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GENDER DISPARITIES IN CUSTOMARY LAND ALLOCATION: LESSONS FROM USAID IMPACT EVALUATION DATA

Communications, Evidence, and Learning (CEL) Project Work Assignment – DDI/EEI Land and Resource Governance

Leveraging Formal Land Rights for Credit Access Report

Communications, Evidence and Learning (CEL) Project

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ACRONYMS AND ABBREVIATIONS

AfSIS	Africa Soil Information Service
CEDAW	Convention on the Elimination of Discrimination Against Women
CEL	Communications, Evidence, and Learning Project
CFP	Community Forest Management Program
CHIRPS	Climate Hazards Group Infrared with Stations Data
DHS	Demographic and Health Surveys
ELAP	Ethiopia Land Administration Program
ELTAP	Ethiopia Strengthening Land Tenure and Administration Program
FAO	Food and Agriculture Organization
GLA	Gender and Land Allocation Research Activity
GSA	General Services Administration
LAND	Ethiopia Land Administration to Nurture Development
NDVI	Normalized Difference Vegetation Index
OLS	ordinary least squares
PCA	principal components analysis
SNNP	Southern Nations, Nationalities, and Peoples' Region
SSA	Sub-Saharan Africa
SDGs	Sustainable Development Goals
TGCC	Tenure and Global Climate Change Zambia
TRG	Training Resources Group, Inc.
USAID	United States Agency for International Development
USGS FEWS	U.S. Geological Survey's Family Early Warning System

EXECUTIVE SUMMARY

For the smallholder farmers who make up the majority of the population in sub-Saharan Africa, land is a vital economic asset. Secure rights to land are often the difference between a sustainable agricultural livelihood and extreme poverty. Despite the fact that women provide much of the agricultural labor and are active participants in the agricultural sector, land access and ownership remain severely unequal. The Food and Agriculture Organization (FAO) estimates that less than 5-20 percent of agricultural landholders in developing regions are women (FAO 2010). Allocation of land by customary systems is common in sub-Saharan Africa, with traditional rules and authorities determining what land rights are given to whom. Women are often disadvantaged under these customary land allocation systems, which is a significant source of gender bias in land access. However, specific evidence on the extent and implications of gender bias in customary land allocation is limited.

This report presents an empirical analysis of gender bias in customary land allocation using USAID impact evaluation datasets from Ethiopia and Zambia. The analysis combined survey datasets to create a larger sample, and used statistical methods to compare relevant outcomes between female- and male-headed households. The key research questions and findings are summarized as follows:

- **Research Question 1: Are female-headed households less likely to receive customary land allocations?** The data show that female-headed households in the study areas are less likely than male-headed households to have received customary allocations of land. Male-headed households have on average 0.85 parcels that have been acquired via customary allocation, compared to 0.74 parcels for female-headed households. The findings suggest that this disparity is explained by differences in other household characteristics that tend to disadvantage female-headed households, rather than explicit discrimination in the form of biased rules or decision-making by customary authorities. For example, larger households and parcels that were acquired further in the past are associated with a higher likelihood of customary allocation. Both of these characteristics are also more common in male-headed households, which accounts for much of the observed gender disparity.

- **Research Question 2: Does the land that female-headed households receive through the customary system have less productive potential compared to land of male-headed households?** The analysis also looked at the quality of agricultural land received by customary allocation, in terms of the size, soil quality, and other factors that determine the overall productivity of the land. Our results show that when female-headed households do receive customary land allocations, it has substantially less productive potential compared to male-headed households. Even after accounting for differences between female- and male-headed households in terms of these characteristics, we still find substantial gender disparity in the quality of customarily allocated land. Thus, our results suggest customary rules and decision-making tend to discriminate against women in terms the quality of the land that they provide.

  Research Question 3: Do female-headed households perceive their land tenure security as weaker compared to male headed households—both for parcels

acquired by customary allocation and otherwise? Are female-headed households more likely to experience land-related disputes compared to male-headed households? The datasets also include responses to subjective questions on perceived tenure security and land disputes that allow us to consider gender disparities along these dimensions on customarily allocated land. In terms of perceived tenure security, the central finding is that for the sample as a whole, we do not find statistically significant evidence of gender disparity; controlling for other factors, female household heads do not tend to perceive their tenure as less secure than male household heads. We do find some evidence of gender disparity with regard to incidence of disputes. Female headed households are 14.9% more likely to have experienced a dispute, though this result is statistically significant only at the 10% level. We also find that female headed households are less likely to have experienced a dispute on land that they have purchased, relative to other modes of acquisition.

