudugu (2011) and Melesee and Awele (2020), who suggest that land is often deemed a measure of wealth; thus, wealthier farmers use better complementary inputs such as fertiliser, hence greater productivity.

An increase in the years of schooling of the household head by one year increases maize productivity by approximately 46.780 Kg/Ha. Education allows farmers to adopt intensive agricultural technology and innovation better, improving productivity (Joel & Bergaly, 2020). The use of certified seeds also influenced maize productivity. The use of certified seeds increases maize productivity by approximately 476. 887 Kg/Ha. Certified seeds possess the requisite genetic capability and can adapt to local conditions, which could lead to high productivity. Certified seeds are manufactured with characteristics such as pests and disease resistance, high yielding, and early maturing, which may increase the production per unit area of land (Coulibaly, 2022; Dembele, 2011).

On the other hand, using inorganic fertiliser reduces maize productivity by about 228.483 Kg/Ha. Excessive use of inorganic fertiliser alters soil pH, inhibiting the absorption of minerals necessary for crop growth and reducing productivity. Similarly, Vigani *et al.* (2015) note that inorganic fertiliser can only increase productivity in a controlled biophysical soil environment.

4.4 Conclusion and Recommendations

The study examined the nexus among land tenure security, credit access, and maize productivity as a contribution toward achieving the SDGs, especially goals 1 and 2 on zero poverty and zero hunger. The study was underpinned on the assumption that land tenure security facilitates access to credit, which can be used to undertake short- and long-term investments, increasing maize productivity. Specifically, the study investigated the determinants of land tenure security, the effects of land tenure security on credit access, and the effects of credit access on maize productivity using the conditional mixed processes model.

Descriptive results show that the majority (53.01%) of the sampled farmers had no title deeds. Additionally, most land tenure secure households acquired credit (51,74%), and their land productivity was higher (268.64 Kg/Ha) than land insecure households. The Durbin W. Hausman results indicate the presence of endogeneity, justifying the use of a conditional mixed process. The CMP results show that land tenure security was significantly influenced by

sex, marital status, education level of the household head, land disputes, soil fertility, and land acquisition through purchase. The study confirmed that there is indeed a relationship among land tenure security, credit access, and maize productivity. Land tenure security significantly and positively influenced credit access, while credit access also positively and significantly affected maize productivity. Respondents with access to credit produced 2001.902 Kg/Ha more than those who did not have access to credit. The results of this study are consistent with the findings by Joel and Bergaly (2020) and Rashid (2021), who found a relationship among land tenure security, credit access and maize productivity. The findings of this study underscore the need for governments and other stakeholders to develop additional policies that would facilitate access to land title deeds by the rural population to increase maize productivity. Furthermore, agricultural credit could be made accessible to most small-holder farmers to enable them to undertake short and long-term investments that would increase their productivity.

4.5 Limitations of the study and further research

The study aimed to analyse the relationship among land tenure security, credit access and maize productivity for improved livelihoods of small-holder farmers. The study only focussed on measuring land tenure security using possession of a land title deed. Since land tenure security has different dimensions, future studies should explore using different measures of land tenure security, such as ownership and control of land rights. The study also used maize as a food security crop; however, in the future, maize crop enterprise can be used as a cash crop to inform about the contribution of land tenure security to income. Furthermore, other crop enterprises, such as rice beans, may also be used.

CHAPTER FIVE

EFFECT OF LAND TENURE SECURITY ON HOUSEHOLD FOOD SECURITY AMONG SMALL-HOLDER MAIZE FARMERS IN NAROK COUNTY, KENYA

Abstract

Access to secure land rights is crucial to improving the livelihoods of rural people. However, empirical studies to validate this statement are still limited, especially in Sub-Saharan Africa (SSA). The study uses the endogenous switching regression (ESR) model on primary cross-sectional data to analyse the role of land tenure on household food security among small-holder farmers in Narok County, Kenya. Data were collected from 366 respondents obtained from a multistage sampling procedure. Descriptive statistics show that household heads from land tenure secure households were significantly older, had fewer household members with more land, and reported higher food consumption scores and maize productivity levels than insecure land tenure households. Food consumption scores measured household food security, and the results show that household size, acquisition of land through purchase, land concentration, land fertility, number of years the household stayed on the land, and the time taken from homestead to the parcel were the critical determinants of land tenure security. Household food security status was influenced by marital status, education level, age of the household head, household size, household income, maize productivity, number of contacts with extension agents, access to credit and ownership of an ox. The results also show that land tenure security positively and significantly affected household food security. Land tenure insecure households would have increased their food security by 38% if they were land tenure secure, while land tenure secure households would have decreased their food security status by 4% if they were land tenure insecure. Findings call for enacting policies and strategies to facilitate access to secure ownership and transfer land rights by rural farming households, encouraging farm investments to improve household food security.

5.1 Introduction

Improving agricultural productivity to ensure food security has been a significant policy issue in most developing countries. Despite governments and international organisations' efforts, food insecurities and malnourishment still exist, especially in Sub-Saharan Africa (SSA) (Lawry *et al*., 2017). According to FAO *et al*. (2021), more than 768 million people in the world are food insecure, while FAO *et al*. (2021) indicate that about 600 million people in Africa, Asia and Latin America suffer from food insecurity, with close to 600 million people projected to be food insecure by 2030. These findings 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 the acute food insecurity crisis stage, with the number expected to rise to 3.5 million in the second half of 2022 (WFP, 2022). The world population is projected to be at the 9.3 billion mark by 2030; therefore, the world's food production must increase by approximately 70% to meet the growing food demand (FAO, 2021). According to Lawry, land tenure insecurity is identified as one of the significant causes of food insecurity since most resource-poor small-holder farmers are the primary food producers in third-world countries such as Kenya.

Land tenure security and food security have conventionally been viewed as distinct subjects. This is because land tenure security is primarily seen through legal and institutional lenses, while food security is explained using economic, social, and bio-medical terms (Maxwell & Wiebe, 1999). In addition, research on land tenure, especially in developing countries, faces variations and complexities associated with land tenure systems (Holden & Ghebru, 2016). The policy significance of the linkage between land tenure security and food security is further emphasised by the decreasing arable, especially in poor countries that face climate-related risks (Godfray *et al*., 2010; Holden & Otsuka, 2014). However, their definitions indicate close conceptual linkages. Whereas land tenure security occurs when someone has unlimited rights of access to and use of land due to social and legal systems and governing institutions (Holden & Ghebru, 2016), food security, on the other 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).

5.1.1 Conceptual framework

Conceptually, the leading causes of land tenure insecurity are encroachment and grabbing of land by private investors or government reallocating. According to Holden *et al.*

(2013), land rights can be categorised into user, transfer, and mortgaging rights. However, in this study, land rights are broadly grouped into user and transfer rights. These groups can further be explained as follows: user rights include the right to choose which crop to grow, do land fallowing, develop the land, dispose off crop produce after harvesting, and prevent others from using such as grazing, while land transfer rights are the rights to give land along the customary line, the right to inherit land, lease or rent land, sell the land, and mortgage.

Transfer rights such as the right to rent, lease, or 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, the market or both. This, therefore, affects the food security of both the land users and owners. Additionally, it affects the supply of food in the market.

With well-defined and stronger land user rights, holders are more likely to increase their investment in the land and thereby increase productivity. Since most rural dwellers are small-holder farmers and food is the main product produced mainly for home consumption and any excesses for the market, enhancing their rights would improve their food security status. Land can also be used as collateral to access credit facilities. If the credit is invested in the land, it is more likely to increase maize productivity and food security. However, when the returns on investments are low, the risks in production tend to increase. This scenario occurs primarily when agricultural insurance markets are missing, and covariate risks characterise the environment. It is, therefore, not advisable to use the land as a security to obtain credit for poor small-holder farmers living in such risky environments because they may end up undertaking distress sales and foreclosures.

5.1.2 Literature review

According to Holden and Ghebru (2016) and Holden *et al.* (2013), global land reforms can be categorised into two, based on the intended outcomes. The first category is redistributive reforms meant to enhance equitable land ownership in areas where unequal land ownership exists (Holden *et al.*, 2013). Such reforms were rampant in most African countries in the 1950s and 60s, especially after independence, when uneven land distribution existed. This category of reforms focused more on distributing land to the landless to increase food production. The second category aims to strengthen the existing rights of the holders. This enhances investments and land transfer to promote production efficiency. These reforms are aimed at enhancing the development of markets and growing the economy to increase food security by providing alternative livelihoods other than agriculture.

Land tenure security contributes to food security when people have secure access to land and related resources. The resources would enable them to produce enough food for their consumption or sale to get income that could be used to buy food. Previous studies on the linkage between the two subjects have found that the link starts from access to productive resources such as land, which stimulates production and income generation and finally results in the improved nutritional status of the households (Platteau, 2000). The linkage can also be manifested by the relationship among land tenure, resource use, agricultural productivity, and income generation (Ghebru & Holden, 2013; Lovo, 2016; Mendola & Simtowe, 2015; Swift, 1993).

Land tenure security is vital to achieving poverty reduction, and food and nutritional security for rural households whose livelihood depends on agriculture (Higgins *et al.,* 2018; Holden & Ghebru, 2016; Mwenzwa *et al.,* 2018). Similar findings by Espinosa (2019) indicate a significant increase in food availability for families with secure land tenure than those with insecure land tenure. According to Holden and Ghebru (2016), land tenure security is seen as a critical ingredient in providing social protection and a safety net for the citizens of a country. In arid and semi-arid areas, land tenure security incentivises small-holder farmers to invest in irrigation technologies, sustainable pasture use and planting crops resistant to drought (Lokonon & Pilo, 2021). Goldstein and Udry (2008) and Jacoby and Minten (2007) note that farmers' ability to invest in adaptive drought methods depends on how certain they will reap the intended benefits. Ajefu and Abiona (2020) refer to this type of effect of land tenure security on food security as an assurance effect.

Previous studies by Deininger (2003) and Meinzen-Dick *et al.* (2019) have shown that small-holder farmers with stronger land tenure security are likely to engage in land and environmental management practices, including mulching, fallowing, planting of trees, and building of gabions. These practices can increase land productivity and, hence, improve food security. Land tenure security reduces incidences of land disputes, promotes the use of land as collateral for credit facilities, and encourages both short-term and long-term investments that would increase productivity, food security and incomes (Brasselle *et al.*, 2002; Deininger *et al.*, 2011; Linkow, 2016; Lovo, 2016; Place, 2009). Deininger and Castagnini (2006) and Deininger and Jin (2006) also note that land tenure security can enhance access to capital since land can be used as collateral to access credit in a financial institution. In addition, landowners can lease out or even sell their land to raise income to buy food and other non-food commodities. ANGOC (2017) noted that land tenure security stimulates investments in agriculture and reduces unfair land expropriation and forced migration, thus increasing

households' resilience. Ajefu and Abiona (2020) argue that food security is affected by climatic and weather conditions and land tenure security. A study by Holden and Ghebru (2013) found that land certification led to increased food production and, hence, increased access to food by poor women-led households who practised sharecropping on their land.

Recent literature on the linkage between land tenure security and food security has conflicted (Payne *et al.,* 2016). Kenny-Lazar (2016) argues that persons with less or no land 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 impact land investment (Besley, 1995; Deininger & Castagnini, 2006; Deininger & Jin, 2006). Moreda (2018) in Ethiopia suggested that land tenure insecurity doesn't contribute to land degradation but somewhat limited access to other resources such as 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. These linkages, however, are inadequate in addressing the question of whether land tenure only affects household production decisions or household consumption decisions as well. In addition to that, does food security play a role in access to resources (Maxwell & Wiebe, 1999).

Holden and Ghebru (2016) found that food security played a key role in access to land. As neo-classical economists suggest, the most inefficient farmers will lease their land to efficient farmers, and food insecure farmers who may be efficient in production may be forced to deplete their resources, e.g. land, in times of food scarcity. At the same time, food-secure farmers will acquire the assets of food-insecure farmers in exchange for food or cash. Carter and Wiebe (1994) indicated that, even with secure land rights, food-insecure farmers may be forced to invest in low-riskier and low-return crops such as cassava instead of investing in highly profitable but riskier crops or purchase land in an active market due to their food insecure position. Maxwell and Wiebe (1999) argued that, given the positive links between land tenure and food security, interpretation should be done carefully, especially when titling acquisition is an endogenous process since it is determined by the conditions of input and output markets before titling. Carter and Olinto (2003) indicated that land title deeds have potential benefits for productivity, and hence, food security might be available for properly positioned farmers in terms of market opportunities such as input, output, and land markets. Additionally, corruption and inefficiencies leading to high costs in land titling may disadvantage the poor and favour the rich (Benjaminsen *et al.,* 2009; Holden & Ghebru, 2016).

Despite the importance of land tenure security on food security, as highlighted, there is

limited literature on that crucial subject, especially in SSA. Thus, to bridge this knowledge gap, the study aims to provide empirical evidence on the effect of land tenure security on household food security in Kenya. The continued increase in land scarcity among poor countries emphasises the need to study the link between land tenure security and food security (Lambin & Meyfroidt, 2011).

This paper contributes to the ongoing debate on land governance in the following ways. First, it intends to re-focus the attention of land sector stakeholders, not just view land title deeds as a panacea to land insecurity challenges. However, we realise that rights to use and transfer land can also play a critical role in shaping the land tenure security landscape, especially in rural areas where land registration is still low. 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 the ESR model, an innovative econometric model to analyse the role of land tenure security on household food security while considering possible self-selection and endogeneity problems. Lastly, from a policy point of view, it calls for government and other stakeholders to broaden the perspective that land is not just a physical space. Still, it's a factor of production with significant implications for the welfare of rural communities. The paper is organised as follows: the first section provides a brief introduction, conceptual framework, and literature review on the study, the problem, and study objectives, while the second section discusses the methodology and sampling procedure. The third section presents results and discussions, whereas the fourth section provides conclusions and policy recommendations based on study findings.

5.2 Methodology

5. 2.1 Study area and sampling procedure

The study was conducted on 366 randomly selected farming households in Narok County, Kenya. The study area lies between latitudes 0^0 50’ and 1^0 50’ and longitudes $35^0$28’ and 36^0 25’ (CGN, 2018). It borders the Republic of Tanzania to the south, Bomet, Migori, Nyamira and Kisii counties to the west, and Nakuru and Kajiado counties to the north and east, respectively. The county consists of six (6) sub-counties and 30 wards. These sub-counties are Narok North, Narok South, Trans Mara East, Trans Mara West, Narok East and Narok West. According to the KNBS (2019), the county population is approximately 1,057,873 persons with a gender ratio of approximately 1:1. Land ownership in the county is categorised into three (3): community, trust, and private land.

The study used a multistage sampling procedure to select the respondents. Firstly, a

purposive selection of Narok County was made due to high land tenure insecurity-related conflicts (Kariuki *et al.,* 2016). Secondly, two sub-counties (Transmara West and Transamara East) were chosen because they were the highest maize producers in the county (CGN, 2018). Thirdly, two wards were chosen in each sub-county since they had the highest number of small-holder farmers in the sub-counties (CGN, 2018). Lastly, to obtain the 366 small-holder farmers, every 5^{th} person on an alphabetically arranged list of eligible small-holder farmers obtained from the county agricultural offices was chosen. Data were collected by trained enumerators using pre-tested semi-structure questionnaires installed in Open Data Kit (ODK) software. Descriptive and econometric data were analysed using Stata 15 computer software (StataCorp, 2014).

5. 2.2 Analytical framework

Measurement of household food security

The study used household food security as the dependent variable. Food security is a multidimensional subject and can measured using various methods. However, just like other livelihoods or welfare measures, these methods have their disadvantages; thus, the choice of one method over the other is contextual (Tian & Yu, 2015). Babatunde *et al*. (2008) used the amount of food (converted into calories) consumed by the household to estimate household food security. Studies by Mallick and Rafi (2010), Mendola and Simtowe (2015), Tibesigwa *et al*. (2016), and Tibesigwa and Visser (2016) used per capita household food consumption expenditure. According to their studies, the per capita household food expenditure is defined as the total consumption of purchased food, food produced from farming, food given as gifts, and payments divided by the number of people in the household. However, this measure does not account for issues of vulnerability and sustainability; thus, it fails to provide adequate information on food security status (Pinstrup-Andersen 2009). Kassie *et al.* (2014) stated that due to consumption volatility, it may also under or over-report the food security situation. This measure also fails to account for seasonal fluctuations in food consumption.

