FEMALE LAND OWNERSHIP, AGRICULTURAL PRACTICES, AND FOOD SECURITY: EVIDENCE FROM ETHIOPIA

by

NARESH KHAREL

(Under the Direction of Wojciech Florkowski)

ABSTRACT

The study examines the effect of female land ownership on agricultural practices and household food security in Ethiopia, using data from the Ethiopian Socioeconomic Panel Survey (ESPS 2021/22). The findings show that female land ownership positively influences both household food security and the adoption of agricultural practices, such as the use of synthetic fertilizer, crop rotation, and the use of improved maize seed. The effect was statistically significant when a woman in a household jointly owns land with male members. However, households where women are the sole landowners do not show better outcomes compared to those in which women do not own land at all.

INDEX WORDS: female land ownership, agricultural practices, food security, Ethiopia, Rasch model, logit regression

FEMALE LAND OWNERSHIP, AGRICULTURAL PRACTICES, AND FOOD SECURITY: EVIDENCE FROM ETHIOPIA

by

NARESH KHAREL

BS, Agriculture and Forestry University, Nepal, 2021

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2025

FEMALE LAND OWNERSHIP, AGRICULTURAL PRACTICES, AND FOOD SECURITY: EVIDENCE FROM ETHIOPIA

by

NARESH KHAREL

Major Professor:	Wojciech Florkowski
Committee:	Greg Colson
	Travis Smith

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
August 2025

DEDICATION

I dedicate my work to my parents, whose continuous support provided me with the inspiration to continue my work. Their hard work and dedication have been an immense source of my dedication. I also want to thank my friends who have helped me throughout my graduate study.

ACKNOWLEDGEMENTS

First of all, I would like to thank my major advisor, Dr. Wojciech Florkowski, for guiding me during my time at the University of Georgia. He provided me with the necessary ideas and feedback and shaped my research path. I would like to thank Dr. Travis Smith and Dr. Greg Colson for their valuable feedback and suggestions, which helped me improve my research.

I am grateful to the Department of Agricultural and Applied Economics at the University of Georgia for funding my graduate study. I appreciate the instructors who provided me with the knowledge of economic theories and methods of econometric analysis.

Finally, I would like to thank my friends Manish Sharma, Samir Kunwar, and Biraj Sharma for making valuable comments on my research.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

Land ownership is a crucial factor determining land use and agricultural productivity (Lawry et al., 2017; Yang et al., 2022). The lack of a proper land certification system was one of the major hurdles in Ethiopia. Since 1998, a large-scale land certification program has been implemented to distribute land rights to agricultural households (Adamie, 2021). The certification was a big success and gained a lot of praise for its efficiency (Deininger et al., 2012). Although big progress was made in land certification, there is still a big gender bias in land ownership (Dokken, 2013; Holden, 2021). Land ownership is predominantly held by male household members, who own almost 80% of the total land (Deininger et al., 2008).

Women face serious economic constraints due to unequal land access. Limited access to land restricts their economic opportunities and participation in household decision-making (Doss, 2006; Mishra & Sam 2016; Nyakato et al., 2020). Yet, women in Sub-Saharan Africa play a crucial role in agricultural production, comprising 40% of agricultural labor (World Bank Group; Palacios-Lopez et al., 2017). With limited female involvement in decision-making, decisions on the adoption of good agricultural practices are hindered (Perelli et al., 2024). Women are responsible for managing food and nutrition (Jones et al., 2019). Women prioritize household members' well-being and make choices that help to strengthen food security (Madzorera et al., 2023). Given their importance in crop production and household nutrition, the economic restrictions caused by a lack of land access affect household food security (Rehman et al., 2019; Madzorera et al., 2023).

Rising food insecurity is one of the biggest global challenges. The impact of COVID-19, coupled with the rise in conflicts and weather shocks, has pushed the cases of food insecurity to an all-time high (Weldegiargis et al., 2023; Hassen et al., 2024) . According to the State of Food Security and Nutrition in the World report (2024), about 733 million people faced hunger in 2023, an increase of 152 million from 2019. Africa has the largest proportion of the population facing hunger, with one out of every five individuals facing a hunger crisis. The situation in Ethiopia is representative of Africa, where 15.8 million people in Ethiopia need food assistance, and almost 55% of the children under the age of 5 years are malnourished (WFP, 2025).

Existing literature has demonstrated a positive effect of female land ownership on food security (Hillesland et al., 2022; Burrone & Giannelli, 2023). UN Sustainable Development Goals also target female land ownership as a key element for poverty reduction and food security (Stanley & Lisher, 2023). However, although existing literature from Ethiopia has studied the impact of female land ownership on female empowerment, household expenditure patterns, and human capital development, there is a lack of studies to show the association between women's land rights and household food security (Muchomba, 2017; Meinzen-Dick et al., 2019).

Also, existing literature has focused on the impact of land certification on agricultural practices (Melesse & Bulte, 2015; Gedefaw et al., 2020; Tesfaye et al., 2023). Although all this research points towards the positive impact of land certification, there is a lack of research on how granting land certificates to women affects the adoption of agricultural practices.

The objective of this research is to fill these existing gaps in the literature. The research has two major objectives. Firstly, the current study examines the role of female land ownership in the adoption of agricultural practices, i.e., the use of synthetic fertilizer, crop rotation, and the use of improved maize variety. Secondly, the study attempts to evaluate the relationship between

female land ownership and household food security. The study applies data from the Ethiopian Socioeconomic Panel Survey (ESPS 2021/22), a part of the Living Standard Measurement Study-Integrated Survey in Agriculture (LSMS-ISA).

The research focus is on the households that own agricultural plots of land. Chemical fertilizer application, crop rotation, and improved maize variety use are identified as improved agricultural practices, and the Food Insecurity Experience Score (FIES) is used as an indicator of household food security status. FIES is a direct measure that uses individual experience to measure food insecurity status. It provides reliable data on food access at the individual or household level (Saint Ville et al., 2019).

Female land ownership positively and significantly affects the adoption of agriculture practices (use of synthetic fertilizer, crop rotation, and use of improved maize variety) and household food security. Households with females having sole or joint ownership of a plot were 4.7%, 4%, and 12% more likely to use chemical fertilizer, practice crop rotation, and use improved maize variety, respectively. Extension of the model to include sole and joint land ownership showed that joint ownership has a positive and statistically significant effect on the adoption of good agricultural practices. Whereas sole female landownership did not have a significant association with the practices. We find that female land ownership reduces household food insecurity by 7% and severe food insecurity by 4.5%. The result was similar to agricultural practices for the extended model, with joint ownership having a positive and significant effect, while sole female landownership had a statistically insignificant effect.

The rest of the thesis is outlined as follows: Chapter 2 presents the literature review. Chapter 3 describes the data used in the study, the construction of land ownership variables, data description, and summary statistics of the variables used in the study. Chapter 4 provides the

validation analysis of FIES and describes the models used in the study. Chapter 5 presents the findings of the study. Chapter 6 provides the conclusions, and Chapter 7 outlines the policy implications of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Land Ownership in Ethiopia

The Ethiopian land reform in 1975 nationalized all the land and eliminated rural landlords. Land ownership was based on clan and communal systems (Deininger et al., 2008). Since land was not owned by individuals, renting, mortgaging, or selling it was not possible. The government encouraged peasant cooperative formation in each kebele, the smallest administrative unit, and distributed land use rights (Feder & Noronha, 1987; Deininger et al., 2008). Land use rights passed through the generations, giving households the right to use land for production. In the late 1990s, Ethiopia shifted away from the clan and communal land ownership system. Following the end of the military regime in 1991, the government implemented a large-scale certification program to distribute land rights among the households (Muchomba, 2017).

Ethiopia implemented a land certification system providing land rights for 20 million plots to around 6 million households (Deininger et al., 2008). The reform started in the Tigray region in 1998, where land was granted to the household head (Knippenberg et al., 2020; Mengesha et al., 2021). Household heads were predominantly males and obtained land use rights. Land distribution in Amhara started in 2002, and in Oromia and SNNP in 2004, under gender-friendly policies in which land was allocated jointly to household heads and spouses (Muchomba, 2017). The rural land registration and certification process provided rights to both men and women (Deininger et al., 2008; Holden & Tilahun, 2020). Around 35% to 45% of the land was registered in the name of women through joint certification, with variation across the regions (Deininger et al., 2012).

Although the new policies of land certification seem to promote female land ownership, women face substantial disadvantages in obtaining land use rights (Fafchamps & Quisumbing, 2002; Lavers, 2017). Lavers (2017) identifies informal institutions like peasant groups and underlying power relations in society as important factors determining land rights distribution. So, although policies favor female land rights, existing informal institutions may resist the desired result. Fafchamps & Quisumbing (2002) found that land inherited after marriage comes primarily from the male lineage. Daughters do not inherit land rights from their parents. Ayebazibwe (2019) showed that the patrilocal system of marriage creates male dominance in land ownership rights. Additionally, female-headed or female adult-only households face a higher tax incidence than male-headed households (Komatsu et al., 2022). All these factors, such as inheritance favoring male ownership, patriarchal informal institutions, and tax burden on female-headed households, strengthen male dominance in land ownership (Deininger et al., 2008; Gaddis et al., 2018; Holden & Tilahun, 2020; Komatsu et al., 2022).

2.2 Female land ownership and women's empowerment

Land ownership empowers women by promoting their participation in household decision-making. Amir-ud-Din et al. (2023) reported asset ownership to have a positive and significant influence on female empowerment. Owning land can increase women's role in decision-making related to their health, household purchases, and social connections (Doss, 2006; Nyakato et al., 2020). Land ownership increases women's bargaining power in household decision-making and redirects household resources (Holden & Bezu, 2013; Adebayo, 2014; Mishra & Sam 2016). Furthermore, land ownership enhances the participation of women in income-generating activities, promotes economic and social life, and encourages independent

decision-making (Chakrabarti, 2018; Chacko & Scaria, 2023). Land-owning females become involved in financial decision-making within the household (Nguyen & Le, 2023). Additionally, female ownership supports the involvement of women in decisions related to children and investment, contributing to the improvement in social capital (Goli et al., 2025; Strusi & Balestri, 2025).

Owning land improves resource and time allocation for women. It encourages women to cultivate cash crops and increase agricultural productivity (Dimova & Gang, 2015; Buabeng et al., 2024). Generating earnings from cash crop cultivation and sale, land ownership indirectly helps to increase women's income. More importantly, several studies (Deere et al., 2004; Efobi et al., 2019; Schling & Pazos, 2024) found that female land ownership promotes women's participation in non-agricultural activities. Also, female land ownership may stimulate participation in social meetings, involvement in non-farm enterprises, or other community works, and ultimately uplift the social status of women (Mukahigiro, 2015.).

Female land ownership empowers women through financial accessibility. Balasubramanian et al. (2018) reported that women's land ownership status influences their demand and usage for basic financial services. Land-owning females have easier access to credit facilities than landless females. Access to financial resources allows women to positively influence household savings and expenditures (Nguyen & Le, 2023). The increased access to financial resources enhances women's involvement in employment and entrepreneurship (Nikolova, 2021).

2.3 Female land ownership and food security

Women are traditionally responsible for family health, especially in developing countries (Kabira et al., 1997). Women play a crucial role in household nutrition and food intake (Kurz &

Johnson-Welch, 2001; Melesse, 2021). Their involvement in the agriculture value chain is crucial for food security in developing countries (Mehra & Rojas, 2008). Female role in food procurement and food management is essential in ensuring household food security (Ivers & Cullen, 2011; Agarwal, 2018). Existing literature highlights the importance and the need to promote gender equality in achieving household food security (e.g., Oniang'o, 2005; Fonjong et al., 2010; Babugura, 2017; Wyant, 2021).

Given the role of female land ownership in women's empowerment, many studies have attempted to evaluate its relationship with household food security. Existing literature has shown a positive and significant effect of female land ownership on household food security (Rehman et al., 2019;Adem et al., 2022; Schling et al., 2023). Schling & Pazos (2024) found that female land ownership increases crop diversity and strengthens household food security. Female land ownership promotes income diversification and contributes to household food security in the face of adversity (Etea et al., 2019; Hillesland et al., 2022). Women's land ownership rights have been associated with higher agricultural productivity, critical for household food security (Adenugba & Raji, 2013; Mwesigye et al., 2020). Joint land ownership, where both the household head and spouse were granted land ownership rights, had higher household consumption (Muchomba, 2017). Women's rights to land are thus crucial in improving household food security in developing countries (Fonjong et al., 2010; Alemu, 2015; Adem et al., 2022).

However, land rights alone cannot assure gender equality and household food security. In the case of a diversified rural household, female land ownership increases the farm workload for women, while male household members get better-paid non-farm jobs and, thus, gender disparity may persist (Shi et al., 2024). In such cases, female land ownership decreases the contribution of agriculture to the household budget (Rao, 2006).

2.4 Food Security in Ethiopia

Ethiopia faced severe poverty in 2000, with 56% of the population living under $1.25 purchasing power parity (PPP). Although Ethiopia has experienced impressive improvement in poverty reduction since the 2000s, poverty still remains widespread (Ethiopia Poverty Assessment, 2014, 2015). Ethiopia remains one of the poorest countries in the world, with about 33% absolute poverty in rural areas (Goshu et al., 2024). Agriculture is a dominant contributor to the Ethiopian economy, and it comprises 36% of the total GDP (Statista, 2023). Agriculture is the backbone of Ethiopian economy and 85% of Ethiopia depends upon agriculture for its livelihood. Thus, any negative shock to agriculture, like climatic shock, market fluctuation, pest, and disease, significantly impacts poverty and food security (Grossi & Dinku, 2022). Agricultural disruptions limit the household income and worsen food insecurity in Ethiopia (Teferra et al., 2018; Tenaye, 2020).

Despite the importance of the agricultural sector, Ethiopia's farming practices are still traditional and vulnerable to shocks (Gebrehiwot & van der Veen, 2013). Technology adoption is very low, and farmers are inefficient in the use of available inputs, constraining productivity (Krishnan & Patnam, 2014; Mezgebo et al., 2021; Alemu et al., 2022). Agriculture is predominantly rainfed, and about 95% of the total output comes from smallholders (Tigre & Heshmati, 2023). Food supply is vulnerable to production shocks, and any change in price caused by reduced production significantly worsens food security status. Therefore, assuring food security is a major challenge in Ethiopia (Wendimu, 2021).

Besides traditional farming constraints, Ethiopia is plagued by climatic shocks (Endalew & Sen, 2021). The climate shocks have a negative and significant effect on household food

insecurity, particularly on marginalized households (Geffersa & Berhane, 2015; Lewis, 2017). For example, the 2015 El Nino drought resulted in poor rainfall, leaving more than 10 million people needing food aid (Hirvonen et al., 2020). Climatic shocks like the 2015 drought induce a perennial cycle of food insecurity (Deressa, 2007; Arndt et al., 2011; Mera, 2018) .