Research Question 4: To what extent are female-headed households able to use land sales and/or rental markets to acquire land as an alternative to gender-biased customary systems? Given the gender bias in customary land allocation, it is also important to consider whether female-headed households can utilize sales or rental markets as an alternative means to obtain land. In our study areas, we find that female-headed households tend to be unable to access land markets in ways that mitigate the disparities encountered in customary land allocation. Since both Ethiopia and Zambia have legal restrictions on buying and selling land, land sales are very rare for both female- and male-headed households throughout the sample. Rental markets are more commonly used and thus provide a potential means for women to obtain land. However, after accounting for other differences in household characteristics, we find that female-headed households have substantially less access to rental markets compared to male-headed households. A parcel in a female-headed household is 54% less likely to have been acquired by rental compared to an otherwise identical male-headed household.

It is important to bear in mind that our datasets include study areas in Ethiopia and Zambia only, and thus the extent to which the findings can be generalized may be limited. Moreover, our analysis is limited to gender disparities faced by female-headed households only, as the data do not allow us to investigate these issues for married women. Nonetheless, our findings provide valuable empirical evidence that customary land allocation systems can be an important source of gender bias in access to land. Our results suggest three main recommendations as follows:

1. It is essential for programs seeking to formalize aspects of customary land governance systems to take cognizance of the potential for gender bias in customary land allocation systems. While the importance of harmonizing formal and informal land tenure systems is widely recognized, our findings show that customary systems can also reflect substantial gender bias. Thus, careful attention to potential gender bias is needed in legitimizing and codifying aspects of customary systems into law so that women are not placed at a disadvantage.

2. Future assessments of gender bias in land rights and allocation for the purposes of program design or policy advice should pay careful attention to land quality as a source of gender

disparity. Our findings show that female-headed households are somewhat less likely to receive customary land allocations, and when they do receive land, the productive potential is lower. Thus, it may not be sufficient for assessments of gender bias to consider only whether or not women are able to access land and the size of their landholdings. Instead, such assessments should also carefully consider the productive potential of land as another potential source of disparity.

3. Future data collection efforts should consider including surveys of all husbands and wives within the household, focusing on intra-household dynamics and decision-making processes. Such data would allow for the investigation of gender disparities facing married women in addition to female-headed households, overcoming a key limitation of our analysis.

1 INTRODUCTION

The Communications, Evidence, and Learning (CEL) Project is a five-year project funded by USAID to carry out a range of research, evaluation, communications, and learning activities for several USAID operating units, including USAID/LAND. CEL is implemented by a consortium led by Training Resources Group, Inc. (TRG), along with its partners NORC at the University of Chicago, Landesa, Urban Institute, ECODIT, and Forum One.

This report presents the final results of the CEL Gender and Land Allocation (GLA) research activity. The objective of GLA is to investigate the extent to which customary land allocation systems exhibit gender bias in order to inform policy and programming intended to provide secure land rights for women. To this end, GLA utilizes secondary household datasets that have been collected for impact evaluations of previous USAID land tenure projects in sub-Saharan Africa (SSA). GLA also incorporates publically available spatial datasets to improve the precision of the analysis, as well as to investigate spatial characteristics of the household data.

On the basis of the objectives of the research and the contents of the available USAID impact evaluation datasets, GLA is structured in terms of four specific research questions:

RQ1: Are female-headed households less likely to receive customary land allocations? As a first question, it is important to consider the extent to which female-headed households are able to access land at all through the customary system.

RQ2: Does the land that female-headed households receive through the customary system have less productive potential compared to land of male-headed households? The related analyses will focus on comparing aspects of such allocated land, including size, soil condition, levelness, agricultural yields and revenues, and other indicators of productive potential.

RQ3: Do female-headed households perceive their land tenure security as weaker compared to male headed households—both for parcels acquired by customary allocation and otherwise? Are female-headed households more likely to experience land-related

disputes compared to male-headed households?[1] The datasets also include responses to questions on perceived tenure security that will allow us to consider gender disparities in the security of customary land allocations, as well as more broadly.