Lutomia *et al.* (2019) used the household food insecurity scale to measure food insecurity in the Eastern and Western regions of Kenya. This scale uses self-reported food security data and contains two questions: the occurrence and frequency of occurrence. Occurrence questions are used to get the households' experience of food insecurity. This is followed by a question on how frequently the situation has been happening. The scores obtained are then used to classify households as either food secure, mild food insecure, moderate food insecure or severe food insecure (Coates *et al.,* 2007).

Other food security measures are subjective measures, such as the Household Dietary Diversity Score (HDDS) and Household Food Consumption Score (HFCS). Subjective measures, as used by Kassie*et al.* (2014), Mallick and Rafi (2010), and Tibesigwa and Visser (2016), used the respondent's perception of their food security status based on food production, availability, purchasing power, and access to shared resources. The respondents are asked to assess their food security status in the last 12 months and categorise it as follows: food shortage (chronic), occasional food shortage (transitory), no food shortage but no surplus either (break-even), and food surplus. In gender-related studies, the perception of food security of male and female-headed households may differ systematically. The expectation of government or NGO assistance may also lead to false data on their food security perception. However, the latter is a general problem for all food security metrics data, especially in developing countries. To counter this problem, studies usually interview all the adult household members who are present at the homestead during the data collection period. Although the household heads may have more information on issues such as land holding, cultivation, and questions which require some bit of judgement, such as on food security, the responses are discussed among the adult household members before answering; hence, food security is a household but not an individual issue (Tibesigwa & Visser, 2016).

Household Dietary Diversity Score (HDDS) is also used as a proxy for household food security (Andersen, 2009). Evita *et al.* (2013) defined household dietary diversity score as the degree to which households consume a variety of food groups. According to Wabwile *et al.* (2016), dietary diversity represents 12 food groups consumed by members of the household over a 24-hour reference period. HDDS gives an equal weight of 1 to all food groups. The score is the total of all the responses for the particular household as provided by the respondent (household head). The higher the score, the higher the food security status.

Household Food Consumption Score (HFCS) can also be used to measure household food security. This tool was developed by the World Food Programme (WFP) and is used as a proxy for access to food. It is a 7-day recall period measure, where a respondent is asked to indicate whether they consumed any of the 12 food groups for the past seven days (Kennedy *et al.,* 2010). Food groups consumed more than seven times in a week are recorded as 7. Each food group is weighted based on caloric density. Weighted scores are added together to formulate a final FCS for each household. The minimum score possible is 0, and the maximum score possible is 112.

Households with composite scores below a threshold of 21 are defined as having "poor" food consumption, between 21 and 35 is "borderline" food consumption, and households in

excess of 35 have "acceptable" food security (World Food Programme, 2008). Shorter recall periods may lead to the exclusion of foods served as habitual but infrequent at the household. It may also overestimate food consumption, especially when the survey is done over special days such as weddings, funerals, etc. Thus, this measure provides a clear picture of food consumption in the household. This method uses information on both dietary diversity and food frequency (number of days the food is consumed per week) and applies a weighting system (0.5 to 4) (Wekesa *et al.,* 2018). As in HDDS, the higher the score, the more food secure the household is.

Due to the low levels of education among respondents in most developing countries, such as Kenya, they do not keep records of their consumption. Hence, the data provided may be inaccurate, especially for the longer recall period measures such as HFCS. To counter this problem, self-report questionnaires were left to the respondents for seven days to record their consumption as they consume the foods. The more extended reference period allows for capturing a wide range of food groups consumed, hence the best indicator of food security (Wekesa *et al.,* 2018). The study, therefore, used HFCS 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 of production, consumption and investment, as suggested by Kassie *et al.* (2014), Mallick and Rafi (2010), and Tibesigwa and Visser (2016). In this study, a household head is defined as a household member who is the key decision-maker on food consumption matters.

Measurement of land tenure security

The study used land tenure security as the main independent variable. Being a multidimensional measure, land tenure security can be measured in a number of ways. Cattaneo (2001) used the years a household resided on the piece of land before eviction, while Place and Otsuka (2002) used the method of land acquisition. Rao *et al.* (2016) used the probability of eviction. Land tenure systems associated with the land, that is, private, communal, or public, can also be an indicator of land tenure security (Carter & Olinto, 2003). Owoo and Boakye-Yiadom (2015) and Ma *et al*. (2016), on the other hand, used ownership of a title deed or land certificate as a proxy for land tenure security. However, possessing a title deed may not necessarily mean having the security of tenure over land (Place & Otsuka, 2000). Illegal settlers in government land have relatively secure land tenure since they face a lower probability of evictions, yet they lack legal title over the land. Arnot *et al.* (2011) argue that when

governments are unstable, possessing a legal title may not mean anything. The various measures discussed do not explicitly capture all the aspects of land tenure security.

Due to these inefficiencies in singular measures of 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 types of land rights (Table 11) categorised into two broad categories (right to use and right to transfer). The study adopted Brasselle *et al.*'s (2002) approach, which appreciates the different weights each right possesses as opposed to assigning equal weight to all the rights, as suggested by Place *et al.* (1994). In this approach, respondents were asked whether they had 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.

Land user rights are as follows: (i) choice of crop to grow, (ii) land fallowing and cultivation at the end of the fallow period, (iii) making land developments, (iv) dispose of crop produce, and (v) prevent people's livestock from grazing on the land. Additionally, respondents were asked if they required any approval from someone else to enjoy the following 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. These rights capture the existing concerns relating to land tenure security that may affect investment. To differentiate between secure and insecure land tenure households, two (2) categories, secure land tenure and insecure land tenure, were derived from the data, making the LTS a binary variable. This approach allows for capturing the different roles of land tenure security alternatives for rural dwellers (Ajefu & Abiona, 2020; Brasselle *et al.*, 2002).

Table 11 presents the frequency distribution results of the respondents' various land rights (to use and transfer) in the study area. Among the sampled households, choice of crops to grow, land development, and the right to prevent grazing were the most common rights; hence, they could not be used in categorisation. Moreover, a small number of the respondents held less than one right (permanent or transitory). On the other hand, the prevalent right in the transfer rights was the inheritance right, followed by the right to lease the land, the right to give land along customary lines, the right to sell the land, and the right to mortgage. Thus, only user rights (ii and iv) and all transfer rights were used to create categories since they exhibited sufficient variations.

Table 11: Frequency distribution table of sampled households based on possession of the various land rights

Type of land right	**%**	**Type of land right**	**%**
(i) Choice of the crop to grow		(vi) Give land along 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 following		(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) Lan 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	39.34
Temporary right	12.84	Without Approval	28.96
Permanent right	79.78	With Approval	31.69
Total	100.00	(366 respondents)	100.00

Category 1 (Land tenure insecure) if they do not hold any transfer rights or only hold the right to inherit and right to give land along traditional lines or one of the two rights and do not 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 the 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).

Model specification

This study aims to provide empirical evidence on the effect of land tenure security on household food security in Kenya. However, unobserved factors such as intended benefit that may affect the household head's land tenure security decision may also affect household food security, resulting in a self-selection problem due to the unobserved heterogeneity. Thus, analysing such a relationship while ignoring the heterogeneity bias would result in biased estimates of parameters (Mwaura *et al.,* 2020).

To address such a challenge, the study used the endogenous switching regression (ESR) since it considers the correlation between unobserved factors in land tenure security and food security equations (Ayuya *et al.,* 2015; Raoul, 2021; Wabwile *et al.,* 2016). ESR can also derive probabilities in counterfactual cases for household food security status on land tenure security (Ayuya *et al.,* 2015; Bidzakin *et al.,* 2019). The binary nature of the main independent variable (land tenure security) also favours the application of ESR.

The endogenous switching regression method is modelled in two stages (Di Falco *et al*., 2011). Stage one involves a probit model to analyse determinants of land tenure security with land tenure security measured as a binary variable (Secure land tenure =1 and 0 Insecure land tenure). Stage two is an analysis of the effect of land tenure security on food security estimated separately for farmers with secure land tenure and those with insecure land tenure. The effect of land tenure security on food security can modelled following the utility maximisation approach. Suppose that U_{i1}^{*} represents the latent variable of the expected utility that ith household derives by having secure land tenure compared to one with insecure land tenure U_{i0}^{*}. Households decide to be secure in land tenure if net benefits outweigh the costs $C_i^{*} = U_{i1}^{*} - U_{01}^{*} > 0\, C_i^{*}$. is a function of latent variables determined by socio-economic, land-related, and institutional characteristics and the residual term as represented in equation 22.

$$C_i^{*} = X_i^{*}\beta + \mu_i \tag{22}$$

$$\begin{bmatrix} C_i = 1 \; if \; C_i^{*} > 0 \\ \quad = 0 \; if \; C_i^{*} \leq 0 \end{bmatrix} \tag{23}$$

where C is a binary variable which takes a value of 1 if the farmer is land tenure secure and 0 if 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 also 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 23 presents the criterion of a household being secure or insecure in land tenure. In the ESR, we use two separate models (regimes) for those with secure and insecure land tenure, as expressed in equations 24 and 25.

$$Y_{1i} = \alpha_1 J_{1i} + \varepsilon_{1i} \text{ if } G_i = 1 \tag{24}$$

$$Y_{0i} = \alpha_{01} J_{01i} + \varepsilon_{0i} \text{ if } G_i = 0 \tag{25}$$

where variables Y_1 Y_0 represent household food security under secure land tenure and insecure land tenure, respectively. J_1 J_0 and 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 23. Ordinary Least Square (OLS) estimates are biased as the study suffers from sample selection bias, and the errors ε_{1i} and ε_{0i} conditional to the sample selection criterion have a non-zero value (Maddala, 1983; Lee & Trost, 1978). The error terms μ ε_1 ε_0 are assumed to have a tri-variate normal distribution with a 0 mean and non-singular covariance matrix $\sum$, $(\mu, \varepsilon_1, \varepsilon_0)' \approx N(0, \sum)$ as shown in equation 26.

With $\sum = \begin{bmatrix} \sigma_{\varepsilon 1}^2 & \sigma_{\varepsilon 1 \varepsilon 0} & \sigma_{\varepsilon 1 \mu} \\ \sigma_{\varepsilon 1 \varepsilon 0} & \sigma_{\varepsilon 0}^2 & \sigma_{\varepsilon 0 \varepsilon \mu} \\ \sigma_{\varepsilon 1 \mu} & \sigma_{\varepsilon 0 \mu} & \sigma_{\mu}^2 \end{bmatrix}$ (26)

where σ_{μ}^2[?] represents the variance of the error in the criterion equation 22, which is 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 ε_0 and respectively in outcome equations 24 and 25 respectively. The values $\sigma_{\varepsilon 1 \mu}$ $\sigma_{\varepsilon 0 \mu}$ are the covariance of error terms μ ε_1 and ε_0. As Maddala (1983) suggested, the outcome of equations 24 and 25 is not observed simultaneously; hence, the covariance between ε_1 ε_0 and are not defined. Since the error μ of equation 22 is correlated with the error terms of the outcome equations 24 and 25, the expected values of the error terms are not equal to zero given the sample selection bias as expressed in equations 27 and 28.

$$E\left[\varepsilon_{1i} \middle| G_i = 1\right] = \sigma_{\varepsilon 1 \mu} \frac{\phi(\beta X_i / \sigma)}{\phi(\beta X_i / \sigma)} \equiv \sigma_{\varepsilon 1 \mu} \lambda_{1i} \tag{27}$$

$$E\left[\varepsilon_{0i} \middle| G_i = 0\right] = -\sigma_{\varepsilon 0 \mu} \frac{\phi(\beta X_i / \sigma)}{1 - \phi(\beta X_i / \sigma)} \equiv \sigma_{\varepsilon 0 \mu} \lambda_{0i} \tag{28}$$

where $\phi(.)$ and $\phi(.)$ represent the standard normal probability density function and normal cumulative density, respectively. λ_{1i} λ_{0i} Moreover, is the inverse mills' ratio representing the estimated ratio of $\phi(.)$ and $\phi(.)$ estimated at. If $\sigma_{\varepsilon 1\mu}$ $\sigma_{\varepsilon 0\mu}$ they are statistically significant, then land tenure security and household food security are correlated, hence evidence of endogeneity and the presence of sample selection bias (Maddala & Nelson, 1975). Asfaw *et al.* (2012), Di Falco *et al*. (2011), and Lee and Trost (1978) suggest that maximum likelihood estimation is an efficient method of estimating ESR. Considering the assumption of the logarithmic likelihood function, the error distribution in equations 22, 24 and 25 can be expressed as in equation 29

$$LnL = \sum_{i=1}^{N} G_i \left[\ln \phi(\frac{\varepsilon_{1i}}{\sigma_{\varepsilon 1}}) - \ln \sigma_{\varepsilon 1} + \ln \Phi(\phi_{1i}) \right] + (1 - G_i) \left[\ln \phi(\frac{\varepsilon_{0i}}{\sigma_{\varepsilon 0}}) - \ln {}_{\varepsilon 0} + \ln(1 - \Phi(\phi_{0i})) \right] \quad (29)$$

where $\phi_{ji} = \frac{(\beta X_i + y_j \varepsilon_{ji} / \sigma_j)}{\sqrt{1 - y_j^2}}$ j=0,1 with, y_j representing the correlation coefficient between the error term (μ_i) of the criterion model in equation 22 and the errors (ε_{ji}) of the outcome equations 24 and 25.

Conditional expectations, treatment and heterogeneity effects

Endogenous switching regression can estimate the effect of a variable for actual and counterfactual conditions (Di Falco *et al*., 2011). That is a comparison of the expected household food security of the land tenure secure households (equation 30) with respect to the land tenure insecure household (equation 31) and to analyse the expected household food security in the counterfactual hypothetical (equation 32) that the land tenure secure households are land tenure insecure, and (equation 33) that the land tenure insecure households are land tenure secure. The observed expected household food security and counterfactual conditions are represented by equations 30, 31, 32 and 33.

$$E(y_s | A_i = 1) = X\beta_s + \sigma_{s\eta}\lambda_s \quad (30)$$

$$E(y_{ns} | A_i = 0) = X\beta_{ns} + \sigma_{ns\eta}\lambda_{ns} \quad (31)$$

$$E(y_{ns} | A_i = 1) = X\beta_{ns} + \sigma_{ns\eta}\lambda_{ns} \quad (32)$$

$$E(y_s | A_i = 0) = X\beta_s + \sigma_{s\eta}\lambda_s \quad (33)$$

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

Table 12: 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} household food security for land tenure-secure households is not. TT refers to the effect of treatment on the treated, TU denotes 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 12, the effect of treatment of the treated (TT) refers to the difference between the 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).

Table 13: Falsification tests for the validity of instruments

Variable	**Model 1**		**Model 2**		**Model 3**	
	Determinants of land tenure security		**Food security for land tenure insecure households**		**Food security for land tenure insecure households**	
	Coefficient	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**
Land stay	0.030***	0.008	0.112	0.139	-0.123	0.072
Ward stay	-0.013**	0.006	-0.132	0.094	0.245	0.378
Constant	0.159	0.137	57.19	2.55	60.58	2.38
Wald test χ^2	34.29**					
Pseudo R^2	0.301					
R^2			0.41		0.46	
F-stat.			5.25***		5.38***	
Test for endogeneity	6.742***					
Sample size	366		142		224	

** and *** represent significance levels at 5% and 1%, respectively

The study used exclusion restrictions as instruments for the model to be identified. This is in addition to what has already been generated from the selection model of determinants of land tenure security. For instruments to be valid, they must be directly correlated with the endogenous or selection variable (land tenure security) but not the outcome variable (household food security) (Di Falco *et al.*, 2011). The study used the number of years a household had stayed on the land and the number of years the household had stayed on the ward. A falsification test was carried out to determine the validity of the instruments, and the results are presented in Table 13. Results show the selected instruments were valid since they are jointly significant determinants of land tenure security (model 1; $\chi^2 = 34.29$; $p = 0.00$); however, they are 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, $p = 0.00$). ESR has been widely used in other studies, such as Ayuya *et al*. (2015), Bocher *et al.* (2017), Paltasingh and Goyari (2018), and Wabwile *et al.* (2016). The choice of other independent variables (Table 14) was informed by previous research by Bocher *et al.* (2017), Paltasingh and Goyari (2018), and Wabwile *et al.* (2016).