Besides inefficient farming methods and climate shocks, recurring armed conflicts are major causes of food insecurity in Ethiopia (Weldegiargis et al., 2023). Historical narrations, power struggles, land ownership, tribal differences, politics, and weak institutions are identified to be the major causes of this interest (Asgele Siyum, 2021). Asgele Siyum (2021) identified political entrepreneurs, informal groups, state and regional media, and neighboring countries as the major actors of such conflicts. The conflicts are of a recurring nature, with the Tigray conflict being the most recent. Jima (2023) identified a constitutional crisis and ambition to annex the Tigray region as the major causes of the Tigray conflict. Armed conflicts in Ethiopia destroy the food supply chain, displace the farming population, eliminate market access, and increase vulnerabilities (Weldegiargis et al., 2023; Araya & Lee, 2024). These conflicts also interrupt health services, causing immediate and long-term impacts on the population (Mesfin et al., 2023)

All these factors, combined with a high inflation rate, have repeatedly pushed millions of households into food insecurity (Alem & Köhlin, 2014; Hassen et al., 2024). The World Food Program WFP (2025) reported that 15.8 million people need food assistance in Ethiopia, with almost 55% of the children under the age of five suffering from malnutrition. Tekile et al. (2019) called children's malnutrition a public health problem. The situation of food insecurity is more severe in rural areas, and road expansion and access to markets seem to improve food security (Sisha, 2020; Usman & Haile, 2022).

2.5 Food Insecurity Experience Scale (FIES)

Measurement of food insecurity is complex, and there are no single indicators with worldwide acceptance. There is a variety of indicators in use, and each indicator measures different dimensions of food insecurity (Maxwell et al., 2013; Pérez-Escamilla et al., 2017; Bertelli, 2020). One of the important aspects of food security is consistent economic access to adequate food. The Food Insecurity Experience Scale (FIES) was developed by the UN FAO – Voices of the Hungry project (FAO–VOH) to accurately capture this access dimension of food security (Nord et al., 2016).

FIES is an experience-based metric that uses responses to questions regarding access to food quality and quantity to measure food security status at the individual or household level. The metric comprises of 8 questions, each probing for specific effects of food insecurity. The questions of FIES are presented in Table 1. An affirmative response to each item is assigned a value of 1, and a negative response yields a value of 0. The scores are summed, and the total score ranges from 0 to 8.

Question 1 in Table 1 captures the concerns of respondents about an insufficient amount of food. Being worried about food availability is a common proxy used to asses food security (Henjum et al., 2019; Engelman et al., 2021; Rogus et al., 2022). The second question captures the household's inability to access healthy food. The third question captures the lack of access to a greater food variety. Food variety has been recognized as a simple measure of risk of food and nutrition insecurity (Oldewage & Kruger, 2008) , and remotely located households have been found to eat less diverse diets in Ethiopia (Stifel & Minten, 2017). The fourth question assesses if the household members were forced to skip a meal during the last 12 months, signifying a more severe form of food insecurity. Meal skipping has been identified as a coping strategy with food

insecurity among students in South Africa as well as in Ethiopia (Mohamed, 2017; Rudolph et al., 2018). The fifth question records the incidence of limited food consumption. Eating smaller meals has been practiced when facing food insecurity in Ethiopia (Tsegaye et al., 2018). The sixth question captures an even more severe case when the household completely ran out of food. The seventh question asks to share the experience when household members were hungry but did not eat anything due to a lack of food. The incidence of such experience has been documented in Ethiopia (Regassa & Stoecker, 2012). The eighth question captures the experience where household members go a whole day without eating due to a lack of food. Being hungry and going without eating for a whole day are severe forms of food deficiency (Cafiero et al., 2018). Taylor & Loopstra (2016) used food worry, lack of nutritious food, limited consumption, and hunger to evaluate food insecurity in the UK.

Table 1: Eight questions listed in the FIES questionnaire and their reference names

Question number	During the last 12 months, was there a time when you or any other HH member	Reference name
Q1	were worried you would not have enough food to eat?	(WORRIED)
Q2	were unable to eat healthy and nutritious food?	(HEALTHY)
Q3	ate only a few kinds of foods?	(FEWFOODS)
Q4	had to skip a meal?	(SKIPPED)
Q5	ate less than you thought you should?	(ATELESS)
Q6	ran out of food?	(RANOUT)
Q7	were hungry but did not eat?	(HUNGRY)
Q8	went without eating for a whole day?	(WHOLEDAY)

2.6 Study Area

The current study's geographical focus is Ethiopia. It is the most populated landlocked country in the world. Ethiopia neighbors Eritrea in the north, Djibouti in the northeast, Somalia in the east, Kenya in the south, South Sudan in the west, and Sudan in the northwest. The country is divided into 12 regional states (Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations, Nationalities, and Peoples' Region, Sidama, Gambela, Harari, Southwest Ethiopia Peoples' Region, and Central Ethiopia) and two chartered cities (Addis Ababa and Dire Dawa). Oromia is the largest region and covers the majority of the central and eastern parts of Ethiopia. Each region is further divided into zones, woredas, and kebeles. Kebele (tabia or tabiya) is the smallest administrative unit.

Ethiopia is home to 132 million inhabitants, making it the second most populated country in Africa, after Nigeria. The population is very diverse, with over 80 ethnic groups. Oromo, Amhara, Somali, and Tigrayans are the four major ethnic groups. Oromo is the largest ethnic group, accounting for 35.8% of the population, Amhara's share is 24.1%, Somali represents 7.2%, and Tigray comprises 5.7% of the population (MPI, 2014). Agriculture is the largest contributor to the national GDP, and accounts for almost one-third of the total (Statista, 2023).

Figure 2 shows the area covered by the survey that covered the data used in the study, created using ArcGIS. The socio-economic survey used in the study collected data from all regions except Tigray, located in the northwest part. The omission of Tigray was due to the ongoing war in the region (Al Jazeera, 2022). After filtering for missing observations and selecting households that owned an agricultural plot, the sample still covers all the regions marked by the dots on Figure 1.

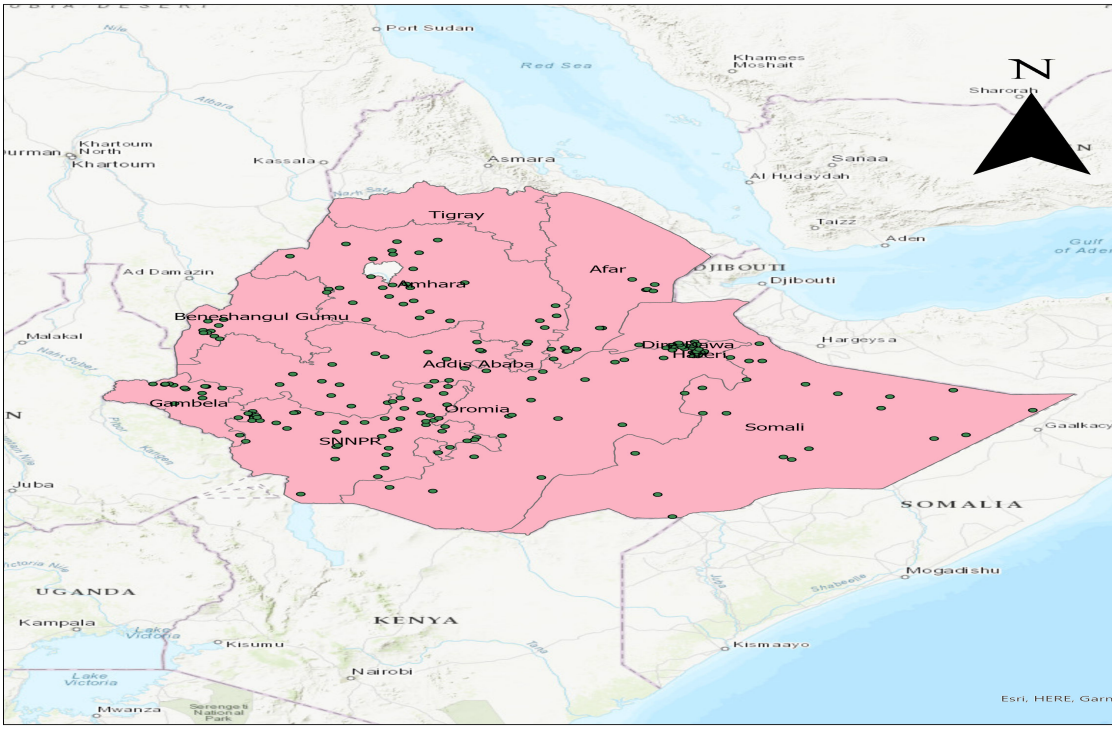

Figure 1: Location of the sites covered by the Ethiopian Socioeconomic Panel Survey, 2021/22

CHAPTER 3

DATA

3.1 Ethiopian Socio-economic Panel Survey

This study uses data from the fifth wave of the Ethiopian Socioeconomic Panel Survey (ESPS 2021/22) implemented by the Ethiopian Statistical Service with technical support from the Living Standard Measurement Study (LSMS), World Bank. The LSMS-ISA is a longitudinal study designed to improve the understanding of individual and household welfare, agricultural activities, and people's livelihoods. The surveys collect panel data from the household with a special focus on agriculture. The fourth and fifth wave of the survey collects panel data. The fifth wave of surveys was conducted from September 12, 2021, to June 30, 2022. The survey is a nationally representative survey that covers all regions of Ethiopia except Tigray.

The sample selection followed a two-stage sampling method. First-stage sampling constituted the selection of EAs using simple random sampling. The second stage of sampling included the selection of households from each enumeration area (EA) using systematic random sampling. From each rural EA, ten agricultural households and two non-agricultural households were selected. For each urban EA, the selection included 15 households regardless of household economic activity. The survey interviews with 4,999 households from 438 EA.

The survey used five sets of questionnaires, i.e., household, post-planting, post-harvest, livestock, and community questionnaires. The household questionnaire collected data on household members, labor use, education, health, assets, consumption, income, shocks faced, and possession of a non-farm enterprise. Three agriculture questionnaires (post-planting, post-harvest,

livestock) were administered to all households engaged in agricultural activities. The post-planting questionnaire was used to collect data on plot characteristics, plot ownership, livestock, and cultivation practices. The post-harvest questionnaire was used to collect data related to crop harvest, crop damage, and crop disposition. The livestock questionnaire was used in households where at least one household member was involved in agriculture. The livestock questionnaire collects data on livestock holding, production cost, and income from livestock. The community questionnaire is used to collect data on socioeconomic indicators of EA, where sample households are based.

Data were collected during two enumerator visits to each household. The first visit was carried out between September 2021 and January 2022 and collected data using the post-planting questionnaire. The second visit took place between April and June 2022 and collected data using post-harvest, household, and community questionnaires. Besides the survey data, LSMS provides geographic data on rainfall and the location of the household. The survey thus offers a rich set of data for the study.

The current study considers only households with access to agricultural land. The households from Addis Ababa did not have access to agricultural land and thus did not respond to the agriculture questionnaire. Therefore, the observations from Addis Ababa are not used in the regression study. Households composed exclusively of the dependent population (less than 15 years old) and households that did not respond to the FIES questionnaire were also excluded from the study. The study utilizes 1,826 observations from 9 regions.

3.2 Land Ownership

There are three measures of land ownership: reported ownership, documented ownership, and effective ownership (Doss et al., 2015). Reported ownership is obtained by asking the respondent whether they own the land. Documented (certificate) ownership is backed by legal documents like title deeds or official records. Effective ownership involves the control and use of the land. The person who makes the decision related to land use is regarded as the owner of the land in case of an effective ownership measure. This study uses the ownership certificate as a measure. The respondent provided information at the plot level, with ownership details reported for up to four plot owners per plot. A single plot could be owned by both male and female household members, in which case it was categorized as joint ownership. If a plot was owned entirely by either a male or female household member, it was classified as sole male ownership or sole female ownership, respectively. The plot-level ownership data were then aggregated at the household level. Based on the ownership structure of all their plots, households were categorized:

- **Sole male ownership households:** All plots were owned solely by male household members.
- **Sole female ownership households:** All plots were owned solely by female household members.
- **Joint ownership households:** The household had a mixed ownership. Both male and female household members had ownership of land.
- **No land certification households:** The households did not have any certificates confirming the ownership of the farmed land.

The study uses the classification and creates a new category, i.e., female landowner. Households with either sole female ownership plots or joint ownership plots were grouped under this category.

This study assumes that the bargaining power of the household member is directly correlated with the person's land ownership. Such an approach enables to use of female land ownership as a proxy for her involvement in household decision-making. Women emphasize household welfare. It is hypothesized that female land ownership encourages adoption of agriculture practices like the use of synthetic fertilizer, crop rotation, or use of improved maize variety, and improves household food security status.

3.3 Source of land right transfer

Table 2 presents the source of the transfer of land ownership rights for sole female ownership, joint ownership, and sole male ownership at the plot level in the sample data. The major source for obtaining land ownership rights was through inheritance for all land ownership types. Inheritance slightly favored sole male ownership.

Table 2: Method of land right acquisition for different land ownership categories in percentage

Land right source	Sole female ownership	Joint ownership	Sole male ownership
Granted by local leaders	38.81	29.86	24.57
Inherited	48.55	45.69	56.60
Rent	1.89	5.63	2.30
Borrowed for free	0.15	0.45	0.80
Moved in without permission	1.74	1.51	2.18
Shared crop in	4.36	9.56	6.77
Purchased	3.63	6.61	6.08
Others	0.87	0.68	0.69
Number of plots	688	2646	871

3.3 Descriptive statistics

Table 3 provides the descriptive statistics of household characteristics, land attributes, climate and location factors, food insecurity, and land ownership of the sample. The mean age of the household head was 46 years. The study dropped the household composed entirely of members below the age of 15 years. Therefore, the lower bound of the age of the household head for the sample is 16 years. The upper limit of the age of the household head was 97 years old. Most of the households were headed by a male (76%). About half of the household heads were able to read or write in any language.

The dependency ratio was calculated to reflect the proportion of dependent population (household members under the age of 15 and 65 or older) in each household. The average dependency ratio is equal to one. The dependency ratio shows that the proportion of dependent and independent populations in the sample is almost equal.

The data used in this study have information on the incidence of drought shock faced by the household during the 12 months preceding the survey. Drought shocks indicate adverse weather conditions affecting the household farm production. About 22% of the households reported facing drought.

The collected survey data include information on the possession of non-farm enterprises and the asset holding of the household. About 7% of the households have a non-farm enterprise. The asset data were available for 37 assets, ranging from fans to vehicles. The asset index is a common method of controlling for wealth in the LSMS dataset (Booysen et al., 2008). The asset index was created using Principal Component Analysis (PCA) using a set of 37 reported assets. The PCA method provides weights to each asset based on the relative scarcity of the asset and creates a single-dimensional value, enabling ordinal ranking of household wealth.