RQ4: To what extent are female-headed households able to use sales and rental markets to obtain land? Finally, we will consider whether women who face disadvantages in the customary system are able to find alternative means of accessing land by using markets to purchase or rent land. Controlling for other factors that might affect market participation, are female-headed households more likely than male-headed households to use land markets? Moreover, are female-headed households that fare relatively poorly under the customary system more likely to utilize land markets than those that fare better?

To preview the findings, our results show substantial gender disparity in customary land allocation in our study areas in Ethiopia and Zambia. We find that female-headed households are substantially disadvantaged with respect to both the likelihood of receiving a customary allocation, and the productive potential of land when they do receive customary land allocations. Female-headed households are also more likely to encounter disputes on customarily allocated land. Moreover, we find that neither sales nor rental markets are a viable alternative for female-headed households to mitigate these disparities. We do not find gender disparities in terms of perceived tenure security, although this may be due to data limitations.

The remainder of this report is organized as follows: We begin with a review of the literature on several topics that are relevant to GLA. In Section III, we describe the data, report on key descriptive statistics, summarize the IE datasets selected for analysis, and explain the theoretical framework and empirical approach for each of the four research questions. Section 4 summarizes the empirical methods (we include a more thorough and technical discussion of the methods in an appendix) and presents the results of the statistical estimations. Finally, Section 5 identifies the key findings from the analysis, discusses policy implications, and presents recommendations for research, programming, and policy.

2 BACKGROUND AND LITERATURE REVIEW

For the smallholder farmers who make up the majority of the population in SSA, land is a fundamentally important economic asset. Secure rights to land are often the difference between a sustainable agricultural livelihood and extreme poverty. Despite the fact that women provide much of the agricultural labor and are active participants in the agricultural sector, land access and ownership remain severely unequal: The Food and Agriculture Organization (FAO) estimates that less than 5-20 percent of agricultural landholders in developing regions are women (FAO 2010). Women are often disadvantaged under customary systems of allocating land rights, and these customary systems retain significant authority over land in many contexts. This problem is widely recognized, and the gender biases of customary systems of land allocation have been documented in many specific contexts. However, to

[1] This research question has been slightly revised from the original version due to limitations of the data.

date there have been no rigorous empirical analyses to characterize the extent and nature of gender biases in customary land allocation systems. This research activity provides a starting point for filling that gap using secondary datasets collected for USAID impact evaluations in Ethiopia and Zambia.

2.1 GENDER DISPARITIES IN RIGHTS TO LAND

While data on gender and land that allow for national estimates or cross-country comparisons are limited,[2] the available sources[3] point to gender disparities in many SSA countries, including the two GLA study countries. Data from the Demographic and Health Surveys (DHS) across a set of ten SSA countries indicate that 43 percent of men in these countries have individual ownership[4] rights to land, compared to only 12 percent of women. Similarly, in a set of World Bank surveys from six SSA countries, 56 percent of land is owned by men with 17 percent owned by women. The data show that women are also disadvantaged in terms of decision-making authority over land: in Ethiopia and Zambia, women are the primary decision-makers for only 19 percent of landowning households, while the figure is 6 percent in Guinea.

Further evidence of gender disparities is provided by Doss et. al. (2013) in a review of 16 studies that use household survey data collected in SSA. They noted that across different countries and indicators, women are disadvantaged in both reported and documented ownership, land management and decision-making. The data they consider also show that where women own or manage land, on average the size of their landholdings is smaller than that owned or managed by men. Moreover, a study by Stickler and Huntington (2015), using some of the same impact evaluation datasets that we use in our study, also identified gender inequities along several dimensions. In all four countries included in the study (Ethiopia, Guinea, Liberia, and Zambia), the analysis found that female-headed households are perceived to be disadvantaged in land-related rules, decisions, and outcomes. For example, women have less access to farmland in Ethiopia, are less willing to leave land fallow and risk expropriation in Liberia, and are less likely than men to have permission to plant tree crops in Guinea.