Table 14: Description and measurement of variables used in the Endogenous Switching Regression model

Variable name	Description and measurements of variables	Type of variable
Dependent variable		
Land tenure security	Land tenure security	Dummy-1=land tenure secure, 0=land tenure insecure
Independent variables		
Age	Age of the household head in years	Continuous
Education level	Years of schooling of the household head	Continuous
Household size	Number of people in the household	Continuous
Land stay	Number of years household had stayed on the land	Continuous
Land size	Total land size in hectares	Continuous
Parcel access	Time taken from the house to the parcel in minutes	Continuous
Market access	Walking time from the homestead to the nearest market in minutes	Continuous
Extension contacts	Number of contacts the respondent had with an extension agent	Continuous
Household food security	Level of household food security	Continuous
Maize productivity	Productivity of maize (Kg/Ha)	Continuous
Household income	Total household income in Kenya shillings	Continuous
Sex	Sex of the household head	Dummy-1=male, 0=female
Marital status	Marital status of the household head	Dummy-1=married, 0=not married
Community leadership	Whether the household head is or was a community leader	Dummy-1=yes, 0=no
Land	Whether the land is concentrated in	Dummy-1=yes, 0=no

concentration	one area	
Land acquisition	Method of land acquisition	Dummy-1=purchase, 0=no purchase
Land dispute	Whether there is a dispute concerning the land	Dummy-1=yes, 0=no
Land fertility	Fertility of land	Dummy-1=high, 0 =low
Land topography	Topography of the land	Dummy-1=hilly, 0=flat
Credit access	Whether the household head has the ability to take credit	Dummy-1=yes, 0=no
Group membership	Whether the household head is a member of at least one group	Dummy-1=yes, 0=no
Oxen ownership	Whether the household head owns at least an ox	Dummy-1=yes, 0=no

5.3 Results and discussion

5.3.1 Descriptive and inferential statistics

Results in Table 15 show that the mean age of land tenure secure household heads (42.134 years) was higher than that of land insecure household heads, which was at 38.099 years, and the difference was significant at a 1% level. Old age is associated with the accumulation of properties, including land; hence, household heads tend to secure their properties against encroachment. Valkonen (2021) argues that older people are more informed about the different ways to secure their properties; hence, they are more secure in land tenure than younger people.

Results also show that, in addition to having older household heads, land tenure secure households had significantly fewer household members than land tenure insecure ones at a 1% significance level. The average household size of a land tenure-secure household was about four members, while the land tenure-insecure household had about five members. In most rural communities, household members are often used as a labour source to undertake farm and household duties. Therefore, the higher household size for the land tenure insecure households could imply that it was necessary to provide adequate labour and produce enough food for the household since they were not certain of their land tenure security (Djurfeldt, 2020).

The mean number of years the household had stayed on the land for the land tenure secure households was 18, while for land tenure insecure households, they had stayed on the land for an average of 14 years. The results also show that land tenure secure households significantly stayed on the land for more years compared to land tenure insecure households at a 1% significance level. The period a person or household stays on a piece of land in most African societies determines the level of land tenure security. The more an individual stays on the parcel of land, the higher the land tenure security. This could be attributed to the fact that, as individuals stay on the land, they make certain investments, such as planting trees and setting up soil conservation structures such as gabions and terraces; hence, this increases their land tenure security (Brasselle *et al.*, 2002).

Table 15: Descriptive and inferential statistics of continuous variables used in the Endogenous switching regression model

Variable Name	Description of variable	Overall sample	Insecure land tenure	Secure land tenure	Significance
Continuous variables			**Mean**		**t-statistic**
Age	Age of the household head in years	40.568 (11.408)	38.099 (11.746)	42.134 (10.928)	-3.343***
Education level	Years of schooling by the household head	8.590 (3.937)	8.331 (3.468)	8.754 (4.206)	-1.003
Household size	Number of people in the household	4.544 (1.751)	4.880 (1.776)	4.330 (1.704)	2.959***
Land stay	Number of years household had stayed on the land	16.587 (11.689)	14.268 (10.968)	18.058 (11.915)	-3.057***
Ward stay	Number of years the household has stayed in the ward	26.932 (15.328)	26.662 (16.155)	27.103 (14.814)	-0.268
Land size	Total land size in hectares	1.648 (1.486)	1.347 (1.163)	1.838 (1.632)	-3.119***
Market access	Walking time from homestead to the nearest market in minutes	38.634 (30.204)	37.986 (30.849)	39.045 (29.850)	-0.326
Parcel access	Walking time from the homestead to the parcel in minutes	3.685 (3.031)	2.787 (2.208)	4.255 (3.335)	-4.639***
Road access	Walking time from the homestead to the nearest tarmac road in minutes	11.011 (8.761)	10.373 (9.427)	11.416 (8.308)	-1.110
Extension contacts	Number of contacts the respondent had with an extension agent	1.319 (1.284)	1.193 (1.179)	1.398 (1.342)	-1.491
Household food	Level of household food security	57.680	55.257	59.217	-2.226***

security		(16.670)	(15.244)	(17.372)	
Maize	Productivity of maize (Kg/Ha)	2484.314	2309.972	2594.835	-2.137***
productivity		(1248.982)	(1291.065)	(1211.503)	
Household income	Total household income in Kenya shillings	256598.900	241567.700	266127.500	-1.117
		(205029.800)	(170020.800)	(224260.200)	

Standard deviations in parenthesis

*** represents a significance level at 1%.

Members of the land tenure secure households also took significantly more minutes to walk from the homestead to the parcel of land than the land tenure insecure household members at a 1% significance level. The average time taken to walk from the homestead to the parcel for the land tenure secure household was 4.255 minutes, while for the land tenure secure households was 2.787 minutes. The time taken to walk from the household to the parcel of land determines the exposure of the land to potential land grabbers and encroachers. Sitko *et al.* (2014) argue that the lesser the time, the closer the parcel of land is to the homestead; hence, it is likely to be less exposed to land grabbers. A lesser time taken to walk from the homestead to the parcel of land could also imply that the ownership of the land is private or customary, thus increasing land tenure security status.

The average land size for the land tenure secure households was 1.838 hectares, while for the land tenure insecure households, it was 1.347 hectares. The t-statistics results indicate a significant difference in land size between land tenure secure households and land tenure insecure households at a 1% level. In most rural areas in developing countries, land signifies wealth. This, therefore, implies that individuals with more land are deemed wealthy and, hence, more likely to have access to information resources to secure their land. Additionally, wealthy persons have more social networks. Wealthy individuals are also more likely to be financially literate and know the benefits of securing land (Ghebru & Lambrecht, 2017).

Land tenure-secure households were significantly more food secure than land tenure-insecure households at a 1% significance level. Based on the food consumption score, land tenure secure reported 59.217 scores compared to land tenure insecure households with 55.257 scores. Due to the security of land tenure, households were more likely to invest in modern technologies that would increase production, hence improving household food security. Furthermore, in case of legal security of land tenure, landholders may secure credit facilities from formal financial facilities, which they can use to procure modern farming technologies and input to increase food production. This, therefore, could increase food productivity (Coulibary, 2021).

The results also show that households with land tenure security had higher maize productivity (2594.83 Kg/Ha) on their land compared to households with insecure land tenure, who had maize productivity of 2309.972 Kg/Ha on their parcels of land. Land tenure security incentivises land owners to invest in productivity-increasing farming methods such as manuring and application of fertilisers and pesticides, among other technologies. In addition, land tenure secures household heads to secure loans to invest in the land.

Table 16 shows the result of descriptive and inferential statistics of categorical variables

used in the study. Chi-square results also show that there was a significant relationship between land tenure security and ownership of an ox at a 1% significance level. Approximately 22.32% of land tenure secure households owned at least an ox as compared to 10.56% of land tenure insecure households. Oxen in rural areas are used to provide agricultural labour. In addition, they can be hired for income, which could be used to invest in the farm or buy food from the market.

Regarding land acquisition, 28.57% of land tenure secure households acquired land through purchase, while 12.68% of land tenure insecure households acquired land through purchase. There was also a significant relationship between land tenure security and the method of land acquisition at a 1% significance level. The method of land acquisition determines the status of land tenure security. Land tenure security is usually high if a land acquisition method involves a legal procedure, such as a land purchase in Kenya. A legal procedure is recognised by law; therefore, enforcing such security of land tenure by the government of the day is easier.

There was also a significant relationship between land tenure security and the fertility of land at a 1% significance level. Approximately 76.79% of land tenure secure households had fertile land, while about 64.08% had fertile land. If a parcel of land is fertile, it is more likely to produce more output than less fertile land. This incentivises the holder to secure such land from land grabbers. Furthermore, more fertile land attracts land buyers; thus, securing such a parcel of land increases the purchase prices. This situation, therefore, is an advantage to the owner since buyers will pay more than the prevailing land prices.

Table 16: Descriptive and inferential statistics of categorical variables used in the ESR model

Name of variable	**Description of variable**	**Response**	**Overall sample (%)**	**Land tenure security category**		χ^2
				Insecure land tenure (%)	**Secure land tenure (%)**	
Land tenure security	% of respondents as per the land tenure security category			38.80	61.20	
Sex	Sex of the household head	Male	22.13	19.01	24.11	1.308
		Female	77.87	80.99	75.89	
Marital status	Marital status of the household head	Married	69.67	70.42	69.20	0.062
		Unmarried	30.33	29.58	30.80	
Community leadership	Whether the household head is or was a community leader	Yes	15.57	13.380	16.96	0.849
		No	84.43	86.62	83.04	
Oxen ownership	Whether the household head owns at least an ox	Yes	17.76	10.56	22.32	8.226***
		No	82.24	89.44	77.68	
Credit access	Whether the household head has the ability to take credit	Yes	45.36	45.07	45.54	0.008
		No	54.36	54.93	54.46	
Group membership	Whether the household head is a member of at least one group	Yes	25.41	71.13	76.79	1.468
		No	74.59	28.87	23.21	
Land concentration	Whether the land is concentrated in one area	Yes	97.81	99.30	96.88	2.382
		No	2.19	0.70	3.13	

Land acquisition	Method of land acquisition	Purchase	22.40	12.68	28.57	12.630***
		No	77.60	87.32	71.43	
Land topography	Topography of the land	Hilly	36.61	32.39	39.29	1.778
		Flat	63.39	67.61	60.71	
Land dispute	Whether there is a dispute concerning the land	Yes	10.38	9.86	10.71	0.068
		No	89.62	90.14	89.29	
Land fertility	Fertility of land	High	71.86	64.08	76.79	6.932***
		Low	28.14	35.92	23.21	

*** represents a significance level at 1%

5.3.2 Effect of land tenure security on household food security

Table 17 provides results of the effect of land tenure security on household food security estimated using the Ordinary Least Square (OLS) method, which assumes that there is no selection bias. In the OLS estimation, land tenure security is the main independent variable measured as a dummy variable that is 1 if the household is land tenure secure and 0 if land tenure insecure. The OLS results indicate that the household head's marital status, age, education level, oxen ownership, number of contacts with extension agents, group membership, access to credit and maize productivity positively and significantly affected household food security. On the other hand, household size negatively and significantly affected household food security. However, as pointed out in the methodology, OLS assumes that land tenure security is exogenously determined, yet it is endogenously determined in the equation. Thus, OLS estimates are biased; hence, its results cannot be relied on.

Table 17: OLS results of the effect of land tenure security on household food security

Variables	**Standard error**	**Coefficients**
Land tenure security	1.613	0.6610
Socio-economic characteristics		
Sex	2.102	-1.157
Marital status	1.847	5.32***
Age	0.075	0.198***
Education level	0.228	0.680***
Household size	0.462	-0.7587*
Household income	4.091	-2.631
Maize productivity	0.0006	0.003***
Institutional characteristics		
Market access	0.026	-0.0076
Extension contacts	0.663	1.723**
Oxen ownership.	2.278	3.880*
Group membership	1.868	3.201*
Credit access	1.592	7.173***
Land related characteristics		
Land size	0.425	0.098
Constant	5.096	27.499***
Number of observations		366

Prob>F)	0.000

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

Determinants of land tenure security

In order to take care of the possible endogeneity, the study used the ESR model. Table 17 represents the results of the first stage of the ESR model on the determinants of land tenure security. Household size, land acquisition through purchase, land fertility, the period the household had stayed on the land, and walking time between the homestead and the parcel in minutes influenced land tenure security significantly. An increase in the household size by one member reduces the likelihood of a household being land tenure secure. More household members may translate to increased incidences of land sub-division, making it difficult to secure land (Valkonen, 2021). As the number of household members increases, the power to control ownership of land reduces, hence, more likely to have insecure land tenure. However, in contrast to this finding, Ghebru and Lambrecht (2017) argue that an increase in the number of members in the household may mean an increase in food requirements and, hence, may signal the household heads to secure the land to provide food for their families.

Table 18: Results of the determinants of land tenure security (first stage of Endogenous Switching Regression model)

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>ch2		0.000

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

The households that acquired land through purchase were more likely to have secure land tenure. The land purchasing process, especially in areas with developed land markets in Kenya, is structured and legal; hence, there is a likelihood of land tenure being secure after the process. However, corruption by land market participants, such as government officials, may threaten the trust accorded to the land-buying process (Djurfeldt, 2020). Land fertility also positively and significantly influenced land tenure security. Ownership of fertile land increases the probability of a household being land tenure secure. Fertile land is usually competitive in the land market; 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 secure their land tenure. 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, landholders who have stayed longer on the land are viewed as part of the community and, hence, become more secure in land tenure (Brasselle *et al.*, 2002). Access to parcels of land also influences land tenure security. The more time it takes to reach the parcel from the homestead, the more secure the land tenure is. Distant parcels are more exposed to land grabbers, so it is reasonable to secure them. Sitko *et al.* (2014) argue that, in scenarios where the owners are not seen on the land for some time due to the long distance, people tend to assume they are absentee landlords; hence, they get tempted to 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 18) indicate that it is significant at a 1% level, hence implying the model's goodness of fit. Additionally, it suggests an endogeneity problem, hence justifying ESR's use. The likelihood ratio test of independence equations, the selection and outcome equations (χ^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 coefficients (/ro 0= -0.033, p = 0.0; /ro1= -1.017, p = 0.000) imply that farmers with higher household food security were likely to self-select themselves to be land tenure secure.

Table 19: Results of the Endogenous Switching Regression model on the effect of land tenure security on household food security (second stage of the Endogenous Switching Regression model)

Variables	**Column 1, Land tenure security=0**		**Column 2, Land tenure security=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 ownership	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

Results in table 19, 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 ox, and credit access significantly influenced household food security. Married people were more likely to be food secure than unmarried ones. Marriage in most African societies is meant to support each other emotionally and economically; therefore, this could lead to improved food security. Similarly, Amadu *et al.* (2021) and Djangmah (2016), urge that married people pool their resources together and reduce food costs. Additionally, married people are likely to save some resources to help them during times of low income, hence smoothening their lives. However, Aidoo *et al.* (2013) and Akukwe (2020) suggest that unmarried people would be more food secure due to their possibly 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 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 being able to

adopt the latest technologies for food production. However, Kassie *et al.* (2010) 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. Furthermore, older farmers may have reduced their contribution to welfare, such as food security (Oluwatayo & Ojo, 2019; Yahaya *et al.*, 2018).

Better-educated household heads increased 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 influenced household food security. Larger households reduce the probability of food security for households with land tenure security. An increase in household size may mean an increase in the number of people to feed; 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 adopting new agricultural technology to produce food. Larger households may indicate a higher burden to feed them (Lutomia *et al*., 2019; Tiwasing *et al.*, 2018).