The LSMS-ISA dataset allows to create a variable to record the soil fertility status for each plot reported by the household: 1= poor, 2= fair, and 3= good. The soil fertility variable was created by taking the mean values of self-reported fertility of all plots owned by the household. The average soil fertility value of 2.28 suggests that the quality of land owned by the respondent falls slightly on the fertile side of the spectrum (Table 3).

Simpson Fragmentation Index (SFI) was calculated as a measure of land fragmentation among the sample households. SFI was calculated using the formula:

$$\text{SFI} = 1 - \frac{\sum_1^K \alpha_k^2}{\left(\sum_k^K \alpha_k\right)^2}$$

Where K is the number of plots of land and α_k is the size of each plot. An SFI value close to 1 denotes high land fragmentation. An SFI value of 0 denotes no land fragmentation. The average SFI value of 0.534 shows high land fragmentation among the sample households.

Around 32% of the households did not have any certificate of land ownership (Table 3). Joint ownership of land was more common, with 36.6% of the total households in the sample holding land jointly between male and female members. Sole female ownership is low (13.6%), but the high prevalence of joint ownership contributes to an increased female land ownership of 50.1%. About one in every two households has a female member who either solely or jointly owns land. Following the tradition, after marriage, the couple receives land from local leaders, and land rights for such land are provided to both the household head and spouse. Such a system of land rights transfer increased joint ownership of land.

The average distance to a major road was 10 km. This shows that the road connectivity of the households in the sample was very poor. The average distance from the household in the sample to the administrative headquarters (capital of the region of residence) was 0.153 km. The distance shows that the surveyed households were located fairly close to the main administrative

offices of the region. The statistics demonstrate very poor road connectivity in Ethiopia, even from the local administrative headquarters, and coincides with earlier reports (Legesse, 2016; Dagnew, 2019) .

There are 1,574 observations used to measure the outcome variables: crop rotation and synthetic fertilizer use. The number of observations regarding two outcome variables is lower than the total sample size used in the study (1,826). The difference exists because some households in the survey only raise livestock or do not use their land for farming. There is no systematic bias in the outcome variable.

The use of chemical fertilizer, crop rotation, and improved maize variety differed among the surveyed households (Table 3). About half of the respondents practiced crop rotation, and crop rotation was reported as a practice affecting soil productivity in Ethiopia (Alemayehu et al., 2020). The proportion of the surveyed who had adopted the use of synthetic fertilizer was similar to those who practiced crop rotation. The use of chemical fertilizers has increased in Ethiopia and contributed to increased productivity (Abebe et al., 2022). Less than half of the households involved in maize farming (40%) planted the improved maize variety in their field. The share of farmers using the improved maize seeds is similar to earlier findings (Tarekegn & Mogiso, 2020).

Table 3: Summary statistics with variable description

Characteristic	N	Description	Mean	SD	Min	Max
Age	1,826	Household head age, in years	45.90	14.45	16	97
Male head	1,826	1 if male household head male	0.766	0.423	0	1
Dependency ratio	1,826	Ratio of dependent to independent[1]	1.004	0.907	0	6
Basic education	1,826	Can read or write any language	0.440	0.497	0	1
Drought shock	1,826	1 if faced drought in last 12 months	0.220	0.414	0	1
Non-farm enterprise	1,826	=1 if possess non-farm enterprise	0.0696	0.254	0	1
Asset index	1826	Index developed using principal component analysis	0.148	1.015	-.838	13.41
Soil fertility	1,826	1= poor, 2= fair, 3=good	2.28	0.626	1	3
SFI	1,826	Simpson fragmentation index	0.534	0.304	0	0.948
Female landowner	1,826	1 if at least one woman in household solely/jointly owns a plot of land	0.501	0.500	0	1
Joint ownership	1,826	1 if both male and female jointly own the plots of land	0.366	0.482	0	1
Sole female ownership	1,826	1 if only female members own the plot	0.135	0.342	0	1
Sole male ownership	1,826	1 if only male members own the plot	0.178	0.383	0	1
Distance to road	1,826	In kilometers	10.31	12.45	0	65.40
Distance to admin headquarter	1,826	In kilometers	0.153	0.126	0	0.600
Crop rotation	1,574	1 if uses crop rotation	0.605	0.489	0	1
Chemical fertilizer	1,574	1 if uses Chemical synthetic fertilizers	0.567	0.496	0	1
Improved maize	646	1 if uses improved maize	0.393	0.489	0	1
FIES score	1826	FIES score for the household	2.7305	2.66	0	8

[1] Dependency ratio = $\frac{total\ dependent\ household\ member\ (age<15\ or\ age>64)}{total\ independent\ household\ members\ (age\ 15-64)}$

CHAPTER 4

METHODOLOGY

This chapter outlines the methodology used in this research. The first part involves validation of the FIES questionnaire using the Rasch Model. The study then categorizes households based on the raw FIES score. Two measures of food insecurity, i.e., food insecurity (FI) and severe food insecurity (Sev FI), are created as binary variables to differentiate food secure and food insecure households. The chapter then describes empirical relationships. Since the dependent variables are binary, a logit model was used to evaluate the association between female land ownership, agricultural practices, and food security. Regional variation was accounted for by using regional fixed effects. To test the robustness of the findings, the study develops a continuous measure of food insecurity (FIES factor) using principal factor analysis. The study employs OLS regression to evaluate the relationship between female land ownership and the FIES factor.

4.1 Statistical validation of FIES data

The FIES method assumes that food insecurity is an unstated attribute that can be measured based on respondents' experiences and responses. The unstated attributes are not directly observable but can be inferred from observed experiences using measurement models based on Item Response Theory (Nord et al., 2016). Rasch model is the simplest and widely used model to document the reliability and validity of the instrument (Boone, 2016; Davier, 2016). This study chooses to apply the Rasch model as a tested tool to quantify the latent traits by analyzing the relationship between a person's ability and the severity of food insecurity.

The Rasch model involves two main assumptions: 1) conditional independence of the responses, and 2) equal discriminatory power of the questions (Ballard et al., 2013). Conditional independence can be stated as the probability of confirming that one question among the FIES questions is not dependent upon an affirmative response to any other question, conditional on the respondent's experience. Equal discrimination power means that the items in the scale have similar discriminating power among the respondents. If the Rasch model assumptions are satisfied, the raw score is sufficient to represent the food security of the respondent on an ordinal scale (Ballard et al., 2013; Nord et al., 2016).

The examination of the psychometric properties of FIES allowed for the derivation of the infit score, severity level, and Rasch reliability. Infit statistics show how well the observed data fit the model. The infit score is used to assess the assumption of equal discrimination (Wambogo et al., 2018). The infit score between 0.7 and 1.3 is considered to satisfy the assumption of the model (Nord et al., 2016). An infit score less than 0.7 implies redundancy in the item, and an infit score greater than 1.3 implies weaker discrimination of the items (Ballard et al., 2013; Nord et al., 2016). Rasch reliability denotes the proportion of the total variation accounted for by the measurement model. Rasch reliability greater than 0.7 is considered acceptable (Jubayer et al., 2023). The calculated severity level shows the relative severity of FIES items.

Although 1,826 observations were used in the analysis, the validation of the FIES score was done by using all observations in the dataset. This was done to avoid any estimation error that may arise due to a small sample size (Nord et al., 2016). The households with missing data for any FIES items were dropped from the analysis. The final sample consisted of 4,955 observations.

The result of the Rasch model is presented in Table 4. The Rasch reliability was 0.76, and the infit score fell within the appropriate range, 0.7-1.3. Therefore, the assumption of equal

discrimination is satisfied. The examination of the conditional correlations between the items tested the assumption of conditional independence. The conditional correlation was not found to be excessive for any pair of items. Thus, the assumption of conditional independence is also satisfied.

The FIES items are arranged in ascending order of their severity in Table 4. Not having healthy and nutritious food was the least severe FIES item. Going through a whole day without eating was the most severe FIES item. An affirmative response to an item with higher severity increases the probability of household food insecurity.

Table 4: Rasch reliability, infit score, and severity level

FIES Questions (Items)	**Reference name**	**Severity**	**Infit**	**Rasch Reliability**
Could not eat healthy and nutritious food	Healthy	-1.92	1.02	0.7617
Ate only a few kinds of foods	Fewfoods	-1.89	0.89	
Worried about not having enough food	Worried	-1.42	1.1	
Ate less than you thought you should	Ateless	-0.64	0.86	
Household ran out of food	Runout	0.38	1	
Had to skip a meal	Skipped	0.63	0.95	
Were hungry but did not eat	Hungry	1.74	0.87	
Went without eating for a whole day	Wholeday	3.11	1.1	

Since Rasch model assumptions are satisfied by all FIES items, the raw score evaluates the household food security. Table 5 presents the number of households with affirmative responses to the respective question of FIES from the selected sample of 1,826 respondents used in the regression study. Almost half of the individuals in the sample lacked healthy food, had few food sources, were worried about not having enough food, and consumed less than they would have

liked to save food. About 9% of the households in the selected sample faced extreme cases of food insecurity, going through a whole day without consuming food.

Table 5: Frequency of affirmative response to the FIES questionnaire, n= 1,826

Reference name	Frequency	Percentage
Healthy	929	50.8
Fewfoods	952	52.1
Worried	837	45.8
Ateless	779	42.7
Runout	527	28.8
Skipped	535	29.2
Hungry	336	18.4
Wholeday	164	8.9

Wambogo et al. (2018) validated the use of FIES in sub-Saharan Africa and used the Classification with three food insecurity (FI) levels. The classification was based on the FAO-VOH recommendation of the threshold for FI. A raw score less than 4 represented food security, and a raw score greater than 6 represented severe food insecurity (Sev FI). The study uses the Wambogo et al. (2018) classification system to group household into three categories based on their total FIES score: 1) food secure (FS) with a raw score of 0-3; 2) moderate food insecurity (MFI) with a raw score of 4-6; and 3) severe food insecurity (Sev FI) with a raw score of 7-8. The distribution of the households in these three categories is presented in Table 6. About 12% of the households were facing severe food insecurity. About one-third of the population in the sample faced moderate to severe food insecurity.

Table 6: Distribution of households in food security categories

Categories	FIES Score	Frequency	Percentage
Food Secure (FS)	0-3	1151	63
Moderate Food Insecurity (MFI)	4-6	442	24.2
Severe Food Insecurity (Sev FI)	7-8	233	12.8

The study uses the above classification and creates two dummy variables: food insecurity (FI) and severe food insecurity (Sev FI). The FI variable takes the value one for households with moderate and severe food insecurity and zero otherwise. The Sev FI variable takes the value 1 for households facing severe food insecurity and zero for other households:

$$FI = \begin{cases} 1 & if\ household\ faces\ moderate\ or\ severe\ food\ insecurity \\ 0 & Otherwise. \end{cases}$$

$$Sev\ FI = \begin{cases} 1, & household\ faces\ severe\ food\ insecurity \\ 0, & Otherswise \end{cases}$$

The food insecurity status across the regions is presented in Table 7. The proportion of food secure households varies significantly by region. Harar has the highest percentage of food secure households (83.63%). Oromia had the lowest proportion of food secure households (49.46%). The cases of food insecurity were severe in Oromia, SNNPR, and Somali, where almost half of the households faced moderate or severe food insecurity. Gambela, Benishangul, and Harar had relatively lower food insecurity concerns, with less than five percent of the households facing severe food insecurity. The regions with comparatively higher proportions of food insecurity (Oromia, SNNPR, Somali, and Dire Dawa) lie in the eastern part of Ethiopia. The regions in the western part of Ethiopia have fewer households with poor food security status.

The distribution of food insecurity in Afar is different from other regions, with a greater proportion of severe food insecurity in comparison to the percentage of moderate food insecurity. The observed pattern is likely caused by the small sample of households from the region.

Table 7: Food insecurity by region

Region	Food secure (%)	Moderate food insecurity (%)	Severe food insecurity (%)	Number of observations
Afar	74.55	9.09	16.36	55
Amhara	74.62	20.08	5.30	264
Benishangul	76.00	20.00	4.00	100
Dire Dawa	66.41	27.34	6.25	128
Gambela	79.50	18.63	1.86	161
Harar	83.63	13.45	2.92	171
Oromia	49.46	28.53	22.01	368
SNNPR	50.72	30.68	18.60	414
Somali	53.94	26.67	19.39	165

4.2 Econometric specification

The research has two major objectives. Firstly, the study investigates the role of female land ownership on household agricultural practices, i.e., use of chemical fertilizer, crop rotation, and use of improved maize seed. Secondly, the study examines the association of female land ownership and household food security. The study uses cross-sectional data from the fifth wave of the socio-economic survey in Ethiopia under LSMS. Given the nature of data and variable of interest, we employ the logistic regression technique, where the dependent variables are the selected agricultural practices (use of synthetic fertilizer, crop rotation, and use of improved maize variety) and food insecurity categories (FI and Sev FI).

Logistic statistical technique is suitable for estimation in the case of a dichotomous dependent variable, as it ensures the response probabilities fall strictly between 0 and 1 (Wooldridge, 2020). The study derives the coefficient estimates, which show the nature of the association and the statistical significance. The coefficients lack practical interpretation. The

probability effects are quantified by calculating the marginal effects. The marginal effect estimates measure the probability of the dependent variable taking the value of '1' in response to a given change in the independent variable.

The research question is whether there is an association between: 1) female land ownership and agricultural practices, and 2) female land ownership and food security. The empirical relationship subject to estimation using the logit technique and used to evaluate the association between female land ownership and adoption of agricultural practices is presented below:

$$z_i = \beta_0 + \alpha_1\, female\ landowner + \ \beta_1\, Age_i + \ \beta_2 basic\ education_i + \beta_3 male\ head_i + \beta_4 dependency\ ratio_i + \ \beta_5 NFE_i + \beta_5 asset\ index_i + \ \beta_6 dist\ admin_i + \beta_7 dist\ road_i + \beta_8 soil\ fertility_i + \ \beta_9 SFI_i + \beta_{10} drought\ shock_i + \beta_{11} R_i + \epsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

In equation (1), z_i is the dummy variable indicating the agricultural practices (chemical fertilizer, crop rotation, and improved maize variety) of household 'i' and ϵ_i is the random error term. Among the explanatory variables, the female landowner is the binary variable whose value is 1 if any female in the household has sole or joint ownership of any of the plots of land, and 0 otherwise. Age is the age of the household head measured in years. The dependency ratio is the ratio of the number of dependents to the number of working-age individuals in the household and is calculated using the earlier presented formula. Asset index is the relative wealth level of the household and is constructed using the PCA and the data on the owned assets. The variables related to land characteristics are controlled using the Simpson Fragmentation Index (SFI) and the categorical variable capturing soil fertility.