An important source of these disparities in land ownership and control is gender bias within many customary systems of authority. These customary systems continue to play an important role in land allocation and governance in much of SSA—in some cases because governments lack the capacity to enforce land laws, while in other countries aspects of customary land tenure have been incorporated into the formal legal system. Gender bias is common in customary governance systems, particularly patrilineal systems[5], which are prevalent in all four of the GLA study countries. These systems concentrate authority over land in the hands of males in order to preserve the land claims of the patrilineal clan by passing land from fathers to sons (Collins 2018). Upon marriage, women relocate to their husband's clan from their natal home, and typically forfeit any rights over land in their area of

[2] The Prindex initiative is expected to be a valuable source of such data, though to date Prindex has only limited coverage of SSA.

[3] Unless otherwise noted, data cited in this section has been compiled by the FAO Gender and Land Rights Database.

[4] Note that "ownership" is a somewhat ambiguous concept and may refer to long-term use rights in the context of state ownership of land.

[5] Note that gender bias can also be prevalent in matrilineal customary governance systems.

origin. Because women's land rights are dependent on the relationship to a male, their rights are vulnerable to a change in the status of that relationship (e.g., separation/divorce, death of spouse).

Dodd et. al. (2018) provide an example of how one such system in Liberia excluded women. Cultural norms dictate that land is "men's business," and that women are "difficult" and thus should not be included in land governance. In practice, those who held customary governance positions with authority related to land were overwhelmingly men. The study also noted that women were reticent to participate in community consultations on land issues and were often excluded from both formal and informal community-level meetings on land issues. Similarly, Namubiru-Mwaura et al. (2012) observed that when rural Liberian women do hold leadership positions, they are restricted to certain domains, such as women's issues.

2.2 GENDER BIAS IN CUSTOMARY LAND ALLOCATION

This research focuses on gender bias in land allocation. Specifically, to what extent are women able to access land in customary systems, and to what extent do they tend to receive land of less productive potential compared to men? Quantitative evidence on these questions is limited, though some previous studies using the same USAID impact evaluation data provide suggestive findings. For example, a study using the Ethiopia Land Administration to Nurture Development (LAND) Project data highlights that 24 percent fewer female-headed households owned land compared to male-headed households (USAID 2015). In terms of the *quality* of land allocated to women, another study using the Guinea data noted that, on average, the soil fertility of plots farmed by female-headed households was poorer than plots farmed by male-headed households, and that the type of land they received was likely to be what participants rated as the "least valuable" (USAID 2014).

Case studies of gender and customary land allocation tend to find that women receive less productive land and face greater tenure insecurity compared to men. Several studies find that women need strong support from male relatives in order to request land from customary authorities, including in Liberia (Dodd et al., 2018, Jackson 2003) and North Cameroon (van den Berg 1997). Van den Berg's study of North Cameroon also finds that access to land via a local authority signals a failure of marriage as the primary route, and rights obtained in this manner are less secure than those obtained through marriage. Similarly, Rao (2002) describes an Indian case in which village authorities will sometimes grant land to women, but only on the basis of appropriate and effective gender performance, or abandonment/widowhood.

In addition, a study of customary communities in Ghana by Lambrecht (2016) found that even when women are allocated land, this may not be a sign of gender equity. For example, allocation of land to a woman may reflect her husband's inability to farm productively, or greater off-farm opportunities for her husband, rather than gender equity considerations on the part of customary authorities.

2.3 ALTERNATIVE MODES OF LAND ACQUISITION FOR WOMEN

Given these disparities in customary systems, it is also important to consider the extent to which women are able to effectively use alternative means to access land. One possible alternative is purchasing or renting it through land markets. Another is exercising women's formal legal rights to land

in cases where the law provides protections for women against discriminatory customary practices. However, the literature shows that women often face considerable obstacles to utilizing both approaches. Women's ability to rent or buy land is often constrained by a lack of resources, including access to credit or collateral, and social norms may prohibit individual women from engaging in land transactions (Durand 2014).

In addition, legal rights for women are often insufficient to enable them to access land. Many countries have adopted statutory protections for women's land rights, such as inheritance rights for widows and daughters, or the right to joint ownership for wives. However, there are often barriers to exercising these rights in practice. For example, Bayisenge (2017) highlights the lack of awareness among Rwandan women about their ability to be included on their household's land certificate or an appreciation of the importance to do so, while Po & Hickey (2017) discuss Kenyan women's reluctance to insist on the inclusion of their names on land documents out of a desire to prevent conflicts between them and their sons over inheritance. Collins (2018) points to the approach often taken by policymakers seeking harmonization between statutory and customary systems by allowing customary systems to continue to exist and be applied in areas where they have traditionally been practiced. As a result, when reforms aimed at inclusivity are mandated by the state, even under a statute intended to override a customary practice, the responsibility for implementation often lies with the same male-dominated village governance bodies that continue to follow customs that restrict women's land rights.