An increase in household income decreases the likelihood of being food secure for land tenure secure households while it increases the likelihood of being food secure for households with land tenure security. For insecure land tenure households, they would probably use the increase in income to secure their land instead of food production. Land-secure households, 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, improving food security status. In contrast with the study findings, Habtewold (2018) argues that high-income earners may invest in other commercial activities, such as horticultural production, where prices are volatile. Maize productivity also positively and significantly influenced household food security. Higher maize productivity increases the probability of food security for both secure and insecure land tenure households. In Kenya, maize is considered a staple food; therefore, having more maize implies being food secure. Increased maize productivity translates to increased food on the table and hence increased food security (Santpoort, 2020).

An increase in the number of contacts with an extension agent positively influences the secure land tenure farmer's likelihood of being food secure. More contact with an extension agent could increase the farmers' knowledge of the latest agricultural technologies, which may be used to increase food production. Extension services are vital in promoting innovative farmer technologies and creating awareness of 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 land tenure insecure households increases their likelihood of being food secure. Oxen is a source of agricultural labour in rural areas, increasing food production. Similarly, Mohammed and Mohammed (2021) found 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 (Awoke *et al.,* 2022; Habtewold, 2018).

The land tenure secure households with access to credit facilities were more likely to be food secure. The credit obtained could be used to invest in new agricultural technologies to boost household food production. 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 20. The results present the effect of land tenure security on household food security and also the effects of inherent characteristics on household food security. Results of the causal effects (TE) of food consumption score for land tenure secure households 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 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 a 4% decrease, if they were land tenure insecure. On the other hand, land-insecure households' food consumption score would have increased to approximately 76.337, representing an increase of about 38% if they had been land tenure secure. These results indicate that land tenure security significantly increases household food security. The results are consistent with those of Keovilignavong and Suhardiman (2020), who urged that secure land tenure enables farm households to acquire credit facilities that would be invested in the farm, hence increasing food security. Similarly, Espinosa (2019) suggests that land tenure secure households are more likely to carry out both long and short-term farm investments that would increase their productivity and food security.

Table 20: 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 a significance level at 1%

5.4 Conclusion and recommendations

The study analysed the role of land tenure security on food security to achieve Sustainable Development Goal number 2 of zero hunger and the African Union Vision 2063. In achieving this objective, household food security was measured by the food consumption score, while land tenure security was measured as a binary variable (land tenure secure=1 and 0 land tenure insecure) derived from the possession of land ownership and transfer rights. Results show that household heads from land tenure secure households were significantly older, had fewer household members and more land, and reported higher food consumption scores and maize productivity levels compared to those with insecure land tenure.

The endogenous switching regression results show that the key determinants of land tenure security were household size, acquisition of land through purchase, land concentration, land fertility, number of years the household stayed on the land and the time taken from homestead to the parcel. For the land tenure secure households, food security was influenced by marital status, age of the household head, household size, household income, maize productivity, number of contacts with extension agents, and access to credit. On the other hand, the household head's marital status, education level, household income, maize productivity, and ownership of an ox were the main determinants of food security for land tenure insecure households. Findings also show that land tenure secure households would have a 4% decrease in food security if they were land tenure insecure. On the other hand, there would have been about a 38% increase in food security for land insecure if they were land tenure secure. These results, therefore, indicate that land tenure security improves household food security.

Findings call for enacting policies and laws that would facilitate access to timely, affordable and up-to-date extension services to improve household food security. In addition, there is a need to encourage ownership of productive resources such as oxen that would provide traction on the farm. Government and other stakeholders should also develop policies and strategies that would facilitate access to secure ownership and transfer land rights by rural farming households, encouraging farm investments to improve household food security.

CHAPTER SIX

CAN POSSESSION OF LAND RIGHTS AFFECT WOMEN EMPOWERMENT? INSIGHTS FROM RURAL KENYA?

Abstract

Land remains to be an important factor of production that determines the transformation of any country. However, women's access to land rights in developing countries is still limited, yet it can potentially improve their economic and social power. This paper uses a two-stage least square method to analyse the effect of possession of land rights on women empowerment among rural women in Narok County, Kenya, while taking care of potential endogeneity. Cross-sectional primary data was collected from 366 female participants using a multistage sampling procedure. Descriptive statistics show that women with land rights were more empowered, younger, more educated and owned more land than those without land rights. Econometric results suggest that possession of land rights increases women's empowerment by about 0.25%. Other factors affecting women's empowerment were marital status, education level gap, oxen ownership, polygamous marriage, off-farm income, group membership, and credit access. Findings underscore the need to formulate policies that could facilitate women's access to land rights in rural areas, thereby improving their empowerment.

6.1 Introduction

Globally, land is a key asset in agricultural communities where its accumulation influences their social, political, and economic power (Agarwal, 1994). Ownership of land rights could have a bearing in promoting the welfare of poor rural households who depend on agriculture for their livelihoods (Sen, 2001). Generally, there has been significant gender inequality regarding land ownership in Sub-Saharan Africa (SSA) and other developing countries. In Bangladesh, for example, the estimated percentage of land under individual ownership is less for women than for men (Kieran *et al.,* 2015). Additionally, the size of a parcel of land for women land owners is smaller than that of men (Khan *et al.,* 2016). In SSA and Asia, women own relatively less land than men, even though research shows they work harder on farms than men (Balasubramanian *et al.,* 2019; Doss *et al.,* 2018; Doss *et al.,* 2015). A study by Lambrecht (2016) in Ghana found that women-owned relatively smaller farm sizes than men.

Similarly, even though more women than men were engaged in farming in Nepali, only 19% owned land (Mishra & Sam, 2016). It is, therefore, a serious policy challenge if there exists a disparity in ownership of land rights between men and women. Gender imbalance in ownership of land and other productive assets is one of the main reasons for continued economic, social, and political discrimination worldwide (Khan *et al.,* 2016). The findings underscore the need to provide secure land rights to women as a development ingredient.

In theory, there are four pathways in which land tenure security can improve women's empowerment. Firstly, improvement in land tenure security among women enhances the incentives for women to invest in their land, which could improve the benefits derived from the land. These benefits, therefore, strengthen their financial capability, hence increasing their bargaining power in the household and society at large (Muchomba, 2017). Secondly, Field (2007) notes that improvement in land tenure security tends to reduce time and financial resources which could be spent on land disputes due to poor land tenure security. These resources can, therefore, be invested in other income-generating ventures, increasing women's financial freedom. Thirdly, an increased land tenure security improves the ability of the holder to access credit since the formal land title can be used as collateral to access credit in financial institutions (De Soto, 2000). Finally, formal land registration tends to publicly avail land registration information, reducing the transaction costs during land trading, which would otherwise increase property prices (Deininger *et al.,* 2011). The savings from land trading costs can be invested in other income-generating activities to improve women's income.

Although previous studies such as Anderson and Eswaran (2009), Kieran *et al.* (2015), and Roy and Tisdell (2002) have shown that ownership of assets promotes women empowerment, the land is the most important asset that could promote resilience among rural women. Additionally, land, compared to other assets such as jewellery, provides a more permanent and sustainable income source for financial stability among rural women (Allendorf, 2007; Mishra & Sam, 2016; Wiig, 2013). Previous studies have shown that improving women's possession of secure land rights is a crucial element in attaining improved gender equality (Doss, 2013; Mishra & Sam, 2016). Furthermore, Menon *et al*. (2014) state that improving the possession of land rights to women would have far-reaching benefits, such as improved health and welfare of children due to improved bargaining power. Han *et al.* (2019) note that by improving women's access to productive resources such as land, they are more likely to improve their bargaining power in household decision-making ability. Similar findings were presented by Akaram (2018), who suggested that land ownership among women plays a critical role in promoting their ability to make decisions in the household. Furthermore, women who own land have a better fallback strategy, giving them stronger bargaining power than those without land.

Agarwal (1994) and Mason (1996) argue that there is improvement in women's social, economic and political power if their income-generating capacity is improved through access to land. Access to land by women also increases their financial security, hence promoting their empowerment (Mishra & Sam, 2016). Providing women with secure land rights would also improve their access to credit facilities to invest in entrepreneurial ventures. Menon *et al.* (2014) suggest that resources in parcels of land owned by women are more likely to benefit children than those owned by men. Additionally, intra-household spending patterns improve when women are granted possession of secure land rights in the household (McElroy & Horney, 1981). Customary, religious, and statutory laws governing land use and property transfer in most developing countries have been considered key contributors to continued discrimination against women (Das, 2016; Kieran *et al.*, 2017; Quisumbing *et al.*, 2022).

Even though land ownership among women is fronted a possible panacea to the continued disparity in empowerment between men and women. Abbott *et al.* (2018) and Bhaumik *et al.* (2016) argue that women may not achieve empowerment even after getting land ownership. Mahmud *et al.* (2021) in Bangladesh indicated that patriarchal norms restricting women's access to land are still in existence. Hence, they found no effect of access to land rights on women's income. Countries worldwide have prioritised privatisation of customary land to improve women's access to land. These efforts potentially affect closing the gender land

gap (Boone, 2019). Recent literature from SSA and Asia by Ali *et al.* (2014) and Goldstein *et al.* (2018) suggests that land registration and certification positively affect women's land tenure security. However, the question of what kind of policies need to be put in place to promote land tenure security among women has been a subject of discussion in the academic, research, government and non-governmental organisation spheres. Pinckney and Kimuyu (1994) argue that titling of land, especially in developing countries, has failed to improve women's land tenure security. They also argued that where customary or informal land tenure security is rampant, formalisation of land rights may yield little results. Meinzen-Dick and Mwangi (2009) and Whitehead and Tsikata (2003) made similar arguments and posited that women are the major losers when community land is converted to private land.

In Kenya, the coexistence of formal and customary laws contributes to challenges in women's land ownership (Kameri, 2005; Musangi, 2017). Additionally, the discriminative aspects of customary law that disenfranchise women have remained within households and at the community level. However, Kenya has made some progress in ensuring women's access to land rights. Kenya's quest for enhancement of the security of land tenure started way before independence. This was when Kenya introduced land reforms by initiating a land registration and titling programme in the agricultural-rich areas following the Swynerton Plan of 1954 (Kijima & Tabetando, 2020). Isinta and Flitner (2018) observe that laws on equality in the acquisition and ownership of property, including land across gender, existed prior to the 2010 constitution. For instance, the Law of Succession Act 12 was passed in 1981, specifically providing equal property inheritance rights for both women and men. The Constitution 2010 eliminates all forms of gender discrimination in acquiring and using property such as land. Other Kenyan laws, such as the Matrimonial Property Act of 2012, the National Land Commission (NLC) Act of 2012, and the Land Registration Act of 2012, strive to achieve gender equality and equity in ownership of productive resources. Furthermore, under Article 2 of the 2010 constitution, both regional and international laws such as the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) treaty in 1979, the Beijing Platform for Action 1959, Common Markets for East and Southern Africa (COMESA)'s gender policy of 2002, and East Africa Community (EAC) Treaty of 2000 all advocate for gender equality in ownership of resources are recognised as part of the laws of Kenya (National Council for Law, 2010).

Despite the highlighted efforts by the government and other stakeholders to ensure women have possession of land rights and the potential benefits of their empowerment and household welfare in general, women still lack access to land rights, especially in rural areas.

Additionally, there is limited research, especially in developing countries, that attempts to establish the link between the possession of land rights and women's empowerment. This paper, therefore, tries to bridge the highlighted knowledge gap by examining the role of possession of land rights on the empowerment of rural women in Kenya.

The paper contributes to the body of knowledge on the following fronts; firstly, it does not only focus on whether women possess the land but also whether they possess the rights to use and transfer the land, which are important aspects, especially in the rural areas where patriarchy may be high. Secondly, the study acknowledges the existence of simultaneity (possession of land rights affects women's empowerment and vice versa) in the analysis and hence causes an endogeneity problem. Therefore, the study employs an innovative econometric model (two-stage least square method) to solve this problem. Thirdly, the study measures women's empowerment using the Women Empowerment in Agriculture Index, specifically designed to measure women's empowerment in the agricultural sector, particularly in rural areas. Lastly, the findings of this study contribute to the ongoing policy debate on how to achieve the fifth Sustainable Development Goal of achieving gender equality and empowering all women and girls while at the same time contributing to the achievement of goals 1 and 2 of ending poverty and hunger, respectively. The rest of the paper is organised as follows. Section 2 presents the methodology, which includes the study area, sampling procedure, and analytical framework. Section 3 provides the results and discussion, while Section 4 provides the conclusion and policy recommendations.

6.2 Methodology

6.2.1 Study area and sampling procedure

The study was carried out in Narok County, Kenya. Narok County borders Nakuru and Kajiado counties to the north and east, respectively, the Republic of Tanzania to the south, and Bomet, Migori, Nyamira and Kisii counties to the west. The county is located within latitudes 0° 50', 1° 50' and longitudes 35°28', 36° 25' (CGN, 2018). Narok County consists of six (6) sub-counties and 30 wards with a total population of approximately 1,057,873 persons (529,042 males and 528,831 females), making a gender ratio of approximately 1:1 (KNBS, 2019). Land ownership in the study area is categorised into three (3): community, trust, and private land.

The selection of 366 study respondents followed a multistage sampling procedure. Narok County was purposively selected due to high land tenure insecurity-related conflicts (Kariuki *et al.*, 2016). Additionally, the culture of the Maasai community, which is the most

dominant community in the county, allows women to perform many household responsibilities such as fetching water, constructing huts, cultivation, and cooking, among others; however, the rights to productive resources such as land remains with the man (Wambua *et al*., 2018). Sulle *et al*. (2019) argue that most women in Narok County are not aware of their land rights as enshrined in the 2010 constitution, hence denying them the benefits of the gender-progressive land reforms. Two sub-counties (Transmara West and Transamara East) were chosen due to the county's highest reported cases of land-based conflicts.

Additionally, they were the highest maize producers in the county. Two wards were chosen from each sub-county since they had the highest number of small-holder farmers in the respective sub-counties (CGN, 2018). Finally, systematic random sampling was conducted using a list of small-holder farmers obtained from the county agricultural offices. Based on the requirements of the Women Empowerment in Agriculture Index (WEAI), data was collected from a primary female adult who is a female of 18 years and above living in the household.

6.2.2 Data collection

The study used a semi-structured electronically designed questionnaire installed in Open Data Kit (ODK) software to collect the data. The questionnaire was administered by enumerators who were trained to equip them with the necessary skills to be used during data collection. A one-day pretest was conducted on 36 respondents (10% of the total sample). The pretest results were used to improve the quality of the questionnaire in preparation for the main data collection exercise. Both paper and mobile phone-installed questionnaires were used. The paper questionnaire was specifically used in instances where there were failures in the use of mobile phones either due to power or any other reasons. Thereafter, the data collected manually were entered into the ODK software after the day's exercise. Data were later extracted and coded in readiness for data analysis. For descriptive, inferential and econometric results, data analysis was done using Stata 15 computer software (StataCorp, 2014).

6.2.3 Analytical framework

Measuring possession of land rights variable

Measuring land rights requires going over and above the legal aspect of land rights to determine how women's land rights affect their welfare. It is vital to consider won experiences in access to land rights and understand the different realities and complexities around land rights (Doss & Meinzen-Dick, 2020). Previous studies by Arnold (2002) and von Benda-Beckmann *et al.* (2006) have shown that several persons can have different rights over a

particular piece of land, commonly referred to as a "bundle of rights" or "web of interests" by social scientists. The concept of a bundle of rights means that individuals or a group of persons can hold many different rights. This view contrasts with that of the Western world, where land rights are put into a concept of ownership held by an individual or an entity.

Different scholars have explained the concept of a bundle of rights. Schlager and Ostrom (1992) presented a framework with five elements explaining the idea of a bundle of rights. The first element is access, which provides the right to be on the land, and the second element is the right to withdraw something from the particular land. These rights may include the right to fetch firewood, water and wild fruits. The third right is the right to manage the land. This right encompasses the right to regulate the use of the resources on the land and the right to make improvements on the land, such as planting trees, putting soil conservation measures in place, and planting crops, among other rights. The fourth element is the right to exclude or prevent others from using or deriving benefits from the land. This right may include the right to prevent others from grazing. The last category of rights based on Schlager and Ostrom (1992) is the right to sell, lease, give as an inheritance, gift or bequeath the land.