In equation (1), dist_admin represents the distance from the respondent's house to the administrative headquarters, while dist_road represents the distance to the nearest major road. Basic education is a binary variable whose value is 1 if the household head can read or write in any language and 0 otherwise. Male head is a variable denoting the sex of the household head. The male head takes the value '1' if the head of household is male, '0' otherwise. Non-farm enterprise (NFE) is also a binary variable that has a value of '1' for households possessing a non-agricultural enterprise and '0' otherwise. Drought shock variable is also a binary variable that takes a value of '1' if the household has faced a drought in the last 12 months, '0' otherwise. R is the region fixed effect used to control for variation within a region.

Extension of the modeled relationship in equation (1) includes the sole female land ownership and joint land ownership:

$$z_i = \beta_0 + \alpha_1\, sole\ female\ landowner + \alpha_2\, joint\ ownership + \beta_1\, Age_i + \beta_2 basic\ education_i + \beta_3 male\ head_i + \beta_4 dependency\ ratio_i + \beta_5 NFE_i + \beta_5 asset\ index_i + \beta_6 dist\ admin_i + \beta_7 dist\ road_i + \beta_8 soil\ fertility_i + \beta_9 SFI_i + \beta_{10} drought\ shock_i + \beta_{11} R_i + \epsilon_i \quad \ldots\ldots\ldots\ldots\ldots (2)$$

To evaluate the association between female land ownership and household food security, we use the same set of independent variables. The econometric specification is:

$$Y_i = \beta_0 + \alpha_1\, female\ landowner + \beta_1\, Age_i + \beta_2 basic\ education_i + \beta_3 male\ head_i + \beta_4 dependency\ ratio_i + \beta_5 NFE_i + \beta_5 asset\ index_i + \beta_6 dist\ admin_i + \beta_7 dist\ road_i + \beta_8 soil\ fertility_i + \beta_9 SFI_i + \beta_{10} drought\ shock_i + \beta_{11} R_i + \epsilon_i \quad \ldots\ldots\ldots\ldots\ldots (3)$$

In equation (3), Y_i indicates that the household "i" is food insecure and falls into one of the two categories, the FI or the Sev FI.

An extension of equation (3) includes the sole female land ownership and joint land ownership and is provided in equation (4):

$$Y_i = \beta_0 + \alpha_1\, sole\ female\ landowner + \alpha_2\, joint\ ownership + \beta_1\, Age_i + \beta_2 basic\ education_i + \beta_3 male\ head_i + \beta_4 dependency\ ratio_i + \beta_5 NFE_i + \beta_5 asset\ index_i + \beta_6 dist\ admin_i + \beta_7 dist\ road_i + \beta_8 soil\ fertility_i + \beta_9 SFI_i + \beta_{10} drought\ shock_i + \beta_{11} R_i + \epsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

All items on the right-hand side are as defined earlier.

4.3 The selection of control variables

The dataset offers a rich set of information at the household level, allowing for the inclusion of several control variables. Previous studies reviewed earlier papers for the selection of control variables that help to isolate the association between female land ownership and household food security (Titus & Adetokunbo, 2007; Abafita & Kim, 2014; Akadiri et al., 2018; Knippenberg et al., 2020).

The sex of the household head is an important factor in determining food security and adoption of agricultural practices (Akadiri et al., 2018; Hossain, 2019; Ndagire & Agm, 2021). Florkowski & Kharel (2024) reported that the households with a male head experienced a reduced likelihood of being food insecure in Ethiopia. The current study uses the variable 'male head' to control for the difference in sex of the household head.

The education of the household head has been reported to influence the agricultural practices as well as food security (Abafita & Kim, 2014; Maré et al., 2023). To control for the

effect of the educational attainment level of the household head, this study includes a binary variable, “basic education”.

Household features, including the dependency ratio, wealth, and possession of a non-farm enterprise, have also been reported to influence the agricultural practices and food security (Titus & Adetokunbo, 2007; Owusu et al., 2011; Wight et al., 2014). The ratio of the number of household members outside the productive age to those within the productive age range (dependency ratio) was calculated (Table 3) and used as a control variable. The relative difference in wealth among households was accounted for by including the asset index in the specified empirical relationships. The study also controls for the possession of a non-farm enterprise by the household.

Agricultural practices are directly related to land characteristics. Agricultural input use and practices depend on soil quality (Khanna et al., 2002) , and the self-reported assessment of soil fertility, converted into a categorical variable, is included in the empirical model to account for the difference in land characteristics. Existing literature provides ample evidence of an association between land fragmentation and food security (Cholo et al., 2019; Knippenberg et al., 2020; Tran & Van Vu, 2021). Therefore, the study uses a measure indicating the severe level of food insecurity, SFI, as an explanatory variable in the regression model.

The descriptive statistics revealed regional variation in food security (Table 7). Regional differences in food security have been observed in Ethiopia (Motbainor et al., 2016). The study controls the variation within the region using a regional fixed effect by including eight binary region indicators. The regional effects are compared against Afar serving as the benchmark. The distance from the major road and the administration headquarters is associated with access to agricultural inputs and food (Hirvonen et al., 2020). Shorter distance to a major road implies better connectivity, possibly improving the availability of agricultural inputs, including two key inputs

considered in this study, the synthetic fertilizer and improved maize seed. Road access is a necessity for assuring food availability, a pillar of food security (Sisha, 2020; Usman & Haile, 2022). This study uses the variables 'distance to road' and 'distance to administrative headquarters' to account for variations among households in terms of their accessibility.

The incidence of drought is a major climate-related phenomenon faced by farmers in Ethiopia (Qtaishat et al., 2023). The incidence of drought decreases the agricultural production and risks food insecurity (Arndt et al., 2011). There is temporal variation in the drought incidence, and eastern, southern eastern, and rift valley areas face more frequent drought (Mera, 2018). The study controls for such variation in drought by including the variable 'drought shock' in the empirical model.

4.4 Independent variables

The variables of interest are female landowner, sole female landowner, and joint ownership. The description of these variables is shown below:

$$female\ landowner = \begin{cases} 1\ if\ \ female\ member\ are\ listed\ on\ land\ certificate \\ 0\ otherwise \end{cases}$$

$$Sole\ female\ landowner = \begin{cases} 1\ if\ \ only\ female\ member\ are\ listed\ on\ land\ certificate \\ 0\ otherwise \end{cases}$$

$$joint\ ownership = \begin{cases} 1\ if\ \ both\ male\ and\ female\ member\ are\ listed\ on\ land\ certificate \\ 0\ otherwise \end{cases}$$

The variable "female landowner' takes the value '1' if the female member has their name in the land certificate, '0' otherwise. The ownership may be sole ownership or joint ownership. The variable 'sole female landowner' takes the value of '1' if only female has their name on land certificates. The female should be the sole landowner in the household for the variable 'sole female

landowner' to take the value of '1'. If not, the variable takes the value of '0'. The variable 'joint ownership' takes the value of '1' if both male and female household members have their names in land certificates.

4.5 **Dependent variables**

The study consists of two sets of dependent variables. The first set of dependent variables is the binary variables denoting the adoption of agricultural practices, i.e., chemical fertilizer, crop rotation, and improved maize variety. A value of '1' in these variables denotes adoption of agricultural practices, otherwise, the variables take the value of '0'.

The second set of dependent variables is the binary variable denoting the food insecurity (FI) and severe food insecurity (Sev FI). The variable takes the value of '1' if the household falls in the category and '0' otherwise.

CHAPTER 5

RESULT

5.1 Female land ownership and agricultural practices

Table 8 presents the coefficient estimates for the equation modeling the effects of female landownership on the use of three agricultural practices. The results show that female land ownership has a positive and significant effect on the use of each of the three agricultural practices.

Table 8: Logit estimation results for the use of three agricultural practices in Ethiopia

Variable name	Chemical fertilizer use	Crop rotation	Improved maize variety
Female landowner	0.047**	0.041**	0.121***
	(0.022)	(0.021)	(0.045)
SFI	0.497***	0.364***	0.095
	(0.048)	(0.046)	(0.114)
Age	-0.002***	0.000	-0.005***
	(0.001)	(0.001)	(0.001)
Basic education	0.017	0.013	0.060
	(0.023)	(0.022)	(0.042)
Male head	0.099***	0.084***	0.134**
	(0.026)	(0.026)	(0.052)
Dependency ratio	-0.004	0.022*	-0.015
	(0.012)	(0.011)	(0.022)
Non-farm enterprise	-0.045	0.029	0.141*
	(0.038)	(0.036)	(0.073)
Asset index	-0.006	-0.007	-0.044*
	(0.012)	(0.011)	(0.026)
Distance to admin headquarter	-0.451***	-0.114	-0.360
	(0.109)	(0.104)	(0.228)
Distance to road	-0.005***	0.002	-0.005***
	(0.001)	(0.001)	(0.002)
Soil fertility	0.036*	-0.011	0.185***
	(0.018)	(0.019)	(0.040)
Drought shock	-0.052*	0.135***	-0.053
	(0.029)	(0.030)	(0.058)
Regional Fixed Effect			

Amhara	0.017	0.204**	0.079
	(0.082)	(0.096)	(0.164)
Oromia	0.022	0.009	0.146
	(0.079)	(0.097)	(0.164)
Somali	-0.472***	-0.325**	-0.303*
	(0.149)	(0.127)	(0.170)
Benishangul	-0.088	0.188*	-0.023
	(0.090)	(0.100)	(0.165)
SNNPR	-0.271***	-0.110	0.038
	(0.081)	(0.098)	(0.162)
Gambela	-0.735***	-0.329***	
	(0.077)	(0.107)	
Harar	-0.160*	-0.595***	-0.154
	(0.088)	(0.099)	(0.161)
Dire Dawa	-0.507***	-0.485***	-0.230
	(0.091)	(0.109)	(0.179)
Number of observations	1,574	1,574	595

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The marginal effects were calculated to quantify the effects of all explanatory variables on the probability of using each of the three agricultural practices (Table 9). The result indicates that female land ownership increases the probability of chemical fertilizer use by 4.7%, crop rotation practices by 4%, and the use of improved maize variety by 12.4%, respectively. The positive and significant effect of female land ownership and the use of agricultural practices is in line with expectations that female land ownership influences women's position within the household, leading to better choices of practices.

As expected, male-headed households had a higher probability of using synthetic fertilizer, following crop rotation and using improved maize varieties. The probability of using each of those practices increases by 9.9% for chemical fertilizer use, 8.4% for crop rotation, and 13.4% for using improved maize seeds, respectively, as compared to a female heading the household. Hossain (2019) reported that male-headed households tend to adopt improved agricultural technology. The author identifies limited access to inputs, credit, and extension services in female-headed

households as key factors contributing to their low adoption of technology. Those factors are also crucial for the adoption of agricultural practices such as the use of synthetic fertilizer and use of improved seeds. Therefore, the findings of this study align with those of Hossain (2019).

Similarly, the age of the household head was important in the adoption of all three agricultural practices (chemical fertilizer use, crop rotation, and improved maize variety). The households with a young head were more likely to report using these practices, and the probability of using chemical fertilizers decreased by 2% for the added ten years above the mean age, and by 5% for a similar increase in age in the case of using the improved maize seed (Table 9). The young respondents could have more risk-taking attitudes and a higher propensity to invest in the farm as compared to households with older household heads (Spicka, 2020).

The self-reported experience of drought had negatively affected the use of chemical fertilizers, as indicated by the 5.2% decrease in the probability of using them. However, experiencing drought had a positive effect on the adoption of crop rotation. Experiencing a recent drought increased the probability of adopting crop rotation by 13.5% (Table 9). A risk of drought forces the farmers to plant multiple crops as a coping strategy to assure household consumption and reduce the risk of food insecurity (Mehar et al., 2016).

Soil fertility level was associated with the 3.6% increase in the probability of the household reported use of synthetic fertilizers, while the probability increased by an impressive 18.5% regarding the use of improved maize seed (Table 9). Households reporting fertile soil were more likely to report the use of synthetic fertilizers and the improved maize seed as compared to households farming the less fertile land. As could be expected, fertile soils encourage investment in the use of synthetic fertilizers and improved maize varieties, which tend to produce higher yields under such circumstances. However, the largest probability changes were associated with the

regional indicators. The decreases in the probability were associated primarily with the use of synthetic fertilizers and crop rotation. In the case of the former, the largest probability decrease was identified for the households in Gambela (73.5%), while in the latter case, in Harar (59.5%).

Table 9: Marginal effect estimates and the use of three agricultural practices

Variable name	(1) Chemical fertilizer use	(2) Crop rotation	(3) Improved maize variety
Female landowner	0.047**	0.041**	0.121***
	(0.022)	(0.021)	(0.045)
SFI	0.497***	0.364***	0.095
	(0.048)	(0.046)	(0.114)
Age	-0.002***	0.000	-0.005***
	(0.001)	(0.001)	(0.001)
Basic education	0.017	0.013	0.060
	(0.023)	(0.022)	(0.042)
Male head	0.099***	0.084***	0.134**
	(0.026)	(0.026)	(0.052)
Dependency ratio	-0.004	0.022*	-0.015
	(0.012)	(0.011)	(0.022)
Non-farm enterprise	-0.045	0.029	0.141*
	(0.038)	(0.036)	(0.073)
Asset index	-0.006	-0.007	-0.044*
	(0.012)	(0.011)	(0.026)
Distance to admin headquarter	-0.451***	-0.114	-0.360
	(0.109)	(0.104)	(0.228)
Distance to road	-0.005***	0.002	-0.005***
	(0.001)	(0.001)	(0.002)
Soil fertility	0.036*	-0.011	0.185***
	(0.018)	(0.019)	(0.040)
Drought shock	-0.052*	0.135***	-0.053
	(0.029)	(0.030)	(0.058)
Regional Fixed Effect			
Amhara	0.017	0.204**	0.079
	(0.082)	(0.096)	(0.164)
Oromia	0.022	0.009	0.146
	(0.079)	(0.097)	(0.164)
Somali	-0.472***	-0.325**	-0.303*
	(0.149)	(0.127)	(0.170)
Benishangul	-0.088	0.188*	-0.023
	(0.090)	(0.100)	(0.165)
SNNPR	-0.271***	-0.110	0.038

	(0.081)	(0.098)	(0.162)
Gambela	-0.735***	-0.329***	
	(0.077)	(0.107)	
Harar	-0.160*	-0.595***	-0.154
	(0.088)	(0.099)	(0.161)
Dire Dawa	-0.507***	-0.485***	-0.230
	(0.091)	(0.109)	(0.179)
Number of observations	1,574	1,574	595

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 10 shows the estimated coefficients for the empirical relationship focused on female sole or joint land ownership. The result shows that joint land ownership has a positive and statistically significant effect on the use of synthetic fertilizer, crop rotation, and use of improved maize variety. The association of these practices with sole female land ownership was not statistically significant.