2.4 IMPLICATIONS

Finally, it is important to note that limiting women's access to land imposes substantial social costs. The Sustainable Development Goals (SDGs), Convention on the Elimination of Discrimination Against Women (CEDAW), and other United Nations agreements recognize the importance of women's land rights as human rights. Providing women smallholder farmers with rights to the land they farm gives them opportunities to enjoy a host of other basic human rights—the rights to equality, livelihood, and identity—by elevating women's status within communities and building their access to markets and public spaces (Landesa 2012). Property rights improve a woman's status and bargaining position in her household as well, because a woman with property will achieve a better living standard in case of marriage breakdown. Moreover, there is evidence that the income women generate from land tends to be spent on purchases that benefit their household's well-being, particularly education and food for their children. This contributes to longer-term human capital formation and economic growth through improved health and nutrition outcomes (Katz and Chamorro 2002, Quisumbing and Maluccio 2002).

2.5 MEASURING LAND QUALITY

As our analysis investigates differences in the quality of land allocated to women as compared to men, the literature on measurement of land quality is also important to consider. The primary challenge in measuring land quality is the expense of collecting these types of data. Costs include collection of soil samples and direct measurement of other land characteristics at the parcel level, but also lab analysis of

the samples[6]. Where spatial data for directly observed soil characteristics already exists, the resolution is not high enough to identify soil quality at the plot or even household level.

Several papers have used variables similar to the dummies in the latter set of variables in Bellemare (2012). Ordinal measures for slope, soil quality, and/or severity of erosion (Fort 2008, Petracco and Pender 2009, Deininger et al. 2011, Goldstein and Udry 2008) collected by either respondent rankings or enumerator observation are used as controls in models for investment, credit access, and tenure security. Nominal measures for irrigation type and soil type (Deininger et al. 2011, Goldstein and Udry 2008) are also common. Goldstein and Udry (2008) also include soil pH level in their model for investment. These variables are suitable as controls in these papers' main models.

However, they are not suitable as an outcome variable in our land quality model. While erosion and irrigation are universally important factors in agriculture, slope and soil type are poor indicators for land quality where crop mix is heterogeneous, which is the case for our sample. Even the optimal pH level varies by crop. Soil quality rankings are problematic in our model characterizing household decisions and interactions with others when the rankings are self-reported by households, as they are in our data.

For these reasons, our approach is to derive an ordinal measure of overall land quality. Land quality augments land quantity as a factor of farm production. By accounting for all observed farm inputs in households' crop production, including land area, we infer land quality from what remains. Restuccia and Santaeulalia-Llopis (2017) draw from a similar theory when accounting for land quality in farm production in order to infer the extent of factor misallocation by farmers. We work in the opposite direction, using the education level of the head of household as the best available proxy for farming knowledge. We use available data for farm inputs and outputs, controlling for spatial variation in precipitation and other relevant factors, in a Cobb-Douglas production function similar to Restuccia and Santaeulalia-Llopis.

Our approach also helps to mitigate the potential for selection bias due to gender disparities along other dimensions that would affect productivity. For example, women's relatively limited credit access restricts their use of agricultural inputs, and in female-headed households in particular, there are fewer adults available on average to supply labor to the household farm (Quisumbing 1996; Croppenstedt, Goldstein, & Rosas 2013; Andrews, Golan, & Lay 2015; Karamba & Winters 2015). Where farming knowledge and related skills are lacking, factor misallocation could be affecting farm output. Limited bargaining power can also affect women's ability to mobilize factors of production and thus the productivity of their land (Udry et al. 1995). Gender output gaps can therefore reflect a number of factors beyond land quality, and our production function approach controls for the impacts of such factors that are observed in our dataset.

[6] Bellemare (2012) mitigates the expense of soil testing to an extent by predicting values for pH and the concentration of carbon, nitrogen, and potassium for one subsample of parcels using the lab results from another subsample, combined with data for parcels' clay, silt, and sand content; dummies for soil type (black, red, brown, or white); slope (lowland, hilltop, or hillside), and irrigation source (rain, dam, or spring).