The Roman law system presents a three-element framework that helps understand the concept of the bundle of rights. *Usus* is the first element, which refers to the land users' rights. This encompasses the right to access and benefit from the land, as explained by Schlager and Ostrom (1992). The second element is *Abusus*, which refers to the right to improve or change something on the land. Scholars in legal practice refer to these two elements (*Usus* and *Abusus*) as possession. According to the Roman law system, the third and last element is *fructus*, meaning the right given to the holder to make a profit or loss from the land. Schlager and Ostrom's (1992) framework does not identify the third Roman law system, whereas the Roman law system does not discuss transfer rights.

In most of the literature on women's access to land rights, the discussion has been on the right to use and control to create a difference between the right to land and ownership. Doss and Meinzen-Dick (2020) assert that user rights generally mean the woman has the right to practice farming on the land, and control rights imply that the woman has more powers, such as management rights and the right to make a profit or loss. On the other hand, ownership describes a situation where the woman independently has all the rights, even excluding others from the land. It is also important to note that there may be a difference between having access to land and having the right to access land. Having access to land may be because she may need permission from the person who owns the right to access the land while having the right to access means that they do not need permission. This is referred to as tolerate use (Meinzen-

Dick & Pradhan, 2002). There may be other situations where people may have future interests in land. Such persons may have the right to inherit either from spouses or parents. This implies that, while they may lack user rights, decisions such as selling the land may only be taken with their permission because they will lose their inheritance (Ubink, 2008).

To provide a better understanding of women's land rights, one has to go beyond the rights women hold and how secure the rights are. This, therefore, requires more than just a yes or no question. Land tenure security can be understood from different dimensions. Place *et al.* (1994) identified three components; the first component is the completeness of the bundle of rights. This implies a rights ranking; according to academic and policy studies, transfer rights are ranked the highest. Additionally, a person with more rights is more complete than one with fewer rights.

The second component is duration. This relates to the time the individual has the rights and how well or specifically the time is known. The longer the time the rights are held, the higher the land tenure security. There is, however, a problem when the time the rights are held is still being determined. The owner still determines how long they will have the right over the land. With respect to women's rights, the duration of the rights may not directly affect their land tenure security since, in most African societies, their tenure security depends on their relationship with the man, such as a father, a spouse, or a son (Giovarelli & Scalise, 2016). Women's rights sometimes depend on the duration when they are married, since upon divorce, death of the husband or any other course of separation from the husband, they may lose their rights over the land.

The third component is the robustness of the rights. Robustness of rights refers to the degree to which the rights can be enforced when threatened and how accessible the institutions meant to protect the rights are. This component depends on the type of right, the social and legal systems available, and the institution created to protect the rights. Legal and cultural land rights are more robust than contestable by law or social norms. The robustness of rights also depends on how aware the holders are of their rights, the meaning of the rights, and how to use them and document them in case they are required (Quisumbing & Kumar, 2014).

Rights over land can either be held individually or collectively. The security of tenure over land will be affected by the group rights of the person's position in the group if rights are held collectively. Yaro (2010) argues that, in traditional African societies, the clan often holds land, but women married in that clan are not recognised as owners. In the case of individual ownership, rights can be held by a single person, jointly by spouses or children. Understanding who has the rights helps understand land tenure security (Deere *et al.*, 2013).

The study, therefore, uses a composite measure of various rights over land as a proxy for the possession of land rights. These rights are land user and land transfer rights and the independence given to the transfer rights possessors (Brasselle *et al.,* 2002). The study used ten rights classified into two categories: the right to use and the right to transfer land, as used by Brasselle *et al.* (2002). This approach acknowledges that the rights have different weights in influencing someone's land tenure security instead of assigning equal weights to all the rights, as Place *et al.* (1994) suggested.

The land user rights (i, ii, iii, iv, v) and land transfer rights (vi, vii, viii, ix, x) are presented in Table 21. Respondents were asked whether they had permanent, transitory (temporary), or none of the user rights while on transfer rights; they were asked whether they required approval from a third party to enjoy the right. This approach allows for capturing the different roles of possession of land rights alternatives for rural dwellers (Ajefu & Abiona, 2020; Brasselle *et al.,* 2002). The study derived a binary variable (1 if possessed land rights and 0 if did not possess land rights) from the possession of the different rights by women in the study area.

The frequency distribution results of respondents' possession of the various land rights in the study area are presented in Table 21. The most prevalent land user rights were the choice of crops to grow, land fallowing, and the right to prevent grazing; hence, they could not be used in deriving the land right possession binary variable. Furthermore, a small number of women held less than one right. In the order of prevalence, the most possessed transfer rights were the right to inheritance land, the right to lease land, the right to sell the land, the right to mortgage, and the right to give land along customary lines. Thus, since they exhibited sufficient variations, only user rights (iii and iv) and transfer rights were used to create possession of the land right variable.

The possession of land rights binary variable was derived as follows: Category 1 (do not possess land rights) if they do not hold any transfer rights or only hold the right to inherit and right to lease or one of the two rights and do not 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), (ii) and (v). Category 2 (possess land rights) if apart from the rights to inherit and to lease, they hold rights to sell land, to mortgage land, and right to give land along customary/traditional lines (with or without approval), and at least two permanent rights of use in addition to rights (i), (ii) and (v).

Table 21: Frequency distribution table of sampled households based on possession of the various land rights

Type of land right	**%**	**Type of land right**	**%**
(i) Choice of the crop to grow		(vi) Give land along customary line	
No right	03.61	No right	44.35
Temporary right	14.54	Without Approval	26.31
Permanent right	80.85	With Approval	29.34
(ii) Land fallowing		(vii) Inherit land	
No right	05.63	No right	20.52
Temporary right	18.35	Without Approval	45.61
Permanent right	76.02	With Approval	33.78
(iii) Land development		(viii) Rent or lease land	
No right	20.21	No right	31.15
Temporary right	11.32	Without Approval	40.98
Permanent right	68.47	With Approval	27.87
(iv) Dispose of crop produce		(ix) Sell land	
No right	12.87	No right	40.31
Temporary right	14.13	Without Approval	30.55
Permanent right	73.00	With Approval	29.14
(v) Prevent grazing		(x) Mortgage land	
No right	06.45	No right-	40.69
Temporary right	13.15	Without Approval	29.76
Permanent right	80.40	With Approval	29.55
Total	100.00	(366 respondents)	100.00

Measurement of women empowerment variable

Women's empowerment can be measured using different proxies based on the study objectives. Cunningham *et al.* (2015), Ganle *et al.* (2015), Imai *et al.* (2014), and Varghese (2011) used household decision-making, economic decision-making, freedom of action, women education level, marriage age, the difference in non-labour income, and differences in mortality rate between men and women as indicators of women empowerment. Han *et al.* (2019) and Mishra and Sam (2016), on the other hand, used autonomy in making decisions on house purchasing, consumption of durable goods and daily necessities, fertility choices, medical care choices, job choices, and social interaction choice as proxies for women

empowerment. However, these measures must account for agricultural decision-making, which is an integral part of this study. Therefore, the study adopted the Women Empowerment in Agriculture Index (WEAI) approach developed by Alkire *et al.* (2013) to measure the level of empowerment among women in the agricultural sector.

WEAI is a survey-based index that uses data collected from primary male and female adult respondents living in the same household (Alkire *et al*., 2013; Sraboni *et al*., 2014). It was first developed to evaluate and monitor the United States Government Feed the Future program; however, it was observed to have more applicability to policymakers, development organisations and academicians in their quest to inform policy and efforts to improve women's empowerment. WEIA has two sub-indices: Five Domains of Empowerment (5DE) for women and gender parity. The 5DE measures empowerment for only women, while gender parity measures empowerment within the household for both women and men, thus taking care of the intrahousehold decision-making dynamics. This study only used the 5DE as a measure of empowerment. This approach was piloted in Bangladesh, Guatemala and Uganda in 2011 and 2012 (Alkire *et al.*, 2013). The approach comprises five domains: production, income, resources, leadership, and time. These domains are broken down into ten indicators.

The first domain is production. This domain has two indicators: input in productive decisions, which is concerned with the sole or joint decision-making about agricultural production. That is, food and cash crop farming, livestock, and fisheries, as well as the autonomy in making agricultural production decisions without judgment. On the first indicator, an individual is said to be empowered if they participate and have at least some input in decisions or even if someone else makes the decisions but the individual feels they can do. The second indicator of the production domain reflects a person's ability to act on what they think they should do without being coerced. One is said to be empowered if one's actions are motivated by one's actions and, hence, not forced or afraid of disapproval from others.

The second domain deals with resources and has three indicators: ownership of land and other assets, decision-making regarding the purchase, sale or transfer of land and other assets and access to them, and credit decisions. The first indicator assesses whether the respondent has sole or joint ownership of land and other productive resources such as livestock, fish ponds, televisions and mobile phones. A person is empowered if they have sole or joint ownership of at least one major asset, not including poultry, non-mechanised equipment or small-consumer durables. The second indicator, which is defined by using similar assets, is concerned with who makes the decisions regarding the purchase, sale or transfer of land and other assets. Empowerment of this indicator occurs if the respondent participates or can

participate in the decision to buy, sell or transfer the assets. The third indicator in this domain examines the decision-making on whether to obtain credit and how to use the credit from either formal or informal sources. A person is deemed empowered if they belong to a household with access to credit (even if they do not use it). If the household used the credit, the person should have participated in at least one of its decisions.

The third domain is income. This domain deals with sole or joint decision-making on using income from productive or income-generating activities. This domain has a single indicator that measures the level of input into decisions about the use of income. It also measures the extent to which the person feels they can make their personal decision regarding wage or salary employment. Empowerment in this domain is achieved when the person has input on decisions regarding income generated in the condition of participation in the activity.

The fourth domain is leadership, which recognises the role of social capital in empowerment. It has two indicators: membership to at least one social or economic group and the ability to speak in public on personal and community matters. On membership to a group, a person is considered empowered if they are a member of at least one group. At the same time, on the ability to speak in public, empowerment is achieved if a person is comfortable speaking in public.

Lastly is the time domain, which concerns allocating time for productive and domestic tasks. It is also concerned with whether women are satisfied with the time available for leisure. The first indicator in this domain of domestic workload is derived from the allocation of 24-hour time on various tasks in the household. The respondent is asked to recall the time spent on primary and secondary activities during the last 24-hour period. Empowerment on this indicator is achieved when the person has worked for more than 10.5 hours in the previous 24 hours. On the second indicator, the respondents are asked whether they are satisfied with the time they have available for leisure activities such as visiting neighbours, watching television, listening to the radio, and visiting friends, among other activities. On this indicator, a person is said to be empowered when satisfied with the time available for leisure. This study, however, used a reduced version of 6 indicators, as presented in Table 22

As Alkire *et al*. (2013) suggest, the study assigned a binary response to the six indicators of the five (5) domains, indicating whether they are empowered (1) or not (0) based on the defined cut-off points. After summing up the weights, an empowerment score variable ranging from 0 to 1 was generated for the respondents. This reduces measurement errors in getting the actual level of women's empowerment. Overall, a person is empowered in the five domains if they are in four of the five, or the weighted indicators reflect at least 80% total empowerment.

Unlike other women empowerment indices, WEAI can be decomposed, allowing for the disaggregation of the five domains' achievements by domain and indicator to see the areas contributing the most to women empowerment (Malapit & Quisumbing, 2015).

Table 22: The five domains of women's empowerment

Domain	Indicator	Definition of indicator	Weight
Production	Input in productive decisions	Sole or joint decision-making over food and cash crop farming, livestock and fisheries	1/10
Resources	Ownership of assets	Sole or joint ownership of major household assets	1/15
Income	Access to and decision on credit	Access to and participation in decision-making concerning credit	1/15
	Control over the use of income	Sole or joint control over income and expenditures	1/5
Leadership	Group membership	Whether the respondent is an active member of at least one economic or social group	1/10
Time	Workload	Allocation of time to productive and domestic tasks	1/10

Source: Alkire *et al.* (2013)

WEAI also focuses more on the agency aspect, which may be less studied than other elements such as income and other welfare measures such as educational achievements. In addition, compared to other measures that utilise national surveys, which use a set of questions on decision-making, especially within the specific household, WEAI only includes questions in the domestic setting and excludes questions on productive and economic aspects. Moreover, WEAI does not have similar questions for men and women, a common feature in other metrics of women's empowerment. WEAI can also measure the issues of control over resources in the agricultural sector, which other measures have not attempted to do (Alkire *et al.*, 2013). WEAI has also been used by Ayuya (2018) and Sraboni *et al.* (2014).

Model specification

Due to the nature of the outcome variable, this study could have used a Tobit model since it accounts for the zero-inflated nature of the dependent variable (women empowerment

score), which is between 0 and 1. However, previous studies by Han *et al.* (2019), Mishra and Sam (2016), and Wiig (2013) suggest that there exists possible endogeneity. This is due to reverse causality, which may lead to a correlation of error terms. Possession of land rights increases women's empowerment level, while empowered women tend to possess more rights. The ordinary least square method would have been appropriate, but it does not account for endogeneity; thus, the study used the two-stage least square (2SLS) method, an instrumental variable approach with the ability to account for endogeneity. The 2SLS is a two-stage approach that uses instrumental variables as proxies for the potential endogenous variables (possession of land rights). The first stage involves the analysis of the factors influencing possession of land rights using a probit model as expressed in equation 34;

$$T_i^* = \beta_0 + \beta_i X_{ij} + \varepsilon_i \tag{34}$$

where T_i^* a binary variable denoting possession of land rights by the woman X_{ij} is a vector of socioeconomic, land-related, and institutional variables affecting possession of land rights, while ε_i it is an unobserved factor. Predicted probabilities were obtained from the results of equation 34. The second stage involves the expression of the impact model, whereby women's empowerment was regressed against the other explanatory variables, including the predicted variable obtained in equation 34 to instrument for possession of land rights variable as expressed in equation 35;

$$Y_i^* = \beta_0 + \beta_1 X + \gamma T_i + \varepsilon_i \tag{35}$$

where Y_i^* a continuous variable denotes the outcome variable of women empowerment, γT_i the predicted probabilities generated from the probit model in equation 34, and instruments possession of land rights variable ε_i is the disturbance term. X_{ij} It is a vector of the explanatory variable (demographic, institutional and land-related factors) affecting women's empowerment. For the 2SLS model to be identified, the study used walking time between the homestead and the parcel of land and the number of years the household had stayed on the land as instruments for the endogenous variable. Sargan test was used to test the validity of the instruments, and results ($\chi^2(1) = 5.193$, $p = 0.3130$) indicate that the instruments are valid. The two-stage least square approach was previously used by Mbudzya (2017) and Tirkaso and Hess (2018) in impact studies on food security and household income, respectively. The choice of explanatory variables in this study (table 23) was informed by previous studies on women

empowerment by Alkire *et al.* (2013), Ayuya (2018), Han *et al.* (2019), and Mishra and Sam (2016).

Table 23: Description and measurement of variables used in the 2SLS model

Variable name	Description and measurement of variables	Variable type
Dependent variable		
Women empowerment	Level of women empowerment (index)	Continuous
Possession of land rights	Possession of land rights	Dummy (1=possession of land rights, 0=no possession of land rights)
Independent variables		
Age	Age of the woman in years	Continuous
Education level	Years of schooling of the woman	Continuous
Age gap	Age difference in years between men and women	Continuous
Education level gap	The difference in years of schooling between men and women	Continuous
Household size	Number of people in the household	Continuous
Land size	Total land size in hectares	Continuous
Market access	Walking time from the homestead to the nearest market in minutes	Continuous
Road access	Walking time from the homestead to the nearest tarmac road in minutes	Continuous
Extension contacts	Number of contacts the woman had with an extension agent	Continuous
Non-farm income	Total non-farm income in Kenya shillings	Continuous
Marital status	Marital status of the woman	Dummy-1=married, 0 =not married
Community leadership	Whether the woman is or was a community leader	Dummy-1=yes, 0=no
Type of family	Type of family set-up	Dummy-1=polygamy,

		0=monogamy
Credit access	Whether the woman has the ability to take credit	Dummy-1=yes, 0=no
Group membership	Whether the woman is a member of at least one group	Dummy-1=yes, 0=no
Oxen ownership	Whether the woman owns at least an ox	Dummy-1=yes, 0=no

6.3 Results and discussion

6.3.1 Descriptive and inferential statistics

Table 24 presents the descriptive and inferential statistics results of the continuous variables used in the study. Results indicate that the majority (61.20%) of the women in the study area did not possess land rights. In Narok County, women are deprived of their rights due to the cultural background of the people living in the area. Sulle *et al*. (2019) noted that women in Narok County do not possess land rights because they are not aware of them in the first place. In most African traditional societies, possession of land rights follows a patriarchal system; thus, it depends on the woman's relationship with the husband, son or father (Doss & Meinzen-Dick, 2020).