Table 10: Logit estimation results with split ownership for the use of three agricultural practices in Ethiopia

Variable name	Chemical fertilizer use	Crop rotation	Improved maize
Sole female ownership	0.394	0.495	0.524
	(0.297)	(0.321)	(0.547)
Joint ownership	0.295**	0.259*	0.612***
	(0.149)	(0.151)	(0.229)
SFI	3.236***	2.578***	0.461
	(0.346)	(0.342)	(0.577)
Age	-0.013***	0.002	-0.024***
	(0.005)	(0.005)	(0.007)
Basic education	0.112	0.090	0.298
	(0.149)	(0.156)	(0.209)
Male head	0.707***	0.733***	0.604
	(0.258)	(0.272)	(0.498)
Dependency ratio	-0.025	0.152*	-0.075
	(0.076)	(0.080)	(0.109)
Non-farm enterprise	-0.294	0.202	0.705*
	(0.243)	(0.256)	(0.369)
Asset index	-0.036	-0.050	-0.222*
	(0.080)	(0.075)	(0.130)

Distance to admin headquarter	-2.917***	-0.784	-1.813
	(0.728)	(0.734)	(1.141)
Distance to road	-0.031***	0.011	-0.027***
	(0.007)	(0.010)	(0.009)
Soil Infertility	0.234*	-0.081	0.924***
	(0.120)	(0.132)	(0.211)
Drought shock	-0.333*	0.951***	-0.263
	(0.188)	(0.220)	(0.292)
Regional Fixed Effect			
Amhara	0.102	1.717***	0.386
	(0.550)	(0.608)	(0.794)
Oromia	0.142	0.024	0.696
	(0.532)	(0.564)	(0.790)
Somali	-2.488***	-1.575**	-1.998
	(0.893)	(0.681)	(1.251)
Benishangul	-0.546	1.484**	-0.090
	(0.583)	(0.679)	(0.801)
SNNPR	-1.478***	-0.598	0.195
	(0.542)	(0.568)	(0.781)
Gambela	-5.690***	-1.606***	
	(0.870)	(0.600)	
Harar	-0.925	-3.277***	-0.789
	(0.566)	(0.616)	(0.807)
Dire Dawa	-2.705***	-2.447***	-1.301
	(0.605)	(0.649)	(1.036)
Constant	-0.605	-1.497*	-2.201**
	(0.696)	(0.782)	(1.089)
Number of observations	1,574	1,574	595

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

The marginal effect was estimated to quantify the association between two land ownership types and agricultural practices. Table 11 presents the marginal effect estimate of sole and joint land ownership on agricultural practices (synthetic fertilizer use, crop rotation, improved maize variety use). The study finds that joint ownership of land increased the use of synthetic fertilizer by 4.5%, crop rotation by 3.7%, and use of improved maize variety by 12.3%. The sole female landownership does not have a statistically significant association in any of the three equations representing the use of agricultural practices. Bhaumik et al. (2016) argued that sole female land

ownership in developing countries is not optimum for increasing farm income. Females have a disadvantage in operating an agricultural farm as they lack the required labor and financial access to run the farm efficiently and improve production (Agarwal & Mahesh, 2023). The findings of this study in terms of female land ownership seem consistent with those of Bhaumik et al. (2016).

The effect of other explanatory variables is similar to the results shown in Table 9. An increase in the age of the household head by one year reduced the use of chemical fertilizer by 0.2% and the use of improved maize variety by 0.5%. The household with a male head had 10.9% and 10.4% higher probability of using chemical fertilizer and following crop rotation practices, respectively.

An increase in the soil fragmentation index by 0.1 increased the probability of chemical fertilizer use by almost 5% and the adoption of crop rotation practice by 3.66%. Change in soil fertility, from poor to fair or from fair to good, led to a 3.6% increase in the use of chemical fertilizers and an 18.5% increase in the adoption of improved maize varieties.

The effect of drought shock was heterogeneous. The incidence of drought reduced the use of chemical fertilizer by 5% but increased the practice of crop rotation by 13.5%. The increase in distance to major roads by one kilometer reduced both the use of chemical fertilizer and improved the maize variety by 0.5% (Table 11).

Regional factors had a large marginal effect on the adoption of agricultural practices. Regions including Gamebela, Somali, Dire Dawa, Harar, and SNNPR had a significantly lower likelihood of using chemical fertilizer and practicing rotation as compared to Afar. The households in Somali, SNNPR, Gambela, Harar, and Dire Dawa had 47.1%, 27.3%, 73.6%, 16.1%, and 50.9% lower probability, respectively, of using chemical fertilizer. The households in Somali, Gambela, Harar, and Dire Dawa were 32.2%, 32.9%, 59.9%, and 48.8% less likely, respectively, to adopt

the crop rotation practices. In contrast, the households in Amhara were 19.9% more likely to adopt the practice of crop rotation. The households in Somali were almost 30% less likely to use improved maize varieties as compared to the Afar region.

Table 11: Marginal effect estimates of split land ownership and the use of three agricultural practices

Variable name	Chemical fertilizer use	Crop rotation	Improved maize variety
Sole female ownership	0.061	0.070	0.105
	(0.046)	(0.045)	(0.109)
Joint ownership	0.045**	0.037*	0.123***
	(0.023)	(0.021)	(0.045)
SFI	0.499***	0.366***	0.093
	(0.048)	(0.046)	(0.116)
Age	-0.002***	0.000	-0.005***
	(0.001)	(0.001)	(0.001)
Basic education	0.017	0.013	0.060
	(0.023)	(0.022)	(0.042)
Male head	0.109***	0.104***	0.121
	(0.039)	(0.038)	(0.099)
Dependency ratio	-0.004	0.022*	-0.015
	(0.012)	(0.011)	(0.022)
Non-farm enterprise	-0.045	0.029	0.141*
	(0.038)	(0.036)	(0.073)
Asset index	-0.006	-0.007	-0.045*
	(0.012)	(0.011)	(0.026)
Distance to admin headquarter	-0.450***	-0.111	-0.364
	(0.109)	(0.104)	(0.226)
Distance to road	-0.005***	0.002	-0.005***
	(0.001)	(0.001)	(0.002)
Soil fertility	0.036*	-0.011	0.185***
	(0.019)	(0.019)	(0.040)
Drought shock	-0.051*	0.135***	-0.053
	(0.029)	(0.030)	(0.058)
Regional Fixed Effect			
Amhara	0.015	0.199**	0.083
	(0.082)	(0.096)	(0.167)
Oromia	0.021	0.004	0.150
	(0.079)	(0.098)	(0.166)
Somali	-0.471***	-0.322**	-0.299*
	(0.149)	(0.128)	(0.171)
Benishangul	-0.090	0.183*	-0.019
	(0.090)	(0.100)	(0.167)

SNNPR	-0.273***	-0.114	0.041
	(0.081)	(0.099)	(0.164)
Gambela	-0.736***	-0.329***	
	(0.077)	(0.108)	
Harar	-0.161*	-0.599***	-0.150
	(0.088)	(0.099)	(0.164)
Dire Dawa	-0.509***	-0.488***	-0.226
	(0.091)	(0.110)	(0.181)
Number of observations	1,574	1,574	595

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

5.2 Female land ownership and food security

The coefficient estimates of equation 3 are presented in columns 1 and 3 in Table 12. The coefficient estimates of equation 4 are presented in columns 2 and 4 (Table 12). The results show that being "female landowner" is negatively and statistically significantly associated with food insecurity (FI) and severe food insecurity (Sev FI). Extension of that model was estimated by altering the specification through the breakdown of female land ownership into sole female land ownership and joint land ownership (Table 12). Results show that the joint land ownership has a negative and significant influence on food insecurity as well as severe food insecurity, respectively. The association between sole female landownership and food insecurity was statistically insignificant. Having a basic level of education lowers the likelihood of food insecurity, as does the increasing asset index, but increasing dependency ratio or experiencing a drought in the 12 months preceding the survey increases food insecurity.

Table 12: Logit estimation result for food insecurity categories

Variable name	(1) FI	(2) FI	(3) Sev FI	(4) Sev FI
Sole female ownership		-0.079		-0.183
		(0.224)		(0.277)
Joint ownership		-0.429***		-0.616***

		(0.130)		(0.208)
Female landowner	-0.357***		-0.501***	
	(0.121)		(0.181)	
SFI	-0.847***	-0.830***	-1.472***	-1.460***
	(0.254)	(0.254)	(0.348)	(0.347)
Age	0.006	0.006	0.006	0.006
	(0.004)	(0.004)	(0.005)	(0.005)
Basic education	-0.266**	-0.263**	-0.051	-0.047
	(0.126)	(0.126)	(0.187)	(0.188)
Male head	-0.163	0.014	-0.515***	-0.313
	(0.139)	(0.179)	(0.197)	(0.238)
Dependency ratio	0.257***	0.255***	0.091	0.087
	(0.059)	(0.058)	(0.079)	(0.078)
Non-farm enterprise	-0.245	-0.252	0.498*	0.493*
	(0.208)	(0.209)	(0.291)	(0.288)
Asset index	-0.276***	-0.274***	-0.625***	-0.626***
	(0.100)	(0.099)	(0.158)	(0.159)
Distance to admin headquarter	0.806	0.808	1.339*	1.351*
	(0.502)	(0.503)	(0.697)	(0.700)
Distance to road	-0.006	-0.006	-0.019***	-0.019***
	(0.005)	(0.005)	(0.007)	(0.007)
Soil Infertility	-0.114	-0.117	0.071	0.064
	(0.093)	(0.093)	(0.126)	(0.126)
Drought shock	0.987***	0.989***	1.512***	1.519***
	(0.154)	(0.154)	(0.185)	(0.187)
Regional Fixed Effect				
Amhara	0.865**	0.840**	0.096	0.074
	(0.346)	(0.345)	(0.441)	(0.437)
Oromia	1.813***	1.790***	1.477***	1.457***
	(0.334)	(0.333)	(0.370)	(0.367)
Somali	-0.000	-0.001	-0.818**	-0.826**
	(0.350)	(0.349)	(0.404)	(0.402)
Benishangul	0.801**	0.766*	-0.047	-0.083
	(0.402)	(0.402)	(0.624)	(0.626)
SNNPR	1.745***	1.724***	1.139***	1.124***
	(0.332)	(0.332)	(0.374)	(0.372)
Gambela	0.424	0.430	-1.536**	-1.510**
	(0.358)	(0.357)	(0.670)	(0.666)
Harar	-0.079	-0.098	-1.151**	-1.150**
	(0.379)	(0.378)	(0.577)	(0.573)
Dire Dawa	0.628*	0.608*	-0.736	-0.761
	(0.363)	(0.363)	(0.502)	(0.501)
Constant	-1.278***	-1.425***	-2.198***	-2.347***
	(0.440)	(0.452)	(0.559)	(0.567)
Number of observations	1,826	1,826	1,826	1,826

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13 presents the marginal effect estimates based on equations 3 and 4 (see pp. 30 and 31). The first column shows the effects on food insecurity (FI) (Table 13). If any of the female household members solely or jointly own a plot of land, then the probability of the household being food insecure declines by 6.9%. The result aligns with Schling & Pazos (2024), who found that female land ownership enhances household food security.

By splitting the female landownership between the sole female landownership and joint ownership of the land (Table 13, column 2), the results show that only the joint ownership reduces the household food insecurity The joint ownership of land decreases the probability of the household being food insecure by 8.4% and being severely food insecure by 5.6%.

The third and fourth columns in Table 13 show the marginal effects for equations where severe food insecurity (Sev FI) served as the dependent variable. The result shows that being a "female landowner" lowered the probability of severe food insecurity by 4.5% as compared to households where females did not own any parcel of land. The alternative specification of the relationships (Table 13, fourth column) includes the sole and joint ownership. The latter reduced the incidence of severe food insecurity by 5.6%. However, the effect of sole female land ownership does not significantly lower the severity of food insecurity.

Land fragmentation (SFI) had a positive and significant impact on food security. A 0.1 unit of increase in SFI was associated with a 1.7% decrease in the likelihood of experiencing food insecurity and a 1.36% reduction in experiencing severe food insecurity. Knippenberg et al. (2020) suggested that the positive association between land fragmentation and food security is due to increased crop diversification resulting from land fragmentation.

The ability of the household head to read or write in any language (defined as "basic education") was positively associated with food security. The households in which the head of the household can read or write in any language had a 5% lower probability of facing food insecurity as compared to households where the head lacked education. The result supports the earlier reported findings (Florkowski & Kharel, 2024).

Household characteristics like dependency ratio, drought shock, and asset index were statistically significant factors influencing the probability of household food insecurity. The households with a higher proportion of dependent population were more likely to face food insecurity. An increase in the dependency ratio by a unit increased the probability of reporting food insecurity by 5%. Likewise, the incidence of drought increased the probability of household food insecurity by as much as 19.6%. As expected, the higher asset index increased food security. An increase in the asset index of a unit reduced the probability of food insecurity by 5.5%. The result is consistent with the previous findings in studies of Ethiopia (Cholo et al., 2019; Knippenberg et al., 2020; Florkowski & Kharel, 2024).

The probability of being food insecure was affected by regional indicators. Households in Amhara, SNNPR, and Oromia have 14.3%, 32.9%, and 34.3%, respectively, higher probability of experiencing food insecurity compared to those in the Afar region (base region). In the case of severe food insecurity, households in Oromia and SNNPR have 16.8 and 12% higher probabilities of facing severe food insecurity as compared to Afar households. However, households in Gambela and Harar have a 6.1% and 7.3% lower probability of facing severe food insecurity as compared to the base region.