3 DATA

3.1 DATA SOURCES

To investigate gender bias in land allocation, we use four baseline datasets of rural households originally collected for USAID land tenure impact evaluations, two from Ethiopia and two from Zambia. Baseline data collection for Ethiopia Strengthening Land Tenure and Administration Program (ELTAP) and Ethiopia Land Administration Program (ELAP) both sampled households in Tigray, Amhara, Oromia, and Southern Nations, Nationalities, and Peoples' Region (SNNP). ELTAP data collection took place in the 4th quarter of 2007 and ELAP data collection took place in April and May of 2012 (USAID 2016a). Baseline data collection for Community Forest Management Program (CFP) in Zambia sampled households in Nyimba, Mambwe, and Lundazi districts from March to May of 2015 (USAID 2016b). Baseline data collection for Tenure and Global Climate Change (TGCC) Zambia sampled households in Chipata district of Eastern Province between mid-June 2014 and mid-August 2014 (USAID 2016c). We use the baseline datasets only, since the interventions that the impact evaluations were studying could plausibly affect our outcomes of interest.

The data presents some limitations for analyzing gender disparities. First, the relevant data were collected at the household level rather than individual level. As a result, our analysis must rely on comparing male-headed households and female-headed households. This is an important limitation because it does not allow for examinations of gender disparities faced by women who are not heads of household. Broadly, female heads of household tend to have relatively more decision-making power within their household due to the absence of a male spouse, but are relatively less empowered in the community and have access to fewer resources. Thus, they face a different set of gender-related issues as compared to other women (Doss et al. 2013). It is therefore important to bear in mind that our analysis is limited to only a subset of the population that faces a particular set of issues, and cannot provide a comprehensive look at gender disparities in customary land allocation.

Second, the data are a cross section. Plots are associated with household and land characteristics that are observed at the time of data collection, regardless of when the plot was acquired. This implies the strong assumption that the household and land characteristics included in the analysis have not changed in significant ways between the time when the household acquired their land and the time of the survey. This can be especially problematic in cases where the gender of the household head has changed since land was acquired; some female-headed households might have been male-headed when the land was acquired (and vice versa). The data do not allow us to identify these cases. The year of acquisition is included in statistical models in order to control for time trends in the land available for acquisition and any other time-variant unobservable factors.

In addition to the household data sets, our analysis also utilizes a number of publically available spatial datasets. We use these datasets to construct variables measuring precipitation, vegetative productivity, soil quality, and distance to roads in order improve the accuracy of our measure of land quality. Rainfall data was sourced from Climate Hazards Group Infrared with Stations Data (CHIRPS). We use rainfall means for the growing season, defined as March through June in Ethiopia and October through May in Zambia. Normalized Difference Vegetation Index (NDVI) was sourced from U.S. Geological Survey's

Famine Early Warning System (USGS FEWS). Soil organic carbon content was sourced from the Africa Soil Information Service (AfSIS). Distance from households to roads was calculated using road data sourced from Open Street Maps.

3.2 DESCRIPTIVE CHARACTERISTICS OF THE DATA

Before proceeding with the analysis, we present summary statistics from the data to examine a number of issues relevant to our research questions. These include a comparison of socioeconomic and demographic characteristics between female- and male-headed households in the study, a closer look at the marital and age profile of female-headed households, modes of land acquisition and overall land quality, and outcomes of request for customary allocation.

3.2.1 Gender Composition

When the four baseline datasets are combined, 2,803 of households are female-headed (23.74% of the sample). Individually, the baseline datasets would have limited power to detect statistical relationships between gender of household head and the outcomes of interest, but the larger sample from combining the datasets allows for more robust statistical analyses. Female-headed households have about 0.6 fewer adult household members on average (Figure 1), a statistically significant difference. Female-headed households also have a significantly lower wealth index score (Figure 2). These gender differences are characteristic of the region. Female- and male-headed households differ on several other characteristics, including the education level of the household head, household size, and the investments they make in their land. These differences are displayed in Table 1. As shown in Table 2, male-headed households are more likely than female-headed households to cultivate coffee as their primary crop, while female-headed households are more likely to cultivate some less valuable crops.