The results also show a significant difference in empowerment between the women who possessed land rights and those who did not possess them at a 1% significance level. This implies that women with land rights were significantly more empowered than those without. Land is considered a critical factor of production in most societies; therefore, if an individual possesses certain rights over it, it gives them power. Doss (2013) and Mishra and Sam (2016) note that women's possession of land rights improves their decision-making ability in the household. Additionally, it is considered an opportunity by women to increase their agricultural productivity and improve children's household food security and welfare (Goldstein & Udry, 2008; Holden & Bezabih, 2007).

There was a significant difference between the ages of women with land rights and those without. Women with possession of land rights were significantly younger than those who did not possess land rights at the 1% level. Younger people are more versatile, open-minded, and, therefore, more aware of their land rights. Regarding education level, those possessing land rights were significantly (5% level) more educated, with 9.90 mean years of schooling, than those who did not possess land rights, who had 8.80 mean years of schooling. This implies that women with land rights were more educated than those who did not have land rights. Education plays a key role in the awareness and understanding of one's rights. More

educated women in rural areas are usually elected or appointed to leadership positions, such as land management boards; therefore, they can easily demand their land rights (Mahmud *et al.*, 2021).

Additionally, those who possessed land rights had significantly more household members, with a mean household size of 5, than those who did not have land rights, with a mean household size of 4 members. More household members demand more land with secure rights to ensure the sustainable production of enough food to feed the family. Large household size also implies an increased demand for land through inheritance; thus, holders are compelled to have land rights to assure them of the future. There was also a significant difference in land size between the women who possessed land rights and those who did not. Women who possessed land rights significantly (1% level) owned more land, with a mean land size of 1.84 hectares than those who did not possess land rights, with a mean land size of 1.35 hectares.

Table 24: Descriptive and inferential statistics of continuous variables used in the model

Variable Name	Description of the variable	Overall Sample	No Possession of land rights	Possession of land rights	Significance
		Mean			*t*-statistics
Women empowerment	Level of women empowerment (index)	0.15 (0.13)	0.13 (0.13)	0.18 (0.14)	-3.72***
Age	Age of the woman in years	43.63(11.92)	45.36 (11.18)	40.92 (12.57)	3.53***
Education level	Years of schooling of the woman	9.47 (4.04)	.8.80 (3.49)	9.90 (4.30)	2.57**
Age gap	Age difference in years between men and women	3.06 (2.97)	3.22 (2.63)	2.82 (1.65)	0.63
Education level gap	Difference in years of schooling between men and women	0.88 (1.38)	1.15 (0.41)	0.46 (2.26)	2.70***
Household size	Number of people in the household	4.54 (1.75)	4.33 (1.70)	4.88 (1.78)	-2.96***
Land size	Total land size in hectares	1.65 (1.49)	1.35 (1.16)	1.84 (1.63)	3.12***
Market access	Walking time from the homestead to the nearest market in minutes	38.63 (30.20)	39.04 (29.85)	38.00 (30.85)	0.33
Road access	Walking time from the homestead to the nearest tarmac road in minutes	11.01 (8.76)	11.42 (8.31)	10.37 (9.43)	1.11
Extension contacts	Number of contacts the respondent had with an extension agent	1.32 (1.28)	1.40 (1.34)	1.20 (1.18)	1.49
Non-farm income	Total non-farm income in Kenya shillings	246796.70 (141901.90)	228124.80 (107225.10)	258633.30 (159141.40)	2.01**

Standard deviations in parenthesis

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

The descriptive statistics results also show that women with possession of land rights significantly (5% level) had more off-farm income (KES 258633.30) as compared to those who did not have possession of land rights (KES 228124.80). Possession of secure land rights motivates the holder to use the land as collateral to secure credit facilities from financial institutions. The credit facility can be used to invest in non-farm-related activities. Some land rights may also allow the holder to lease the land and use the income to invest in other non-farm-related activities (Shibata *et al.,* 2020).

Concerning ownership of productive assets, as presented in Table 25, Chi-square results show a significant relationship between those with possession of land rights and those without possession of land rights concerning ownership of oxen. Only 10.56% of those possessing land rights owned at least an ox, while 22.32% of those who did not own land rights owned at least an ox. In the study area, an ox is critical in providing agricultural labour. It is used in cultivating and transporting farm inputs from the homestead to the farm, among other uses. The findings imply that those possessing land rights may have other income streams and, therefore, are less likely to own an ox. Furthermore, those without land rights may be more inclined to own an ox as an alternative source of livelihood. However, a previous study by Abrar-ul-Haq *et al.* (2019) indicates that those possessing land rights use oxen to provide farm labour.

Table 25: Descriptive and inferential statistics of categorical variables used in the 2SLS model

Variable Name	**Description of variable**	**Response**	**Overall Sample (%)**	**Possession of land rights category**		χ^2
				No possession of land rights (%)s	**Possession of land rights (%)**	
Possession of land rights	% of women based on possession of land rights	Yes No		61.20	38.80	
Marital status	Marital status of the woman	Married	64.75	63.84	66.20	0.21
		Unmarried	35.25	36.16	33.80	
Community leadership	Whether the woman is or was a community leader	Yes	15.57	16.96	13.38	0.85
		No	84.43	83.04	86.62	
Type family	Type of family set-up	Polygamy	3.83	4.91	2.11	1.85
		Monogamy	96.17	95.09	97.89	
Oxen ownership	Whether the woman owns at least one ox	Yes	17.76	22.32	10.56	8.23***
		No	82.24	77.68	89.44	
Credit access	Whether the woman has the ability to take credit	Yes	54.64	54.46	54.93	0.01
		No	45.36	45.54	45.07	
Group membership	Whether the woman is a member of at least one group	Yes	25.41	23.21	28.87	1.47
		No	74.59	76.79	71.13	

*** represents a significance level of 1%

6.3.2 Effect of possession of land rights on women empowerment

Table 26, columns 2 and 3 show OLS results of the effect of possession of land rights on women's empowerment. Results indicate that possession of land rights significantly increases women's empowerment by about 4.3%. However, as shown in the methodology, a reverse relationship exists between the possession of land rights and women empowerment. We hypothesise that the possession of land rights affects women empowerment; however, women empowerment can also influence the possession of land rights. This results in an endogeneity problem. Therefore, OLS estimates are biased and inconsistent, making them unreliable in this study. To solve this challenge, the study used a two-stage least square method; results are presented in Table 26, column 5. The endogeneity test results (IVREG2, $\chi^2 = 5.193$, $p = 0.00$) suggest the presence of endogeneity in the equation, hence validating the use of the 2SLS model. Model fit results (F-stat. 8.800, $p = 0.000$) indicate that the model is significant, and thus, it sufficiently explains the relationship between possession of land rights and women empowerment. Furthermore, the uncentered R squared suggests that the independent variables explain about 53.8% of the variations in women's empowerment.

Two-stage least square results (table 26, columns 6 and 6) show that possession of land rights by women significantly increased their empowerment by approximately 0.25%. Han *et al.* (2019) argue that possession of land rights could allow land use as collateral to access credit facilities that would improve women's economic empowerment. Similarly, Mishra and Sam (2016) suggest that, by improving women access to land, they are more likely to increase their bargaining power in the household and hence become more empowered. Other factors affecting women empowerment were marital status, the difference in the education level between a man and woman, type of family, ownership of an ox, non-farm income, group membership, and access to credit. Marriage reduced the level of women empowerment by about 0.06%. Married women may have more household responsibilities, such as cooking and taking care of their spouse and children, thus limiting them from participating in activities that would improve their empowerment. Meinzen-Dick *et al.* (2019) found that unmarried women were considered "liberated" in Burkina Faso and, therefore, more empowered. However, Chakraborty (2017) claims that family is critical to improving women empowerment in society since it provides both emotional and economic support to women.

An increase in the education level gap between women and men by one year increased women empowerment by 0.008%. This finding underscores education's importance among rural women in the developing world. Educated women are more likely to be aware of new

agricultural technologies, which could increase their incomes. Educated women may have more employment opportunities, hence higher income and improved farm decision-making (Sharuanga *et al.,* 2019). Sell and Minot (2018) indicate that improving the education level of one member disadvantages the other member. Similarly, Meier zu Selhausen (2016) note that an increase in the education gap reduces the ability of a woman to make decisions in the household due to the feeling of inferiority.

Membership in a group by women significantly increased their empowerment in agriculture by about 0.17%. Groups are platforms for sharing information on available economic opportunities that would improve their financial power. Women use group meetings as avenues to deal with household social problems. In addition, women group members sometimes confront abusive spouses, giving power to their members (Brody *et al.,* 2015; Sharuanga *et al.,* 2019). During group meetings, women usually undergo training on different aspects, such as agriculture and financial management, improving their household decision-making ability (Clement *et al.,* 2019).

An increase in off-farm income increased women empowerment by approximately 0.007%. Income obtained by women from off-farm sources helps them have control over income in the household, hence improving their empowerment. Similarly, off-farm income received can be invested in purchasing farm inputs and machinery, which would increase their household income and enhance household bargaining power (Sharuanga *et al.,* 2019).

Ownership of an ox increases women's empowerment by approximately 0.067%. This implies that ownership of non-land productive resources facilitates women's utilisation of land resources to improve their empowerment. In rural areas, an ox is used as a source of traction for titling land and performing other farm-related activities; thus, it improves women's access to farm labour, which is key to their empowerment (Gebre *et al.,* 2021). Ownership of an ox is also a sign of wealth in most traditional societies, thus facilitating women access to credit facilities and improving their economic power (Sharaunga *et al.,* 2019). An ox can also be hired out to provide income to the household (Holden & Tilahun, 2021).

Table 26: Results of the effect of possession of land rights on women empowerment

Variables	**Ordinary Least Squares**		**2 Stage Least Squares**	
	Standard errors	**Coefficients**	**Standard errors**	**Coefficients**
Possession of land rights	0.0122	0.0429***	0.1276	0.2542**
Age	0.0006	-0.0009*	0.0011	0.0005
Marital status	0.0137	-0.0362***	0.0233	-0.0604**
Years of schooling	0.0018	-0.0048***	0.0027	-0.0027
Household size	0.0034	0.0115***	0.0080	0.0005
Age gap	0.0011	0.0002	0.0014	0.00009
Education level gap	0.0026	0.0031	0.0045	0.0077*
Community leadership	0.0161	-0.0124	0.0221	-0.0213
Type of family	0.0302	0.0320	0.0510	0.0841*
Oxen ownership	0.0164	0.0302*	0.0311	0.0672**
Land size	0.0041	-0.0040	0.0060	0.00002
Non-farm income	0.0011	0.0040***	0.0026	0.0073***
Market access	0.0002	0.0001	0.0003	0.0003
Extension contacts	0.0048	0.0043	0.0065	0.0051
Group membership	0.0129	0.1700***	0.0173	0.1667***
Credit access	0.0119	0.0280**	0.0186	0.0439**
Constant	0.0368	0.1005***	0.1049	-0.0541
Number of observations	366			366
F stat,(16, 349)	16.900***			8.800***
Adjusted R-squared	0.411			
Un centered R-squared				0.538
IVREG2-				5.193**

Endogeneity test

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

Access to credit facilities by women improved their empowerment by about 0.044%. Income obtained from credit sources can be used to invest in agricultural and non-agricultural income-generating activities and purchase assets that would improve women's asset ownership and economic power. Mulema (2018) argues that, when obtaining credit, women are trained to use it to improve their lives prudently, improving information access for better household decision-making. Esmaeil *et al.* (2018) found that women with access to credit could control their savings and improve decision-making abilities in their families and society. Additionally, they improved their self-confidence and self-esteem.

Polygamy improved women empowerment by approximately 0.051%. Women who were married to polygamous husbands are more aggressive and can spot economic opportunities due to the perceived stiff competition for resources in the households. Similarly, women from polygamous men, especially the first wives in traditional societies, are neglected, and preference is given to the last wife; therefore, they can join self-help groups to improve their economic status and that of their children (Tsige, 2019). Maunde *et al.* (2019) argue that most women in polygamous marriages are not closely monitored by their patriarchal husbands. Therefore, they solely make most decisions about their lives, giving them decision-making power.

6.4 Conclusion and recommendations

The paper conducted an empirical study to determine the effect of possession of land rights on women empowerment in Kenya as a contribution to achieving SDG number 5 on gender equality. Women empowerment was measured using the Women Empowerment in Agriculture Index. Due to the endogeneity problem, a two-stage least square econometric model was used to analyse the effect of the possession of land rights on women empowerment. Descriptive statistics show that most women in the study area did not possess land rights. In contrast, those who possessed land rights were significantly more empowered than those who did not possess land rights. Additionally, women with land rights were significantly younger, more educated, and had more land and more off-farm income than those who did not possess land rights.

Two-stage lease square method results show that women empowerment increases by about 0.25% if women are given the right to use and transfer land. Results emphasise the importance of

ensuring access to secure land rights among rural women. Government and other stakeholders could develop and implement policies that facilitate women access to land rights that would improve their economic, social and political power. Other factors affecting women empowerment were marital status, education level gap, oxen ownership, polygamous marriage, off-farm income, group membership, and credit access. The government could promote access to both formal and informal education among women to improve their decision-making ability in the household. Efforts to promote women's access to informal and formal credit should be enhanced. Additionally, women should be encouraged to own productive assets such as oxen, which would improve their bargaining and economic power.

CHAPTER SEVEN

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

7.1 Critical review

The study analysed the role of land tenure security on maize productivity, household food security and women empowerment in Narok County, Kenya. To achieve the objective, the study used property rights theory, empowerment theory, production theory, and utility maximisation theory to explain the relationship among land tenure security, maize productivity, household food security, and women empowerment.

Land tenure security is multidimensional and can be measured in different ways. Traditionally, land tenure security has been measured using the possession of a land title deed. However, previous research has shown that in areas where land markets are underdeveloped, a title deed may not be an appropriate measure of land tenure security; hence, the study used a composed measure that takes care of the different aspects of land tenure security.

The conditional mixed process model also provided a solution for analysing the effect of land tenure security on maize productivity through credit access. The model addressed the endogeneity problem in the relationship among land tenure security, credit access, and maize productivity (Rashid, 2021). Since there was reverse causality in the relationship, the CMP model could take of the system of equations, endogeneity and the differences in the dependent variables (Joel & Bergaly, 2020).

Using the endogenous switching regression model to analyse land tenure security's effect on household food security solved the self-selection and endogeneity problems in the analysis (Raoul, 2021; Wabwile *et al.*, 2016). ESR also allowed for the derivation of the probabilities of the counterfactual cases on the effect of land tenure security on household food security (Bidzakin *et al.,* 2019). The nature of the dependent variables also informed this model's choice.

Women Empowerment in Agriculture Index (WEAI) measured women's empowerment among rural women practising agriculture innovatively. WEAI is based on survey data collected from primary male and female adults in a household (Alkire *et al*., 2013). It consists of (six) 6 domains broken down into (ten)10 indicators, which measure how a woman is empowered on various measurements such as production, income, resources, leadership, and time domains (Sraboni *et al*., 2014). A person is said to be empowered if their weighted indicators reflect at least 80% of the empowerment.

7.2 General discussion

Most food consumption decision-makers were females (77.87%), while the farm production decision-makers were male (54.10%). In most rural communities, especially in developing countries, most farm production-related decisions, such as ploughing and planting, are deemed masculine and require much physical energy; hence, men tend to undertake them. On the other hand, food consumption-related decisions are usually associated with women since they are responsible for food preparation for the household (Habtewold, 2018).