Table 13: Marginal effect estimates for food insecurity categories

Variable name	(1) FIES	(2) FIES	(3) Sev FI	(4) Sev FI
Sole female ownership		-0.011		-0.015
		(0.044)		(0.025)
Joint ownership		-0.084***		-0.056***
		(0.025)		(0.019)
Female landowner	-0.069***		-0.045***	
	(0.024)		(0.016)	
SFI	-0.169***	-0.165***	-0.136***	-0.135***
	(0.050)	(0.050)	(0.032)	(0.032)
Age	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.000)	(0.000)
Basic education	-0.053**	-0.052**	-0.005	-0.004
	(0.025)	(0.025)	(0.017)	(0.017)
Male head	-0.032	0.005	-0.047***	-0.028
	(0.027)	(0.036)	(0.018)	(0.022)
Dependency ratio	0.051***	0.051***	0.008	0.008
	(0.011)	(0.011)	(0.007)	(0.007)
Non-farm enterprise	-0.049	-0.050	0.046*	0.045*
	(0.041)	(0.042)	(0.027)	(0.026)
Asset index	-0.055***	-0.054***	-0.058***	-0.058***
	(0.020)	(0.019)	(0.014)	(0.015)
Distance to admin headquarter	0.161	0.160	0.124*	0.125**
	(0.100)	(0.100)	(0.063)	(0.064)
Distance to road	-0.001	-0.001	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Soil fertility	-0.023	-0.023	0.007	0.006
	(0.018)	(0.018)	(0.012)	(0.012)
Drought shock	0.196***	0.196***	0.139***	0.140***
	(0.029)	(0.029)	(0.016)	(0.016)
Regional Fixed Effect				
Amhara	0.143***	0.139***	0.007	0.006
	(0.052)	(0.052)	(0.035)	(0.034)
Oromia	0.343***	0.340***	0.168***	0.166***
	(0.050)	(0.050)	(0.035)	(0.035)
Somali	-0.000	-0.000	-0.049*	-0.049*
	(0.048)	(0.048)	(0.026)	(0.026)
Benishangul	0.131**	0.125*	-0.004	-0.006
	(0.064)	(0.064)	(0.047)	(0.047)
SNNPR	0.329***	0.326***	0.120***	0.118***
	(0.049)	(0.049)	(0.033)	(0.033)
Gambela	0.064	0.066	-0.073***	-0.073***
	(0.053)	(0.053)	(0.028)	(0.028)

Harar	-0.011	-0.013	-0.061**	-0.062**
	(0.051)	(0.051)	(0.030)	(0.030)
Dire Dawa	0.100*	0.097*	-0.045	-0.046
	(0.056)	(0.056)	(0.030)	(0.030)
Number of observations	1,826	1,826	1,826	1,826

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

5.3 Robustness Check

To further validate the empirical findings on the association between female land ownership and food security, the study employs an alternative measure of food security obtained by using principal factor analysis. Factor analysis is allowed if the items are collinear and the data fulfill the sample adequacy requirement (Williams et al., 2010). The Bartlett test of sphericity was performed to test the null hypothesis of non-collinearity among eight items in Table A1 (see Appendix). The p-value for the Bartlett test of sphericity was less than the threshold value of 0.05. Thus, the null hypothesis of non-collinearity is rejected (Williams et al., 2010). The Kaiser-Meyer-Olkin (KMO) score was derived to test for sample adequacy. The KMO score was 0.899 and greater than the recommended minimum value of 0.6 (Helmi et al., 2019). The current study generates the variable 'FIES factor' by applying principal factor analysis to all FIES items. Only factors with eigenvalues greater than or equal to one are retained for factor analysis (Koomson et al., 2023).

An OLS regression was carried out to evaluate the role of female land ownership on this alternative food insecurity proxy. The result shows that in households with a female landowner, the measure of food insecurity (FIES factor) is reduced by 0.114. The result is statistically significant at the 5% level. Separate calculations were made for the case of joint land ownership. The result in the middle column of Table 14 shows that joint land ownership reduces the food insecurity measure, FIES factor, by 0.142. The result is significant at the 1% level. The sole female

land ownership does not significantly change the food security measure (Table 14). Other independent variables show similar directional effects on food security as in the earlier specified relationships.

Table 14: OLS estimates of two food security specifications with three types of land ownership involving women

Variable name	FIES factor	FIES factor
Sole female ownership		0.002
		(0.092)
Joint ownership		-0.142***
		(0.048)
Female landowner	-0.114**	
	(0.046)	
SFI	-0.375***	-0.368***
	(0.095)	(0.095)
Age	0.002	0.002
	(0.002)	(0.002)
Basic education	-0.132***	-0.131***
	(0.047)	(0.047)
Male head	-0.072	0.002
	(0.055)	(0.073)
Dependency ratio	0.092***	0.091***
	(0.023)	(0.023)
Non-farm enterprise	-0.101	-0.104
	(0.077)	(0.077)
Asset index	-0.093***	-0.093***
	(0.021)	(0.021)
Distance to admin headquarter	0.321	0.321
	(0.200)	(0.199)
Distance to road	-0.003*	-0.003*
	(0.002)	(0.002)
Soil Infertility	-0.062*	-0.062*
	(0.037)	(0.037)
Drought shock	0.505***	0.506***
	(0.064)	(0.064)
Regional Fixed Effect		
Amhara	0.322**	0.314**
	(0.134)	(0.133)
Oromia	0.817***	0.809***
	(0.135)	(0.135)
Somali	-0.080	-0.078

	(0.153)	(0.152)
Benishangul	0.512***	0.499***
	(0.145)	(0.146)
SNNPR	0.803***	0.796***
	(0.134)	(0.134)
Gambela	0.255*	0.255*
	(0.133)	(0.133)
Harar	-0.082	-0.090
	(0.142)	(0.141)
Dire Dawa	0.308**	0.302**
	(0.142)	(0.142)
Constant	-0.222	-0.283
	(0.179)	(0.181)
Number of observations	1,826	1,826
R-squared	0.194	0.196

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

CHAPTER 6

CONCLUSIONS AND POLICY IMPLICATIONS

Gender disparity remains a major constraint in sub-Saharan Africa, especially in terms of female-granted land rights and the reduction of food insecurity, hindering the progress towards achieving the stated sustainable development goals (SDGs). This research applied land ownership rights as an instrument for women's participation in household decision-making to examine their effect on the adoption of the selected agricultural practices important for food production and household food security.

The empirical analysis shows a clear and significant effect of female land ownership on the adoption of agricultural practices and the reduction of household food insecurity. The breakdown of female land ownership into sole female land ownership and joint land ownership shows that the positive influence is associated with joint land ownership in the surveyed Ethiopian households. Households, where both male and female members owned the land parcels, had a higher adoption rate of the three considered agricultural practices than the households where the land was solely owned.

Also, the study finds a positive and statistically significant association between female land ownership and food security. A breakdown of female land ownership shows that households where both males and females co-owned land were less likely to face food insecurity. The effect of women's sole land ownership on the reduction of food insecurity was not confirmed by the statistically significant effect. The result was robust when an alternative proxy of household food

insecurity was generated using principal factor analysis, and its influence on eight items of FIES was tested.

The findings of the research are important in policy design. Despite some reforms in land ownership rights, there is a big gender disparity in land ownership in Sub-Saharan Africa. Although there is much research emphasizing the need for suitable policy interventions to ensure female participation and reduce gender disparity, this research connects those needs to better agricultural practices and household food security.

This study highlights the importance of female land ownership, especially joint land ownership, in the adoption of agricultural practices and the reduction of food insecurity. Empowering women by increasing their access to land offers a viable approach to tackling the chronic food insecurity in Ethiopia. The government policies focused on the promotion of female land ownership will improve agricultural productivity and food security.

According to the study results, the sole female landownership was not associated with the use of desired agricultural practices and improved food security. A review of the existing literature identifies weak policies and social structures as the major barriers preventing women who solely own land from accessing resources such as extension services and finance (Bhaumik et al. 2016; Khoja & Amina, 2021; Agarwal & Mahesh, 2023). This study recommends policies that strengthen women's land rights and improve their access to resources, enabling the adoption of yield-enhancing agricultural practices. Implementation of such policies will help to fulfill the SDG goals regarding gender equality and the elimination of hunger.

Having a basic education positively influences the use of the selected agricultural practices, suggesting the need for nationwide efforts to enhance the level of literacy among the population. Expansion of technical infrastructure is another factor determined by national policies that is

associated with food security improvement and higher agricultural productivity, as shown in the current study by the positive effect of increased proximity to major roads. Ultimately, the combined effects of female participation in owning land, literacy improvement, and increased mobility by expanding road infrastructure offer a sustained path to assured food security of households in Ethiopia.

However, the study has several limitations. Firstly, there is a potential error regarding the land certification. The definition of land ownership is not unique. As explained in the land ownership section, there are three types of ownership: reported ownership, documented ownership, and effective ownership (Doss et al., 2015). This study uses the documented ownership of land. Use of other measures of land ownership can potentially have a different outcome. Secondly, the research assumes the absence of reporting and enumerator bias. The survey questionnaire allows for the inclusion of up to 4 owners for each parcel of land. Bias from the respondent or the enumerator in recording all the owners of the plots may potentially impact the outcome of the research.

REFERENCES

Abafita, J., & Kim, K.-R. (Eds.). (2014). Determinants of Household Food Security in Rural Ethiopia: An Empirical Analysis. *Journal of Rural Development/Nongchon-Gyeongje*. https://doi.org/10.22004/ag.econ.196613

Abebe, T. G., Tamtam, M. R., Abebe, A. A., Abtemariam, K. A., Shigut, T. G., Dejen, Y. A., & Haile, E. G. (2022). Growing Use and Impacts of Chemical Fertilizers and Assessing Alternative Organic Fertilizer Sources in Ethiopia. *Applied and Environmental Soil Science*, *2022*(1), 4738416. https://doi.org/10.1155/2022/4738416

Adamie, B. A. (2021). Land property rights and household take-up of development programs: Evidence from land certification program in Ethiopia. *World Development*, *147*, 105626. https://doi.org/10.1016/j.worlddev.2021.105626

Adem, A., Namatovu, R., & Farrelly, M. (Eds.). (2022). Women's land rights as a pathway to food security in uganda. *African Journal of Land Policy and Geospatial Sciences*. https://doi.org/10.22004/ag.econ.334483

Adenugba, A. O., & Raji-Mustapha, N. O. (2013). The Role of Women in Promoting Agricultural Productivity And Developing Skills For Improved Quality of Life In Rural Areas. *IOSR Journal of Engineering*, *03*(08), 51–58. https://doi.org/10.9790/3021-03855158

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. *Current Opinion in Environmental Sustainability*, *34*, 26–32. https://doi.org/10.1016/j.cosust.2018.07.002

Agarwal, B., & Mahesh, M. (2023). Does the Landowner's Gender Affect Self-Cultivation and Farm Productivity? An Analysis for India. *The Journal of Development Studies*, *59*(5), 758–777. https://doi.org/10.1080/00220388.2022.2162883

Akadiri, S. S., Nwaka, I. D., & Jenkins, G. P. (2018). *Are Female-Headed Households Less Food Secure? Evidence from Nigeria and Ethiopia.*

Al Jazeera. (2022, November 3). *Ethiopia peace deal hailed as a 'new dawn.'*

Alem, Y., & Köhlin, G. (2014). The Impact of Food Price Inflation on Subjective Well-being: Evidence From Urban Ethiopia. *Social Indicators Research*, *116*(3), 853–868. https://doi.org/10.1007/s11205-013-0318-7

Alemayehu, G., Shibabaw, A., Adgo, E., Asch, F., & Freyer, B. (2020). Crop rotation and organic matter application restore soil health and productivity of degraded highland crop farms in northwest Ethiopia. *Cogent Food & Agriculture*. https://www.tandfonline.com/doi/abs/10.1080/23311932.2020.1831124

Alemu, G. T. (2015). *Women's Land Use Right Policy and Household Food Security in Ethiopia: Review*.

Alemu, M., Berihun, D., Lokossou, J. C., & Yismaw, B. (2022). *Productivity and Efficiency Heterogeneity Among Maize Smallholder Farmers in Ethiopia*. Research Square. https://doi.org/10.21203/rs.3.rs-2199516/v1

Amir-ud-Din, R., Naz, L., & Ali, H. (2023). Relationship between asset ownership and women's empowerment? Evidence from DHS data from 18 developing countries. *Journal of Demographic Economics*, *90*. https://doi.org/10.1017/dem.2023.17

Araya, T., & Lee, S.-K. (2024). Conflict and households' acute food insecurity: Evidences from the ongoing war in Tigrai-Northern Ethiopia. *Cogent Public Health*, *11*(1), 2331844. https://doi.org/10.1080/27707571.2024.2331844

Arndt, C., Robinson, S., & Willenbockel, D. (2011). Ethiopia's growth prospects in a changing climate: A stochastic general equilibrium approach. *Global Environmental Change*, *21*(2), 701–710. https://doi.org/10.1016/j.gloenvcha.2010.11.004

Asgele Siyum, B. (2021, October 15). Underlying Causes of Conflict in Ethiopia: Historical, Political, and Institutional? *Proceedings of The 2nd World Conference on Social Sciences Studies*. 2nd World Conference on Social Sciences Studies. https://doi.org/10.33422/2nd.3sconf.2021.10.102

Ayebazibwe, J. S. (2019). Traditional African systems of land ownership and their impact on lesbian women. In *Routledge Handbook of Queer African Studies*. Routledge.

Babugura, A. A. (2017). Gender Equality, Sustainable Agricultural Development, and Food Security. In *Routledge Handbook of Gender and Environment*. Routledge.

Balasubramanian, S. A., Kuppusamy, T., & Natarajan, T. (2018). Financial inclusion and land ownership status of women. *International Journal of Development Issues*, *18*(1), 51–69. https://doi.org/10.1108/IJDI-06-2018-0091

Ballard, T.J., Kepple, A.W. & Cafiero, C. (2013). *The food insecurity experience scale: Development of a global standard for monitoring hunger worldwide.* http://www.fao.org/economic/ess/ess-fs/voices/en/

Bertelli, O. (2020). Food Security Measures in Sub-Saharan Africa. A Validation of the LSMS-ISA Scale†. *Journal of African Economies*, *29*(1), 90–120. https://doi.org/10.1093/jae/ejz011

Bhaumik, S. K., Dimova, R., & Gang, I. N. (2016). Is Women's Ownership of Land a Panacea in Developing Countries? Evidence from Land-Owning Farm Households in Malawi. *The Journal of Development Studies*, *52*(2), 242–253. https://doi.org/10.1080/00220388.2015.1060314

Boone, W. J. (2016). Rasch Analysis for Instrument Development: Why, When, and How? *CBE—Life Sciences Education*, *15*(4), rm4. https://doi.org/10.1187/cbe.16-04-0148

Booysen, F., van der Berg, S., Burger, R., Maltitz, M. von, & Rand, G. du. (2008). Using an Asset Index to Assess Trends in Poverty in Seven Sub-Saharan African Countries. *World Development*, *36*(6), 1113–1130. https://doi.org/10.1016/j.worlddev.2007.10.008

Buabeng, K., Löhr, K., Asare, R., & Sieber, S. (2024). Unmasking gender disparities in cocoa farming: The case of female land ownership in the Ashanti and Western North regions of Ghana. *Journal of Social and Economic Development*. https://doi.org/10.1007/s40847-024-00378-w

Burrone, S., & Giannelli, G. C. (2023). *Do Households Where Women Own Land Fare Better for Food Security? Evidence for Tanzania* (Working Paper No. 16382). IZA Discussion Papers. https://www.econstor.eu/handle/10419/279080

Cafiero, C., Viviani, S., & Nord, M. (2018). Food security measurement in a global context: The food insecurity experience scale. *Measurement*, *116*, 146–152. https://doi.org/10.1016/j.measurement.2017.10.065

Chacko, A. M., & Scaria, S. (2023). Land Ownership and Well-Being of Women in a Village in Kerala. *South Asia Research*, *43*(2), 227–244. https://doi.org/10.1177/02627280231163077

Chakrabarti, A. (2018). Female Land Ownership and Fertility in Nepal. *The Journal of Development Studies*, *54*(9), 1698–1715. https://doi.org/10.1080/00220388.2017.1400017

Cholo, T. C., Fleskens, L., Sietz, D., & Peerlings, J. (2019). Land fragmentation, climate change adaptation, and food security in the Gamo Highlands of Ethiopia. *Agricultural Economics*, *50*(1), 39–49. https://doi.org/10.1111/agec.12464

Dagnew, B. (2019). Road development and its impacts in Ethiopia. *Journal of African Development Studies*, *6*(2), Article 2. https://doi.org/10.56302/jads.v6i2.3118

Davier, M. von. (2016). Rasch Model. In *Handbook of Item Response Theory*. Chapman and Hall/CRC.