FIGURE 1.

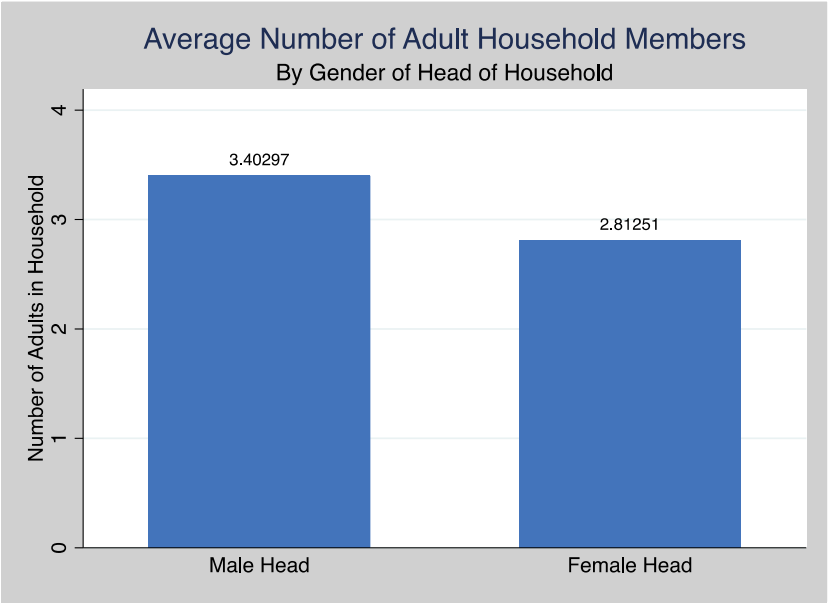


FIGURE 2.

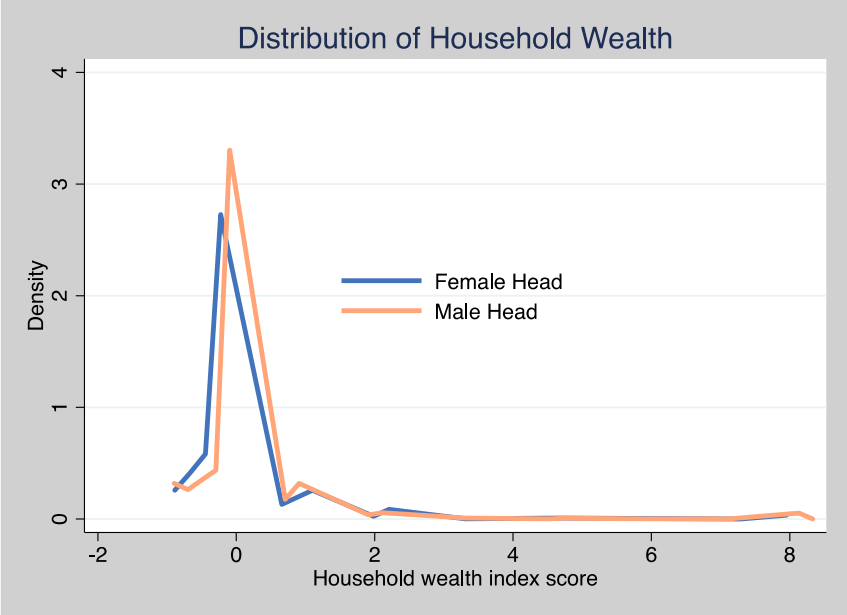


TABLE 1.

			Female-Headed Households	Male-Headed Households
Average age of head ***			49.2	42.9
Highest level of education (% of households)		No formal education ***	61.18 %	59.55 %
		Primary	32.60 %	28.16 %
		Secondary ***	5.98 %	11.81 %
		Post-secondary *	0.23 %	0.48 %
Average household Size ***			5.5	6.3
Average number of Children *			4.3	4.2
Investments Ethiopia	Average length constructed by household	Soil bunds ***	35.89 m	46.64 m
		Trashline ***	3.11 m	5.32 m
		Hedges *	6.43 m	7.28 m
		Soil ditch ***	1.04 m	2.27 m
		Canals ***	5.77 m	15.88 m
	Average number constructed	Water retention structures ***	0.14	0.17
		Shallow wells	0.11	0.11
Investments Zambia	Whether constructed by household (% of plots)	Ridges, mounds, or terraces	0.86 %	0.87 %
		Fencing **	0.01 %	0.01 %
		Irrigation	0.00 %	0.00 %
		Basins ***	0.16 %	0.17 %