Farm production key decision makers were better educated, with average years of schooling of 9.47 years, than those for food consumption, with 8.59 years of schooling. Education is vital in knowledge and skills acquisition, which are needed in decision-making regarding farm operations and their use. Furthermore, more educated individuals can easily access information on the latest farm technologies useful in production. Mohammed and Mohammed (2021) also argue that a better-educated household head may diversify their household income and become more resilient towards food insecurities.

Findings also indicate that the mean age of the key decision makers on farm production and land-related matters was 43.63 years, while for the key decision makers on food consumption matters was 40.57 years. This implies that key decision makers on food consumption matters were younger than those on farm production and land-related matters. Since earlier results also show that most of the key decision-makers on food consumption were females and at the same time, those in farm production and related matters are males, the results concur with the traditions of African societies where men usually marry relatively younger women (Sulle *et al*., 2019). Furthermore, the younger age associated with food consumption key decision makers enables them to be innovative and diverse in their decisions (Valkonen, 2021).

The results also show that the average household size was five people, indicating a relatively larger household size compared to the average household size in Kenya, which is four people (KNBS, 2019). This is also contrary to the scenario in most rural households, where they tend to have a larger household size to act as a source of family labour in farms and household activities (Djurfeldt, 2020). Respondents also had a mean land size of 1.65 Ha with an average of one contact with an extension agent for one year and a mean maize productivity of 2484.31 Kgs/Ha. This finding implies limited access to extension services in the study area. Extension service providers are essential in improving agricultural productivity. In rural areas, they act as a

key source of agricultural information, such as new farming technologies and disease and pest control, which tend to contribute to increased agricultural productivity (Fiaz *et al.*, 2018).

Results also show that 45.36% of the respondents could take credit from formal financial institutions such as banks, microfinance institutions and SACCOs. This implies that the respondents could have possessed items such as land title deeds, valuable household items, and car log books that could have been used as collateral during loan application. A household with access to credit can invest in farm activities such as purchasing fertilisers and pesticides to produce more food, boosting household food security (Awoke *et al.*, 2022).

Regarding group membership, 25.41% of the respondents were at least one group member. These groups included agricultural and non-agricultural related groups. Group membership enhances members' social capital, which is critical in decision-making. Furthermore, groups provide essential information on farm and non-farm-related aspects. Such information helps make decisions in the household.

Regarding ownership of an ox, most respondents (82.24%) did not own an ox. Oxen is used to provide agricultural labour in most rural households. They can also be hired out to other users, providing income to the household (Maharjan & Joshi, 2011). The finding stresses the importance of enhancing ownership of productive assets to boost agricultural productivity and household food security.

The study findings show that 46.99% of the household heads had a land title deed. This indicates that most household heads did not have a title deed. The findings underscore the need for government and other stakeholders to enhance land registration, especially in rural areas. Conditional mixed process results show that possessing a land title deed could improve access to credit facilities invested in agriculture, increasing agricultural productivity. Rashid (2020) argues that a land title deed can serve as a security to acquire a loan from a formal financial institution such as a bank since they can repossess the land in case of a default payment.

Land tenure security also improved household food security, as evidenced by the endogenous switching regression results. Land tenure security is critical in enhancing land investments such as manuring and terracing. Such investments increase agricultural productivity, hence the provision of enough food for the household (Espinosa, 2019). Additionally, land tenure security allows the existence and development of a vibrant land market which could transfer land from inefficient users to efficient ones (Keovilignavong & Suhardiman, 2020). Possession of land

rights by women increased women empowerment by 0.25%, underscoring the role of land tenure security in improving women's voice in the household. Land tenure security among women increases their financial independence, improving their household bargaining power. This, in turn, improves their decision-making ability in the household (Han *et al.,* 2019).

7.3 Conclusions

Objective One: To assess the determinants of land tenure security among small-holder maize farmers in Narok County, Kenya.

The main determinants of land tenure security were age, marital status, and household head years of schooling. Additionally, the number of years the household has stayed on the land, land fertility, land purchase, size of land, walking time from the household to the parcel, and household size also determine the level of land tenure security.

Objective Two: To determine the effect of land tenure security on maize productivity among small-holder maize farmers in Narok County, Kenya.

A relationship existed among land tenure security, credit access and maize productivity. Land tenure security significantly and positively influenced credit access, while credit access also positively and significantly influenced maize productivity. Farmers with access to credit increased their maize productivity by 2001.902 Kg/Ha. Thus, land tenure security positively influenced maize productivity, signalling its key role in acquiring credit for improving maize productivity.

Objective Three: To assess the role of land tenure security on household food security among small-holder maize farmers in Narok County, Kenya.

According to stage one of the ESR, major determinants of household food security were 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 to an ox. Land tenure secure households would have a 4% decrease in food security if they were land tenure insecure. On the other hand, there would have been about a 38% increase in food security for land insecure if they were land tenure secure. These results, therefore, indicate that land tenure security improves household food security.

Objective Four: To analyse the influence of land tenure security on women empowerment among small-holder maize farmers in Narok County, Kenya

Land tenure security is vital in enhancing women empowerment among rural women.

Women empowerment increased by about 0.25% if women were given the right to use and transfer land. Results underscore the importance of ensuring access to secure land rights among rural women. Other factors affecting women empowerment were marital status, education level gap, oxen ownership, polygamous marriage, off-farm income, group membership, and credit access.

7.4 Recommendations

i. The government and land sector stakeholders should fast-track the full implementation of pro-youth and women policies that could increase land tenure security in rural communities. Acquisition of land through purchase has the potential to increase the land tenure security of households; thus, there is a need to focus on participatory implementation of policies geared towards encouraging the development of vibrant land markets that could enhance land purchases, especially in rural areas.

ii. The findings of this study underscore the need for governments and land sector stakeholders to develop additional policies that would facilitate access to land title deeds by the rural population to increase maize productivity. Furthermore, agricultural credit could be made more accessible to most small-holder farmers to enable them to undertake short- and long-term investments that would increase their maize productivity.

iii. Government and other stakeholders should also develop additional policies and strategies to facilitate access to secure ownership and transfer land rights by rural farming households and encourage farm investments to improve household food security.

iv. Government and other stakeholders should develop and implement policies that facilitate women access to land rights that would improve their economic, social and political power. Additionally, the government should promote access to both formal and informal education among women to improve their decision-making ability in the household. Efforts to promote women's access to informal and formal credit should be enhanced. Furthermore, women should be encouraged to own productive assets such as oxen, improving their bargaining and economic power.

7.5 Area of further research

i. The current study used a cross-sectional study; thus, a longitudinal analysis could be carried out in the future to assess the changes in household food security, agricultural productivity, and women empowerment over time and in different subjects.

ii. This study also investigated maize productivity at the primary parcel level. Further research could focus on the parcel level to assess the variations in productivity concerning the parcel's and tenure security status. Additionally, household food security can be analysed at the individual level instead of the household level.

iii. The current study uses two indicators of land tenure security: possession of user and transfer rights and possession of a land title deed. In order to take care of the uniqueness of other indicators, future studies could use other indicators, such as availability of land disputes and duration of stay on the land, among others.

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APPENDICIES

Appendix I: Multi-collinearity test for variables used in the Ordered probit model

Variable	VIF	1/VIF
Sex	2.67	0.374855
Marital status	2.66	0.375824
Age	2.17	0.461082
Land stay	2.10	0.475914
Education level	1.65	0.605338
Land size	1.35	0.739339
Household income	1.22	0.819313
Maize productivity	1.19	0.838479
Land fertility	1.19	0.842514
Household size	1.15	0.872307
Parcel access	1.14	0.878918
Community leadership	1.13	0.886001
Land topography	1.11	0.898413
Land acquisition	1.10	0.911432
Land concentration	1.09	0.920946
Land dispute	1.09	0.921651
Mean VIF	1.50	

Appendix II: Multi-collinearity test for variables used in the CMP model

Variable	VIF	1/VIF
Parcel size	2.73	0.366542
Sex	2.73	0.366637
Marital status	2.68	0.373319
Land size	2.37	0.421454
Age	2.25	0.445131
Land stay	2.23	0.448714
Education level	1.83	0.547109
Maize gross margin	1.76	0.568951
Oxen ownership	1.43	0.699329
Extension contacts	1.42	0.705258
Land fertility	1.33	0.753893
Household income	1.31	0.765980
Fertilizer use	1.26	0.795801
Community leadership	1.26	0.796549
Group membership	1.24	0.808047
Household size	1.24	0.809088
Herbicide use	1.21	0.825239
Parcel access	1.20	0.830190
Land concentration	1.18	0.849533
Credit access	1.16	0.862418
Land dispute	1.15	0.868528
Land topography	1.15	0.870224
Market access	1.13	0.885129
Land acquisition	1.13	0.888108
Hybrid seeds use	1.11	0.897774
Mean VIF	1.58	

Appendix III: Multi-collinearity test for variables used in the ESR model

Variable	**VIF**	**1/VIF**
Land stay	2.85	0.350667
Ward stay	2.17	0.460159
Age	1.93	0.517474
Education level	1.78	0.562996
Road access	1.64	0.608113
Sex	1.51	0.663216
Market access	1.50	0.665278
Marital status	1.44	0.695346
Extension contacts	1.41	0.708476
Oxen ownership	1.41	0.711627
Land size	1.40	0.713515
Household income	1.32	0.759852
Land fertility	1.30	0.772112
Parcel access	1.26	0.794881
Maize productivity	1.25	0.800634
Group membership	1.24	0.803613
Household size	1.20	0.830387
Credit access	1.19	0.837326
Community leadership	1.19	0.841057
Land concentration	1.16	0.864115
Land topography	1.12	0.889390
Land dispute	1.11	0.902214
Land acquisition	1.10	0.912933
Mean VIF	1.46	

Appendix IV: Multi-collinearity test for variables used in the 2SLS model

Variable	**VIF**	**1/VIF**
Age	2.43	0.411553
Land stay	2.31	0.433082
Market access	1.87	0.534407
Road access	1.81	0.552207
Education level	1.75	0.571568
Marital status	1.48	0.677879
Age gap	1.42	0.705163
Education level gap	1.38	0.725744
Extension contacts	1.35	0.738288
Oxen ownership	1.34	0.744267
Land size	1.32	0.756799
Household size	1.22	0.821069
Possession of land rights	1.18	0.846326
Community leadership	1.18	0.846869
Type of family	1.17	0.854891
Non-farm income	1.14	0.877373
Credit access	1.14	0.880689
Group membership	1.11	0.898807
Mean VIF	1.48	

Appendix 5: Descriptive statistics on sub county distribution of the sample

Sub-county	**Frequency**	**Percentage (%)**
Trans-mara East	179	48.91
Trans-mara West	187	51.09
Total	366	100

Appendix 6: Descriptive and inferential statistics of continuous variables with respect to the sub-county

Variable name	**Description of variables**	**Overall sample**	**Trans-mara East**	**Trans-mara West**	**Significance**
Continuous variables				**Mean**	**T-statistic**
Age	Age of the household head in years	43.63 (11.92)	43.13(10)	44.11(11.88)	-0.78
Education level	Years of schooling of the household head	9.47(4.04)	10.22(4.17)	8.75(3.78)	3.54***
Household size	Number of people in the household	4.54(1.75)	4.39(1.57)	4.70(1.90)	-1. 70*
Land stay	Number of years household had stayed on the land	16.59 (11.69)	16.17(12.20)	17.00(11.19)	-1.82*
Land size	Total land size in hectares	1.65(1.49)	1.68(1.63)	1.62(1.33)	-1.69*
Parcel access	Time taken from the house to the parcel in minutes	3.69 (3.03)	3.69(2.78)	3.68(3.26)	0.049
Maize productivity	Productivity of maize (Kg/Ha)	2484.31 (1249.00)	2592.20(1296.43)	2381.05(1196.18)	1.70*
Household income	Total household income in Kenya shillings	256,598.90 (205029.8)	272695.20(209404.30)	241191.10(200100.6)	1.82*

Standard deviations in parenthesis

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

Appendix V: Questionnaire

Introduction

This study is conducted to find out the effect of land tenure on agricultural productivity, food security and women empowerment of small-scale maize farmers in Narok County, Kenya. The information you will provide will assist in formulation of additional policies and programs that will help to improve the livelihoods of small-scale maize farmers in the County. I assure you that the information will be treated as confidential as possible.

Questionnaire Identification

Questionnaire Number …….

Sub-County……...

Ward…….

Location……...

Date…….

1.0 Farmers' Background Information

1.1 Sex of the key decision maker on farming matters: 1= Male, ☐ 0= Female ☐

1.2 Sex of the key decision maker on food consumption matters: 1= Male ☐ 0= Female ☐

1.3 Age of the key decision maker on farming matters (in years) …….....

1.4 Age of the key decision maker on food consumption matter (in years) ……....

1.5 Age of the wife of the key decision maker in farming matters (in years)……

1.6 Age of the husband of the key decision maker on farming matters (in years)……

1.7 Number of years of schooling of the decision maker on farming matters (years)……

1.8 Number of years of schooling of the decision maker on food consumption matters (years)……

1.9 Number of years of schooling of the wife of the key decision maker in farming matters (in years)…

10.0 Number of years of schooling of the husband of the key decision maker on farming matters (in years)……..

10.1 Marital status of the decision maker on farming matters.

1= Married ☐

0= Not married ☐

10.2 Marital status of the decision maker on food consumption matters

1= Married ☐

☐

0= Not married

10.3 How would you categorize your household's way of living?

Nomadic pastoralism ☐ Non-nomadic pastoralism ☐

10.4 How would you categorize your type of family way?

Polygamous ☐ Monogomous ☐

10.5 How many people are there in the household?.....

Name of the member e.g Husband, Wife, Son A, Daughter A	**Sex Male=1, 0 Female**	**Age in years**

10.6 How many household's members in question 10.5 above participate actively in the farming activities? ……..

10.7 Is there a member of household who has a leadership position in the community?

Yes=1 ☐ No=0 ☐

10.8 How many years has the key decision maker on farming matters stayed in the ward?.....

2.0 Land Related Factors

2.1 What is your total land size (acres)…….

2.2 Is the land concentrated in one ward? Yes=1 ☐ No.= 0..☐.....

2.3 Out of the total land you posseses, how many acres do you possess title deed on?

2.4 How many acres were under maize production in the last season?.....

2.5 How did you acquire the land under maize production in last season?

Purchase=1 ☐ (Lease, Inheritance) =0 ☐

2.6 Has there been any dispute on the said land in the last 5 years? Yes=1 ☐ or No=0 ☐

2.6.1 If yes in 2.6 above has the disputed been settled? Yes ☐ No ☐

2.7 How would you categorize the fertility of the land land? High =☐ Low..☐……

2.8 How would you categorize the topography of the land? Hilly =1 ☐ Flat..☐

2.9 How many years have you been farming on the land?.....

20.0 Do you have a title deed on the parcel (s) that you planted maize in the last season?

Yes =1, ☐ No=0 ☐

20.1 The following questions refer to your rights on the parcel (s) that you have been farming maize. ***Please tick as appropriate.***

User Rights

S/N	Nature of the Right	Yes=1, No=0	If yes, Permanently=1, Temporary=0
1.	Right to choose which crop to grow		
2.	Right to put one's land into fallow and recultivate it one the fallow is over		
3.	Right to make improvements to the land,		
4.	Right to freely dispose of crop output		
5.	Right to prevent grazing of other's livestock.		

Transfer Rights

S/N	Nature of the Right	Yes=1, No=0	If yes, without approval=1, with approval=0
1.	Right to lend the land along traditional lines		
2.	Right to give out the land as an inheritance		
3.	Right to rent the land against cash		
4.	Right to sell the land		
5.	Right to mortgage the land		

3.0 MAIZE PRODUCTIVITY

3.1 Land Improvements

The following questions refer to improvements on the land under maize in the last season. Please indicate Yes if the farmer carried the following land improvement (investments) in the past 5 years and No if did not

S/N	Type of land Improvement	Yes=1, No=0
	Planting of trees	
	Delimiting of parcels (Fencing)	

	Digging of small water pans for irrigation	
	Construction of Drains	
	Construction of anti-soil erosion barriers (Terracing)	
	Continuous manuring	
	Construction of Drainage Canals	
	Construction of an Access Road	
	Fallowing	
	Crop Rotation	
	Levelling	
	Mulching	
	Grass Stripping	
	Removing Stumps	

3.2 Use of variable inputs

The following questions refer to the use of variable inputs in maize production in the last season. Please answer accordingly.