Deere, C. D., Durán, R. L., Mardon, M., & Masterson, T. (2004). *Female Land Rights and Rural Household Incomes in Brazil, Paraguay and Peru*. https://hdl.handle.net/20.500.14394/22389

Deininger, K., Ali, D. A., Holden, S., & Zevenbergen, J. (2008a). Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries. *World Development*, *36*(10), 1786–1812. https://doi.org/10.1016/j.worlddev.2007.09.012

Deininger, K., Ali, D. A., Holden, S., & Zevenbergen, J. (2008b). Rural Land Certification in Ethiopia: Process, Initial Impact, and Implications for Other African Countries. *World Development*, *36*(10), 1786–1812. https://doi.org/10.1016/j.worlddev.2007.09.012

Deininger, K., Selod, H., & Burns, A. (2012). *The Land Governance Assessment Framework: Identifying and Monitoring Good Practice in the Land Sector*. World Bank Publications.

Dimova, R., & Gang, I. N. (2015). *Good and efficient? Women's voice in agriculture* (Working Paper Nos. 2015–18). Working Paper. https://www.econstor.eu/handle/10419/130739

Dokken, T. (2013). *Land tenure in Tigray: How large is the gender bias?* [Working paper]. Norwegian University of Life Sciences, Ås. https://nmbu.brage.unit.no/nmbu-xmlui/handle/11250/2478741

Doss, C. (2006). The Effects of Intrahousehold Property Ownership on Expenditure Patterns in Ghana. *Journal of African Economies*, *15*(1), 149–180. https://doi.org/10.1093/jae/eji025

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., & van den Bold, M. (2015). Gender inequalities in ownership and control of land in Africa: Myth and reality. *Agricultural Economics*, *46*(3), 403–434. https://doi.org/10.1111/agec.12171

Endalew, H. A., & and Sen, S. (2021). Effects of climate shocks on Ethiopian rural households: An integrated livelihood vulnerability approach. *Journal of Environmental Planning and Management*, *64*(3), 399–431. https://doi.org/10.1080/09640568.2020.1764840

Engelman, A., Paludneviciene, R., Wagner, K., Jacobs, K., & Kushalnagar, P. (2021). Food Worry in the Deaf and Hard-of-Hearing Population During the COVID-19 Pandemic. *Public Health Reports®*, *136*(2), 239–244. https://doi.org/10.1177/0033354920974666

Etea, B. G., Zhou, D., Abebe, K. A., & Sedebo, D. A. (2019). Household Income Diversification and Food Security: Evidence from Rural and Semi-Urban Areas in Ethiopia. *Sustainability*, *11*(12), Article 12. https://doi.org/10.3390/su11123232

Ethiopia. (2014, January 19). Migrationpolicy.Org. https://www.migrationpolicy.org/country-resource/ethiopia

Ethiopia Poverty Assessment 2014. (2015). https://hdl.handle.net/10986/21323

Ethiopia—Share of economic sectors in the gross domestic product 2023. (n.d.). Statista. Retrieved March 15, 2025, from https://www.statista.com/statistics/455149/share-of-economic-sectors-in-the-gdp-in-ethiopia/

Fafchamps, M., & Quisumbing, A. R. (2002). Control and Ownership of Assets Within Rural Ethiopian Households. *The Journal of Development Studies*, *38*(6), 47–82. https://doi.org/10.1080/00220380412331322581

FAO; IFAD; UNICEF; WFP; WHO. (2024). *The State of Food Security and Nutrition in the World 2024 – Financing to end hunger, food insecurity and malnutrition in all its forms* (p. 286).

Feder, G., & Noronha, R. (1987). Land rights systems and agricultural development in sub-Saharan Africa. *The World Bank Research Observer*, *2*(2), 143–169. https://doi.org/10.1093/wbro/2.2.143

Female Access and Rights to Land, and Rural Non-farm Entrepreneurship in Four African Countries—Efobi—2019—African Development Review—Wiley Online Library. (n.d.). Retrieved February 19, 2025, from https://onlinelibrary.wiley.com/doi/10.1111/1467-8268.12376

Florkowski, W. J., & Kharel, N. (2024). Mitigation of Food Insecurity in Ethiopia: Personal, Household, and Regional Determinants. *Roczniki (Annals)*. https://doi.org/10.22004/ag.econ.348653

Fonjong, L., Sama-Lang, I., & Fombe, L. (2010). An Assessment of the Evolution of Land Tenure System in Cameroon and its Effects on Women's Land Rights and Food Security. *Perspectives on Global Development and Technology*, *9*, 154–169. https://doi.org/10.1163/156914910X487979

Fonjong, L., Sama-Lang, I., & Lawrence Fon, F. (2010). An Assessment of the Evolution of Land Tenure System in Cameroon and its Effects on Women's Land Rights and Food

Security. *Perspectives on Global Development and Technology*, *9*(1–2), 154–169. https://doi.org/10.1163/156914910X487979

Gaddis, I., Lahoti, R. S., & Li, W. (2018). *Gender Gaps in Property Ownership in Sub-Saharan Africa* (SSRN Scholarly Paper No. 3246145). Social Science Research Network. https://papers.ssrn.com/abstract=3246145

Gebrehiwot, T., & and van der Veen, A. (2013). Climate change vulnerability in Ethiopia: Disaggregation of Tigray Region. *Journal of Eastern African Studies*, *7*(4), 607–629. https://doi.org/10.1080/17531055.2013.817162

Gedefaw, A. A., Atzberger, C., Seher, W., Agegnehu, S. K., & Mansberger, R. (2020). Effects of Land Certification for Rural Farm Households in Ethiopia: Evidence from Gozamin District, Ethiopia. *Land*, *9*(11), Article 11. https://doi.org/10.3390/land9110421

Geffersa, A. G., & Berhane, G. (2015). Does Climate Shock Aggravate Household Food Insecurity in Rural Ethiopia? Evidences from Panel Data Estimation. *Journal of Poverty*.

Goli, I., Bijani, M., Koohi, P. K., Skominas, R., Värnik, R., Van Passel, S., Dogot, T., & Azadi, H. (2025). Toward tenure security: The relationship between women's land ownership, formal land title documents and their empowerment. *Land Use Policy*, *148*, 107389. https://doi.org/10.1016/j.landusepol.2024.107389

Goshu, D., Mehare, A., & Tariku, L. (n.d.). *Poverty and pro-poor growth in Ethiopia*.

Grossi, A., & Dinku, T. (2022). From research to practice: Adapting agriculture to climate today for tomorrow in Ethiopia. *Frontiers in Climate*, *4*. https://doi.org/10.3389/fclim.2022.931514

Hassen, A. A., Yimam, Z. G., & Awoke, A. J. (2024). The effect of output level and inflation on food security in Ethiopia: An empirical analysis using the ARDL framework. *Studies in*

Economics and Econometrics, *48*(3), 221–235. https://doi.org/10.1080/03796205.2024.2355107

Helmi, N. Z., Isa, K. A. Md., & Masuri, M. G. (2019). Exploratory Factor Analysis on Food Insecurity Experience Scale (FIES): Latest food insecurity measurement tool by FAO. *Environment-Behaviour Proceedings Journal*, *4*(12). https://doi.org/10.21834/e-bpj.v4i12.1941

Henjum, S., Morseth, M. S., Arnold, C. D., Mauno, D., & Terragni, L. (2019). "I worry if I will have food tomorrow": A study on food insecurity among asylum seekers living in Norway. *BMC Public Health*, *19*(1), 592. https://doi.org/10.1186/s12889-019-6827-9

Hillesland, M., Swaminathan, H., & Grown, C. (2022). Women's Land Ownership and Household Income Diversification Patterns in Malawi. *Journal of African Development*, *23*(1), 58–86. https://doi.org/10.5325/jafrideve.23.1.0058

Hirvonen, K., Sohnesen, T. P., & Bundervoet, T. (2020). Impact of Ethiopia's 2015 drought on child undernutrition. *World Development*, *131*, 104964. https://doi.org/10.1016/j.worlddev.2020.104964

Holden, S., & Bezu, S. (2013). *Joint Land Certification and Intra-household Decision-making:Towards Empowerment of Wives?* (Working Paper No. 14/13). Centre for Land Tenure Studies Working Paper. https://www.econstor.eu/handle/10419/242721

Holden, S. T. (2021). The gender dimensions of land tenure reforms in Ethiopia 1995-2020. In *Land governance and gender: The tenure-gender nexus in land management and land policy* (pp. 143–152). https://doi.org/10.1079/9781789247664.0012

Holden, S. T., & Tilahun, M. (2020a). Farm size and gender distribution of land: Evidence from Ethiopian land registry data. *World Development*, *130*, 104926. https://doi.org/10.1016/j.worlddev.2020.104926

Holden, S. T., & Tilahun, M. (2020b). Farm size and gender distribution of land: Evidence from Ethiopian land registry data. *World Development*, *130*, 104926. https://doi.org/10.1016/j.worlddev.2020.104926

Hossain, M. (2019). Does gender influence farm households' decision to adopt technology and commercial agriculture: Implication for household food security in rural Bangladesh. *SAARC Journal of Agriculture*, *17*(1), Article 1. https://doi.org/10.3329/sja.v17i1.42772

Ivers, L. C., & Cullen, K. A. (2011). Food insecurity: Special considerations for women1234. *The American Journal of Clinical Nutrition*, *94*(6), 1740S-1744S. https://doi.org/10.3945/ajcn.111.012617

Jima, A. O. (2023). Ethiopian political crisis after reform: Causes of Tigray conflict. *Cogent Social Sciences*, *9*(1), 2209991. https://doi.org/10.1080/23311886.2023.2209991

Jones, R., Haardörfer, R., Ramakrishnan, U., Yount, K. M., Miedema, S., & Girard, A. W. (2019). Women's empowerment and child nutrition: The role of intrinsic agency. *SSM - Population Health*, *9*, 100475. https://doi.org/10.1016/j.ssmph.2019.100475

Jubayer, A., Islam, S., Nowar, A., Nayan, M. M., & Islam, M. H. (2023). Validity of Food insecurity experience scale (FIES) for use in rural Bangladesh and prevalence and determinants of household food insecurity: An analysis of data from Bangladesh integrated household survey (BIHS) 2018-2019. *Heliyon*, *9*(6). https://doi.org/10.1016/j.heliyon.2023.e17378

Kabira, W. m., Gachukia, E. w., & Matiangi, F. o. (1997). The effect of women's role on health: The paradox. *International Journal of Gynecology & Obstetrics*, *58*(1), 23–34. https://doi.org/10.1016/S0020-7292(97)02886-5

Khanna, M., Isik, M., & Zilberman, D. (2002). Cost-effectiveness of alternative green payment policies for conservation technology adoption with heterogeneous land quality. *Agricultural Economics*, *27*(2), 157–174. https://doi.org/10.1111/j.1574-0862.2002.tb00113.x

Khoja, bin D. bin, & Amina, D. (2021). Participation of rural women in agricultural activities. *International Journal of Modern Agriculture and Environment*. https://doi.org/10.21608/ijmae.2023.215954.1014

Knippenberg, E., Jolliffe, D., & Hoddinott, J. (2020). Land Fragmentation and Food Insecurity in Ethiopia. *American Journal of Agricultural Economics*, *102*(5), 1557–1577. https://doi.org/10.1002/ajae.12081

Komatsu, H., Ambel, A. A., Koolwal, G., & Yonis, M. B. (2022). Gender norms, landholdership, and rural land use fee and agricultural income tax in Ethiopia. *Land Use Policy*, *121*, 106305. https://doi.org/10.1016/j.landusepol.2022.106305

Koomson, I., Asongu, S. A., & Acheampong, A. O. (2023). Financial inclusion and food insecurity: Examining linkages and potential pathways. *Journal of Consumer Affairs*, *57*(1), 418–444. https://doi.org/10.1111/joca.12505

Krishnan, P., & Patnam, M. (2014). Neighbors and Extension Agents in Ethiopia: Who Matters More for Technology Adoption? *American Journal of Agricultural Economics*, *96*(1), 308–327. https://doi.org/10.1093/ajae/aat017

Kurz, K. M., & Johnson-Welch, C. (2001). Enhancing Women's Contributions to Improving Family Food Consumption and Nutrition. *Food and Nutrition Bulletin*, *22*(4), 443–453. https://doi.org/10.1177/156482650102200418

Lavers, T. (2017). Land Registration and Gender Equality in Ethiopia: How State–Society Relations Influence the Enforcement of Institutional Change. *Journal of Agrarian Change*, *17*(1), 188–207. https://doi.org/10.1111/joac.12138

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

Legesse, T. (2016). Analysis on The Road Transportation Networks of the Amhara Region, Ethiopia. *International Journal for Traffic and Transport Engineering*, *6*(2), 212–221. https://doi.org/10.7708/ijtte.2016.6(2).08

Lewis, K. (2017). Understanding climate as a driver of food insecurity in Ethiopia. *Climatic Change*, *144*(2), 317–328. https://doi.org/10.1007/s10584-017-2036-7

Madzorera, I., Bliznashka, L., Blakstad, M. M., Bellows, A. L., Canavan, C. R., Mosha, D., Bromage, S., Noor, R. A., Webb, P., Ghosh, S., Kinabo, J. L., Masanja, H., & Fawzi, W. W. (2023). Women's input and decision-making in agriculture are associated with diet quality in rural Tanzania. *Frontiers in Public Health*, *11*, 1215462. https://doi.org/10.3389/fpubh.2023.1215462

Maré, T. F., Zahonogo, P., & Savadogo, K. (2023). Farmer education and adoption of sustainable and chemical pesticide-free agriculture: Evidence from rural Burkina Faso. *Journal of*

Agribusiness in Developing and Emerging Economies, *15*(2), 404–425. https://doi.org/10.1108/JADEE-04-2023-0077

Maxwell, D., Coates, J., & Vaitla, B. (n.d.). *How Do Different Indicators of Household Food Security Compare? Empirical Evidence from Tigray*.

Mehar, M., Mittal, S., & Prasad, N. (2016). Farmers coping strategies for climate shock: Is it differentiated by gender? *Journal of Rural Studies*, *44*, 123–131. https://doi.org/10.1016/j.jrurstud.2016.01.001

Meinzen-Dick, R., Quisumbing, A., Doss, C., & Theis, S. (2019). Women's land rights as a pathway to poverty reduction: Framework and review of available evidence. *Agricultural Systems*, *172*, 72–82. https://doi.org/10.1016/j.agsy.2017.10.009

Melesse, M. B. (2021). The effect of women's nutrition knowledge and empowerment on child nutrition outcomes in rural Ethiopia. *Agricultural Economics*, *52*(6), 883–899. https://doi.org/10.1111/agec.12668

Melesse, M. B., & Bulte, E. (2015). Does land registration and certification boost farm productivity? Evidence from Ethiopia. *Agricultural Economics*, *46*(6), 757–768. https://doi.org/10.1111/agec.12191

Mengesha, A. K., Damyanovic, D., Mansberger, R., Agegnehu, S. K., & Stoeglehner, G. (2021). Reducing gender inequalities through land titling? The case of Gozamin Woreda. *World Development*, *145*, 105532. https://doi.org/10.1016/j.worlddev.2021.105532

Mera, G. A. (2018). Drought and its impacts in Ethiopia. *Weather and Climate Extremes*, *22*, 24–35. https://doi.org/10.1016/j.wace.2018.10.002

Mesfin, B., Mersha Demise ,Alexander, Shiferaw ,Mullu, Gebreegziabher ,Freweyni, & and Girmaw, F. (2023). The Effect of Armed Conflict on Treatment Interruption, Its Outcome

and Associated Factors Among Chronic Disease Patients in North East, Amhara, Ethiopia, 2022. *Patient Related Outcome Measures*, *14*, 243–251. https://doi.org/10.2147/PROM.S388426

Mezgebo, G. K., Mekonen, D. G., & Gebrezgiabher, K. T. (2021). Do smallholder farmers ensure resource use efficiency in developing countries? Technical efficiency of sesame production in Western Tigrai, Ethiopia. *Heliyon*, *7*(6), e07315. https://doi.org/10.1016/j.heliyon.2021.e07315

Mohamed, A. A. (2017). *Food Security Situation in Ethiopia: A Review Study*. *2*(3), 86–96. https://doi.org/10.11648/j.hep.20170203.11

Motbainor, A., Worku, A., & Kumie, A. (2016). Level and determinants of food insecurity in East and West Gojjam zones of Amhara Region, Ethiopia: A community based comparative cross-sectional study. *BMC Public Health*, *16*(1), 503. https://doi.org/10.1186/s12889-016-3186-7

Muchomba, F. M. (2017a). Women's Land Tenure Security and Household Human Capital: Evidence from Ethiopia's Land Certification. *World Development*, *98*, 310–324. https://doi.org/10.1016/j.worlddev.2017.04.034

Muchomba, F. M. (2017b). Women's Land Tenure Security and Household Human Capital: Evidence from Ethiopia's Land Certification. *World Development*, *98*, 310–324. https://doi.org/10.1016/j.worlddev.2017.04.034

Mukahigiro, A. (n.d.). *Secure women's land rights in Rwanda: investigating its impact on food security*.

Mwesigye, F., Guloba, M., & Barungi, M. (2020). Women's Land Rights and Agricultural Productivity in Uganda. In M. Konte & N. Tirivayi (Eds.), *Women and Sustainable*

Human Development: Empowering Women in Africa (pp. 71–88). Springer International Publishing. https://doi.org/10.1007/978-3-030-14935-2_5

Ndagire, L., & Agm, B. (n.d.). *Food security inequality between female and male headed households: evidence from northern and south western Uganda*.

Nguyen, M., & Le, K. (2023). The impacts of women's land ownership: Evidence from Vietnam. *Review of Development Economics*, *27*(1), 158–177. https://doi.org/10.1111/rode.12941

Nikolova, E. (2021). *Women's Entrepreneurship in the Arab Region: Assessing the Impacts of Land and Property Ownership* (SSRN Scholarly Paper No. 4917110). Social Science Research Network. https://doi.org/10.2139/ssrn.4917110

Nord, M., Cafiero, C., & Viviani, S. (2016). Methods for estimating comparable prevalence rates of food insecurity experienced by adults in 147 countries and areas. *Journal of Physics: Conference Series*, *772*(1), 012060. https://doi.org/10.1088/1742-6596/772/1/012060

Nyakato, V. N., Rwabukwali, C., & Kools, S. (2020). Women's Land Rights and Maternal Healthcare in Southwestern Uganda: Exploring the Implications of Women's Decision-Making Regarding Sale and Use of Land on Access to Maternal Healthcare. *African Journal of Reproductive Health*, *24*(1), Article 1.

Oldewage-Theron, W. H., & and Kruger, R. (2008). Food Variety and Dietary Diversity as Indicators of the Dietary Adequacy and Health Status of an Elderly Population in Sharpeville, South Africa. *Journal of Nutrition For the Elderly*, *27*(1–2), 101–133. https://doi.org/10.1080/01639360802060140

Oniang'o, R. (2005). Women are still the key in agriculture and food security in Africa. *South African Journal of Clinical Nutrition*, *18*(2), 150–154. https://doi.org/10.1080/16070658.2005.11734057

Open Knowledge Repository. (n.d.). Retrieved March 16, 2025, from https://openknowledge.worldbank.org/entities/publication/88500656-01aa-558f-b241-7f403da53750

Owusu, V., Abdulai, A., & Abdul-Rahman, S. (2011). Non-farm work and food security among farm households in Northern Ghana. *Food Policy*, *36*(2), 108–118. https://doi.org/10.1016/j.foodpol.2010.09.002

Palacios-Lopez, A., Christiaensen, L., & Kilic, T. (2017). How much of the labor in African agriculture is provided by women? *Food Policy*, *67*, 52–63. https://doi.org/10.1016/j.foodpol.2016.09.017

Perelli, C., Cacchiarelli, L., Peveri, V., & Branca, G. (2024). Gender equality and sustainable development: A cross-country study on women's contribution to the adoption of the climate-smart agriculture in Sub-Saharan Africa. *Ecological Economics*, *219*, 108145. https://doi.org/10.1016/j.ecolecon.2024.108145

Pérez-Escamilla, R., Gubert, M. B., Rogers, B., & Hromi-Fiedler, A. (2017). Food security measurement and governance: Assessment of the usefulness of diverse food insecurity indicators for policy makers. *Global Food Security*, *14*, 96–104. https://doi.org/10.1016/j.gfs.2017.06.003

Qtaishat, T., El-Habbab, M. S., Bumblauskas, D. P., & Tabieh, M. (2023). The impact of drought on food security and sustainability in Jordan. *GeoJournal*, *88*(2), 1389–1400. https://doi.org/10.1007/s10708-022-10702-8

Rao, N. (2006). Land rights, gender equality and household food security: Exploring the conceptual links in the case of India. *Food Policy*, *31*(2), 180–193. https://doi.org/10.1016/j.foodpol.2005.10.006

Regassa, N., & Stoecker, B. J. (2012). Household food insecurity and hunger among households in Sidama district, southern Ethiopia. *Public Health Nutrition*, *15*(7), 1276–1283. https://doi.org/10.1017/S1368980011003119

Rehman, A., Ping, Q., & Razzaq, A. (2019). Pathways and Associations between Women's Land Ownership and Child Food and Nutrition Security in Pakistan. *International Journal of Environmental Research and Public Health*, *16*(18), Article 18. https://doi.org/10.3390/ijerph16183360

Rogus, S., Coakley, K. E., Martin, S., Gonzales-Pacheco, D., & Sroka, C. J. (2022). Food Security, Access, and Challenges in New Mexico during COVID-19. *Current Developments in Nutrition*, *6*(1), nzab139. https://doi.org/10.1093/cdn/nzab139

Rudolph, M., Kroll, F., Muchesa, E., Manderson, A., Berry, M., & Richard, N. (2018). Food Insecurity and Coping Strategies amongst Students at University of Witwatersrand. *Journal of Food Security*, *6*(1), 20–25. https://doi.org/10.12691/jfs-6-1-2

Saint Ville, A., Po, J. Y. T., Sen, A., Bui, A., & Melgar-Quiñonez, H. (2019). Food security and the Food Insecurity Experience Scale (FIES): Ensuring progress by 2030. *Food Security*, *11*(3), 483–491. https://doi.org/10.1007/s12571-019-00936-9

Schling, M., & Pazos, N. (2024). Effective land ownership, female empowerment, and food security: Evidence from Peru. *World Development*, *181*, 106680. https://doi.org/10.1016/j.worlddev.2024.106680

Schling, M., Pazos, N., Corral, L., & Inurritegui, M. (2023). *The effects of tenure security on women's empowerment and food security: Evidence from a land regularization program in Ecuador* (Working Paper No. IDB-WP-01558). IDB Working Paper Series. https://doi.org/10.18235/0005355

Shi, X., Huangfu, B., Jin, S., & Gao, X. (2024). Property rights, labor reallocation, and gender inequality in rural China. *Journal of Economic Behavior & Organization*, *220*, 325–342. https://doi.org/10.1016/j.jebo.2024.02.020

Sisha, T. A. (2020). Household level food insecurity assessment: Evidence from panel data, Ethiopia. *Scientific African*, *7*, e00262. https://doi.org/10.1016/j.sciaf.2019.e00262

Spicka, J. (2020). Socio-demographic drivers of the risk-taking propensity of micro farmers: Evidence from the Czech Republic. *Journal of Entrepreneurship in Emerging Economies*, *12*(4), 569–590. https://doi.org/10.1108/JEEE-09-2019-0143

Stanley, V., & Lisher, J. (2023). *Why Land and Property Rights Matter for Gender Equality*. Washington, DC: World Bank. https://doi.org/10.1596/39990

Stifel, D., & Minten, B. (2017). Market Access, Well-being, and Nutrition: Evidence from Ethiopia. *World Development*, *90*, 229–241. https://doi.org/10.1016/j.worlddev.2016.09.009

Strusi, V., & Balestri, S. (n.d.). *Land, Women and Development: A Systematic Review of Causal Evidence*.

Tarekegn, K., & Mogiso, M. (2020). Assessment of improved crop seed utilization status in selected districts of Southwestern Ethiopia. *Cogent Food & Agriculture*. https://www.tandfonline.com/doi/abs/10.1080/23311932.2020.1816252

Taylor, A., & Loopstra, R. (n.d.). Food insecurity in the UK. *2016*.

Teferra, B., Legesse, B., Haji, J., & Kassie, G. T. (n.d.). *Farm Level Efficiency of Crop Production in the Central Highlands of Ethiopia*.

Tekile, A. K., Woya, A. A., & Basha, G. W. (2019). Prevalence of malnutrition and associated factors among under-five children in Ethiopia: Evidence from the 2016 Ethiopia

Demographic and Health Survey. *BMC Research Notes*, *12*(1), 391. https://doi.org/10.1186/s13104-019-4444-4

Tenaye, A. (2020). Technical Efficiency of Smallholder Agriculture in Developing Countries: The Case of Ethiopia. *Economies*, *8*(2), Article 2. https://doi.org/10.3390/economies8020034

Tesfaye, B., Lengoiboni, M., Zevenbergen, J., & Simane, B. (2023). Rethinking the Impact of Land Certification on Tenure Security, Land Disputes, Land Management, and Agricultural Production: Insights from South Wello, Ethiopia. *Land*, *12*(9), Article 9. https://doi.org/10.3390/land12091713

Tigre, G., & Heshmati, A. (2023). Smallholder farmers' crop production and input risk analysis in rural Ethiopia. *Applied Economics*, *55*(6), 671–689. https://doi.org/10.1080/00036846.2022.2094327

Titus, & Adetokunbo. (2007). AN ANALYSIS OF FOOD SECURITY SITUATION AMONG NIGERIAN URBAN HOUSEHOLDS: EVIDENCE FROM LAGOS STATE, NIGERIA. *Journal of Central European Agriculture*. https://doi.org/10.5513/jcea.v8i3.477

Tran, T. Q., & Van Vu, H. (2021). The impact of land fragmentation on food security in the North Central Coast, Vietnam. *Asia & the Pacific Policy Studies*, *8*(2), 327–345. https://doi.org/10.1002/app5.330

Tsegaye, A. T., Tariku, A., Worku, A. G., Abebe, S. M., Yitayal, M., Awoke, T., Alemu, K., & Biks, G. A. (2018). Reducing amount and frequency of meal as a major coping strategy for food insecurity. *Archives of Public Health*, *76*(1), 56. https://doi.org/10.1186/s13690-018-0303-3

Usman, M. A., & Haile, M. G. (2022). Market access, household dietary diversity and food security: Evidence from Eastern Africa. *Food Policy*, *113*, 102374. https://doi.org/10.1016/j.foodpol.2022.102374

Wambogo, E. A., Ghattas, H., Leonard, K. L., & Sahyoun, N. R. (2018). Validity of the Food Insecurity Experience Scale for Use in Sub-Saharan Africa and Characteristics of Food-Insecure Individuals. *Current Developments in Nutrition*, *2*(9), nzy062. https://doi.org/10.1093/cdn/nzy062

Weldegiargis, A. W., Abebe, H. T., Abraha, H. E., Abrha, M. M., Tesfay, T. B., Belay, R. E., Araya, A. A., Gebregziabher, M. B., Godefay, H., & Mulugeta, A. (2023). Armed conflict and household food insecurity: Evidence from war-torn Tigray, Ethiopia. *Conflict and Health*, *17*(1), 22. https://doi.org/10.1186/s13031-023-00520-1

WFP. (2025). *WFP Ethiopia Country Brief January 2025*.

Wight, V., Kaushal ,Neeraj, Waldfogel ,Jane, & and Garfinkel, I. (2014). Understanding the link between poverty and food insecurity among children: Does the definition of poverty matter? *Journal of Children and Poverty*, *20*(1), 1–20. https://doi.org/10.1080/10796126.2014.891973

Williams, B., Onsman, A., & Brown, T. (2010). Exploratory Factor Analysis: A Five-Step Guide for Novices. *Australasian Journal of Paramedicine*, *8*, 1–13. https://doi.org/10.33151/ajp.8.3.93

Wooldridge, J. M. (2020). *Introductory econometrics: A modern approach* (Seventh edition). Cengage.

Wyant, A. (2021). A Cross-National Examination of Food Insecurity and Gender Equality. *Sociology of Development*, *7*(3), 285–313. https://doi.org/10.1525/sod.2019.0022

Yang, Q., Zhu, Y., Liu, L., & Wang, F. (2022). Land tenure stability and adoption intensity of sustainable agricultural practices in banana production in China. *Journal of Cleaner Production*, *338*, 130553. https://doi.org/10.1016/j.jclepro.2022.130553

Yigezu Wendimu, G. (2021). The challenges and prospects of Ethiopian agriculture. *Cogent Food & Agriculture*, *7*(1), 1923619. https://doi.org/10.1080/23311932.2021.1923619

APPENDIX

A1. Principal factor analysis of FIES items

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.891	3.361	0.998	0.999
Factor2	0.529	0.529	0.136	1.135
Factor3	-0.000	0.057	0	1.134
Factor4	-0.057	0.024	-0.015	1.119
Factor5	-0.082	0.023	-0.021	1.099
Factor6	-0.105	0.028	-0.027	1.072
Factor7	-0.133	0.014	-0.034	1.037
Factor8	-0.147	.	-0.038	1
Kaiser-Meyer-Olkin (KMO)				0.899
Bartlett test of sphericity (Chi2)				6862.908***

Note: Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1