3.2.1 Seeds, Fertilizer, Herbicides and Pesticides

Parcel Number	**Area planted (acres)**	**Seeds Used in Kgs/acre**	**Price per Kg**	**Fertilizer (Kgs)/acre**	**Price per Kg/Litre**	**Pesticides Used in liters/acre**	**Price per liter**	**Yield in 90 kg bag/acre**	**Price per 90kg bag**

3.2.2 Labour

		Parcel Code eg A				
Activity	**Land Preparation**	**Ploughing**	**Harrowing**	**Planting**	**Weeding**	**Harvesting**
Man Days Per Acre						
Cost/Acre(Ksh)						

4.0 Food Security

4.1 Household Dietary Diversity Core

The following questions refer to the food security of your household. Please indicate Yes, If you or anyone else in your household ate the following foods yesterday during the day and at night and No if did not

S/No	Question	Response (Yes=1, No=0)
1.	Any ugali, bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, maize,	
2.	Any potatoes, yams, manioc, cassava or any other foods made from roots or tubers?	
3.	Any vegetables?	
4.	Any fruits?	
5.	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	
6.	Any eggs?	
7.	Any fresh or dried fish or shellfish?	

8.	Any foods made from beans, peas, lentils, or nuts?	
9.	Any cheese, yogurt, milk or other milk products?	
10.	Any foods made with oil, fat, or butter?	
11.	Any sugar or honey?	
12.	Any other foods, such as condiments, spices coffee, tea?	
13.	**Total Score**	

4.2 Food Consumption Score

The following questions refer to the consumption of different foods in your household in the **last 7 days**. Please indicate **how many days** in the past week your household has eaten the following foods. For each food, indicate the primary source of each food item eaten that week was, as well as the second main source of food, if any).

Food source codes:

Purchase =1 Own production =2, Borrowed = 3 Received as gift= 4 Food aid =5, other (specify) =6

S/No	**Question**	**Days eaten in the last 7 Days**	**Sources of Food**
1.	Maize		
2.	Rice		
3.	Bread/Wheat		
4.	Tubers		
5.	Groundnuts and Pulses		
6.	Fish (eaten as a main food)		
7.	Fish Powder (Used as a flavour)		

8.	Red Meat (Sheep/Goat/Beef)		
9.	White Meat (Poultry)		
10.	Vegetables Oils, Fats		
11.	Eggs		
12.	Milk and Dairy Products (Main Food)		
13.	Milk in Tea in Small Amounts		
14.	Vegetables (Including Leaves)		
15.	Fruits		
16.	Sweets, Sugars		
17.	**Total Score**		

5.0 Economic Related Factors

5.1 Farm assets

The following questions refer to the farm assets owned by the farmer. Please answer appropriately

Name of the assets	**Purchase Price in KES**	**Year of Purchase**

5.2 Household Income

The following questions refer to the income earned by the farmer for the last 12 months in KES. Please answer appropriately

Source of Income	**Amount in the last 12 months (KES)**	**Who contributes it?(Husband =1, Wife =0**
Farm Income		

Non-Farm Income		

Livestock Ownership

Livestock Specie e.g. Cattle, goats	**Number of Livestock**	**Age**	**Breed**	**Value**

6.0 Institutional Factors

6.1 Farming Experience

6.1.1 How many years have you been practicing maize farming?.....

6.2 Credit Access

6.2.1 Did you request for any credit for agricultural production in the last 3 years?

1=Yes ☐ 0= No ☐

6.2.2 If, Yes, for what purpose in agricultural production did you request the credit facility?……

6.2.3 How much in KES did you request for? .....

6.2.4 How much were you awarded in KES?……

6.2.5 What was the source of the credit facility?

Bank..☐.Microfinance..☐.Mobile Applications..☐.OtherInformal sources.☐….

6.3 Market Access

6.3.1 What is the walking time from your home to the nearest market in minutes……

6.3.2 What is the walking time from the land to the nearest road in minutes?.....

6.3.3 What is the walking time from the house to the parcel in minutes?.....

6.4 Group Membership

6.4.1 Are you a member of any group? Yes=1 ☐ No=0 ☐

6.4.2 If Yes, how many are

Agricultural Related……

No- Agricultural Related……

6.5 Agricultural Extension Access

6.5.1. Were you visited by any agricultural extension agent in the last 1 year?

Yes=1 ☐ No=0 ☐

6.5.2 If Yes, how many times did they visit you have?…….

6.5.3 What kind of information did you get form the visits?.....

7.0 WOMEN EMPOWERMENT

7.01. Do you possess a title deed on the land you farm? Yes or No

7.02. Are you a leader in any community group? Yes or No

7.03. The following questions refer to level of women empowerment in your household. Please answer appropriately

Module G. Women's Empowerment in Agriculture Index: Adapted from Alkire *et al.* (2013)

MODULE G1. INDIVIDUAL IDENTIFICATION

	Code			**Code**
G1.01. Household		**G1.05.** Outcome of interview		
G1.02. Name of respondent currently being interviewed (ID Code from roster in		**G1.06.** Ability to be interviewed alone:		
	...2 ...	**G05**	**G06**	
G1.04. Type of household		Completed 1	Alone.....1	
Male and female adult 1		Incomplete 2	With adult females present 2	
Female adult only 2		Absent 3	With adult males present 3	
		Refused 4	With adults mixed sex present…. 4	
		Could not locate 5	With children present 5	
			With adults mixed sex and children present……6	

7.1 Module G2: Role in Household Decision-Making around Production and Income generation

Activity		Did you (singular) participate in the following in the past 12 months (that is during the last [one/two] cropping seasons)? Yes.....1 No ..... 0 >> next activity	How much input did you have in making decisions about the activity	How much input did you have in decisions on the use of income generated from the activity
Activity	**Activity Description**	**G2.01**	**G2.02**	**G2.03**
A	Food crop farming: crops that are grown primarily for household food consumption			
B	Cash crop farming: crops that are grown primary for sale in the market			
C	Livestock raising			
D	Non-farm economic activities: Small business, self-employment, buy-and-sell			
E	Wage and salary employment: in-kind or monetary work both agriculture and			
F	Fishing or fishpond culture			

	G2.01, G2.02/G2.03: Input into decision making No input.....1 Input into very few decisions 2 Input into some decisions 3 Input into most decisions.4 Input into all decisions ....5 No decision made 6

7.2 Module G3: Access to Productive Capital

Productive Capital	Does anyone in your household currently have any this item? Yes=11 No = 0	How many of the item does your household currently have?	Who would you say owns most of the items	Who would you say can decide whether to sell the item most of the time?	Who would you say can decide whether to give away the item most of the time?	Who would you say can decide to mortgage or rent out the item most of the time?	Who contributes most to decisions regarding a new purchase of the item?
Productive Capital	**G3.01a**	**G3.01b**	**G3.02**	**G3.03**	**G3.04**	**G3.05**	**G3.06**
A Agricultural land(pieces/plots)							

B	Large livestock (oxen, cattle)							
C	Small livestock (goats, pigs, sheep)							
D	Chickens, Ducks, Turkeys, Pigeons							
E	Fish pond or fishing equipment							
F	Farm equipment (non-mechanized)							
G	Farm equipment (mechanized)							
H	Non-farm business equipment							
I	House (and other structures)							
J	Large consumer durables (fridge, TV, sofa)							
K	Small consumer durables (radio,							

M	Other land not used for agricultural purposes (pieces, residential or commercial land)				
N	Means of transportation (bicycle, motorcycle, car)				
				G3.02-G3.06: Decision-making and control over productive capital Self ..... 1 Partner/Spouse .....2 Self and partner/spouse jointly .....3 Other household member…….....4 Self and other household member(s)…….5 Partner/Spouse and other household member(s)……6 Someone (or group of people) outside the household.7 Self and other outside people……..8 Partner/Spouse and other outside people…….9 Self, partner/spouse and other outside people.....10	

7.3 Module G3 Continued: Access to Credit

Lending sources		Has anyone in your household taken any loans or borrowed cash/in-kind from [SOURCE] in the past 12 months?	Who made the decision to borrow from [SOURCE]?	Who makes the decision about what to do with the
Lending source names		**G3.07**	**G3.08**	**G3.09**
A	Non-governmental organization (NGO)			
B	Informal lender			
C	Formal lender (bank/financial institution)			
D	Friends or relatives			
E	Group based micro-finance or lending including VSLAs / SACCOs/ merry-go-rounds			
F	Mobile and Online Lending companies			

	G3.07 Taken loans Yes, cash .....1 Yes, in-kind.....2 Yes, cash and in-kind 3 No.....4 Don't know……5	**G3.08/G3.09: Decision-making and control over credit** Self…….1 Partner/Spouse.....2 Self and partner/spouse jointly…… .....3 Other household member.....4 Self and other household member(s)…… 5 Partner/Spouse and other household member(s)… …6

4.0 Module G4. Individual Leadership and Influence in the Community

Q No.	Question	Response	Response codes
G4.01	Do you feel comfortable speaking up in public to help decide on infrastructure (like small wells, roads, water supplies) to be built in your community?		No, not at all comfortable ..... 1 Yes, but with a great deal of difficulty ..... 2 Yes, but with a little difficulty3 Yes, fairly comfortable ..... 4 Yes, very comfortable..... 5
G4.02	Do you feel comfortable speaking up in public to ensure proper payment of wages?		
G4.03	Do you feel comfortable speaking up in public to protest the misbehavior of authorities or elected officials?		

7.5 MODULE G4 Continued: GROUP MEMBERSHIP AND INFLUENCE IN THE GROUP

Group membership		Is there a [GROUP] in your community? Yes…...1 No …...2	Are you an active member of this [GROUP]? Yes……1 No…….2
	Group Categories	**G4.04**	**G4.05**
A	Agricultural / livestock/ fisheries producer's group (including		
B	Water users' group		
C	Forest users' group		
D	Credit or microfinance group (including SACCOs/merry-go-rounds/		
E	Mutual help or insurance group (including burial societies)		
F	Trade and business association		
G	Civic groups (improving community) or charitable group (helping others)		
H	Local government		
I	Religious group		
J	Other women's group (only if it does not fit into one of the other categories)		
K	Other (specify)		

7.6 Module 5: Decision Making

ENUMERATOR: Ask G5.01 for all categories of activities before asking G5.02. Do <u>not</u> ask G5.02 if G5.01 response is 1 and respondent is male OR G5.01 response is 2 and respondent is female. If household does not engage in that particular activity, enter 98 and proceed to next activity.		When decisions are made regarding the following aspects of household life, who is it that normally takes the decision?	To what extent do you feel you can make your own personal decisions regarding these aspects of household life if you want(ed) to? Ask only if G5.01 is 1 and respondent is female, G5.01 is 2 and respondent is male, or G5.01 is 3-7.
		G5.01	**G5.02**
A	Getting inputs for agricultural production		
B	The types of crops to grow for agricultural production		
C	Taking crops to the market (or not)		
D	Livestock raising		
E	Your own (singular) wage or salary employment		

F	Major household expenditures (such as a large appliance for the house like refrigerator)		
G	Minor household expenditures (such as food for daily consumption or other household needs)		
		G5.01: Who makes decision Main male or Main female or wife Husband and wife jointly	**G5.02: Extent of participation in decision making** Not at all ……1 Small extent…….. 2 Medium extent……..3 To a high extent……4

MODULE G6: TIME ALLOCATION

Enumerator: ***G6.01:*** *Please record a log of the activities for the individual in the last complete 24 hours (starting yesterday morning at 4 am, finishing 3:59 am of the current day). The time intervals are marked in 15 min intervals and <u>one to two activities can be marked for each time period</u> by drawing a line through that activity. If two activities are marked, they should be distinguished with a P for the primary activity and S for the secondary activity written next to the lines. Please administer using the protocol in the enumeration manual.*

		Night								Morning																Day																							
	Activity	4				5				6				7				8				9				10				11				12				13				14				15			
A	Sleeping and resting																																																
B	Eating and drinking																																																
C	Personal care																																																
D	School (also homework)																																																
E	Work as employed																																																
F	Own business work																																																
G	Farming/livestock/fishing																																																
J	Shopping/getting service (incl health services)																																																
K	Weaving, sewing, textile care																																																
L	Cooking																																																
M	Domestic work (incl fetching wood and water)																																																
N	Care for children/adults/elderly																																																
P	Travelling and communiting																																																
Q	Watching TV/listening to radio/reading																																																
T	Exercising																																																
U	Social activities and hobbies																																																
W	Religious activities																																																
X	Other, specify…																																																

MODULE G6 continued: TIME ALLOCATION

								Evening						Night																																			
	Activity	16				17				18				19				20				21				22				23				24				1				2				3			
A	Sleeping and resting																																																
B	Eating and drinking																																																
C	Personal care																																																
D	School (also homework)																																																
E	Work as employed																																																
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U	Social activities and hobbies																																																
W	Religious activities																																																
X	Other, specify																																																

MODULE G6 continued: SATISFACTION WITH TIME ALLOCATION

QNo. Question Response Response options/Instructions G6.02

How satisfied are you with your available time for leisure activities like visiting neighbors, watching TV, listening to the radio, seeing movies or doing sports? READ: Please give your opinion on a scale of 1 to 10. 1 means you are not satisfied and 10 means you are very satisfied. If you are neither satisfied or dissatisfied this would be in the middle or 5 on the scale.

Appendix VI: Research permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 124085

Date of Issue: 23/August/2021

RESEARCH LICENSE

This is to Certify that Mr.. Joseph Jabu Mbudzya of Egerton University, has been licensed to conduct research in Narok on the topic: EFFECT OF LAND TENURE ON HOUSEHOLD FOOD SECURITY AND WOMEN EMPOWERMENT AMONG SMALL SCALE MAIZE FARMERS IN NAROK COUNTY, KENYA for the period ending : 23/August/2022.

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Appendix VII: List of publications

Mbudzya et al., *Cogent Food & Agriculture* (2022), 8: 2139805
https://doi.org/10.1080/23311932.2022.2139805

cogent food & agriculture

SOIL & CROP SCIENCES | RESEARCH ARTICLE

Effect of land tenure security on agricultural productivity among small scale farmers in Kenya: a conditional mixed processes analysis

Joseph Jabu Mbudzya[1]*, Eric Obedy Gido[1] and George Owuor[1]

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Reviewing editor:
Manuel Tejada Moral, University of Seville, Seville Spain

Additional information is available at the end of the article

Abstract: Security of land tenure among rural households is an integral part in achieving high agricultural productivity. However, there is limited information on the nexus between land tenure security, credit access and agricultural productivity. This study investigates the effects of land tenure security on maize productivity through credit access. Using pre-tested semi-structured questionnaires, cross-sectional primary data were collected from randomly selected 366 small-scale maize farmers in Trans-Mara East and Trans-Mara West sub counties of Narok County, Kenya. Descriptive statistics and conditional mixed process (CMP) model were used to analyse the data. Results show that about 46.99% of the interviewed households had land title deeds. Household heads with land title deeds were more educated, had larger land and farm sizes, had more produc-

Mbudzya et al., *Cogent Social Sciences* (2023), 9: 2220232
https://doi.org/10.1080/23311886.2023.2220232

cogent social sciences

SOCIOLOGY | RESEARCH ARTICLE

Determinants of land tenure security among small-holder farmers in rural Kenya: An ordered probit analysis

Joseph Jabu Mbudzya[1]*, Eric Obedy Gido[1] and George Owuor[1]

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Ana Maria Lopez Narbona, University of Malaga: Universidad de Malaga, Spain

Additional information is available at the end of the article

Abstract: Land tenure security is key to rural transformation, diversification, increased agricultural production, and environmental sustainability. However, its determinants are still unclear, especially in Sub-Saharan Africa (SSA), where land tenure insecurity is widespread. The study evaluated the determinants of land tenure security using the ordered probit model. Using pre-tested semi-structured questionnaires, data were collected from 366 respondents in Narok county, Kenya using a multistage sampling procedure. From the results, household heads in the high land tenure security category were older, more educated, owned relatively larger land sizes, and had higher maize productivity with somewhat smaller

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

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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