Significantly different at level: p>0.1 *, p>0.05 **, p>0.01***

TABLE 2. PRIMARY CROP ON ALL HOUSEHOLD PLOTS IN ETHIOPIA				
	Female-Headed Households		**Male-Headed Households**	
	Top Ten	**% households**	**Top Ten**	**% households**
1.	coffee	17.83	coffee	21.66
2.	enset	11.46	enset	12.88
3.	pepper	11.10	teff	11.07
4.	maize	10.01	bean	10.05
5.	wheat	8.28	pepper	7.00
6.	bean	7.64	maize	7.23
7.	teff	7.64	chat	4.29
8.	barley	6.37	barley	2.94
9.	chat	2.55	wheat	2.82
10.	sorghum	1.91	haricot beans	2.71

The distribution of female- and male-headed households is not uniform across study areas. Figures 3a and 3b show the concentration of female-headed households in Ethiopian study woredas and Zambian study chiefdoms. For this reason, spatial control variables are necessary to produce accurate land quality estimates for RQ2.

FIGURE 3a.

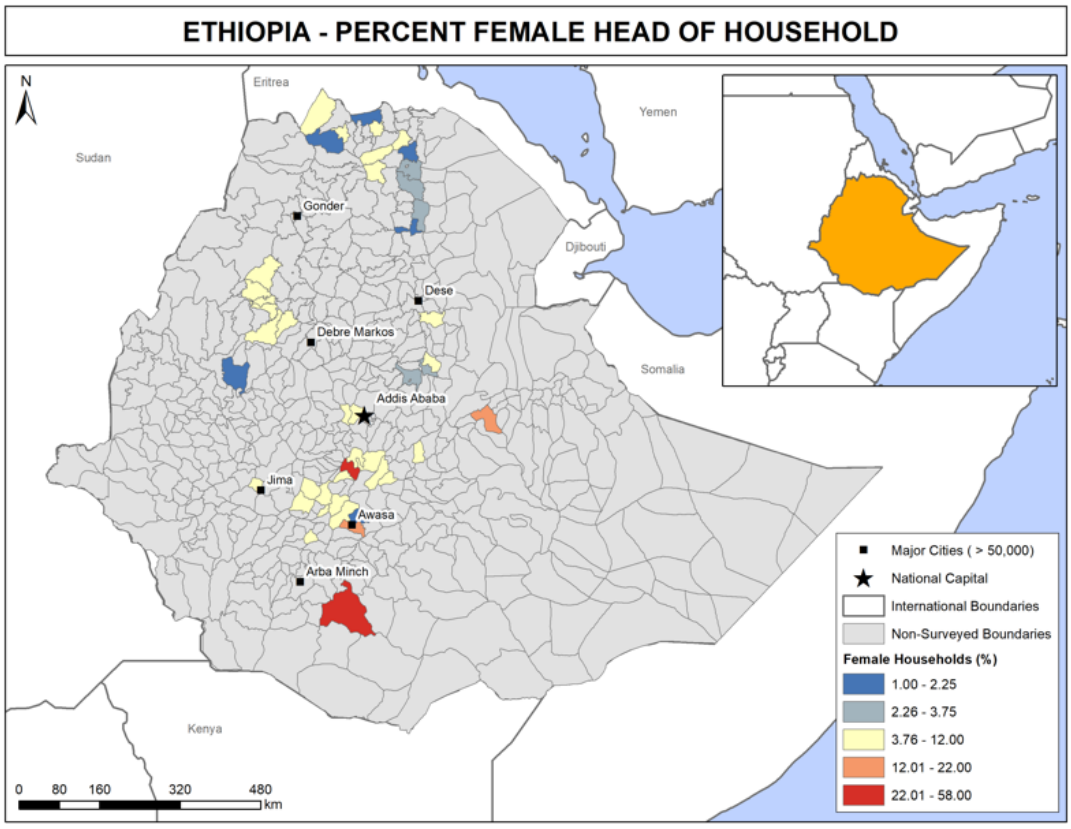
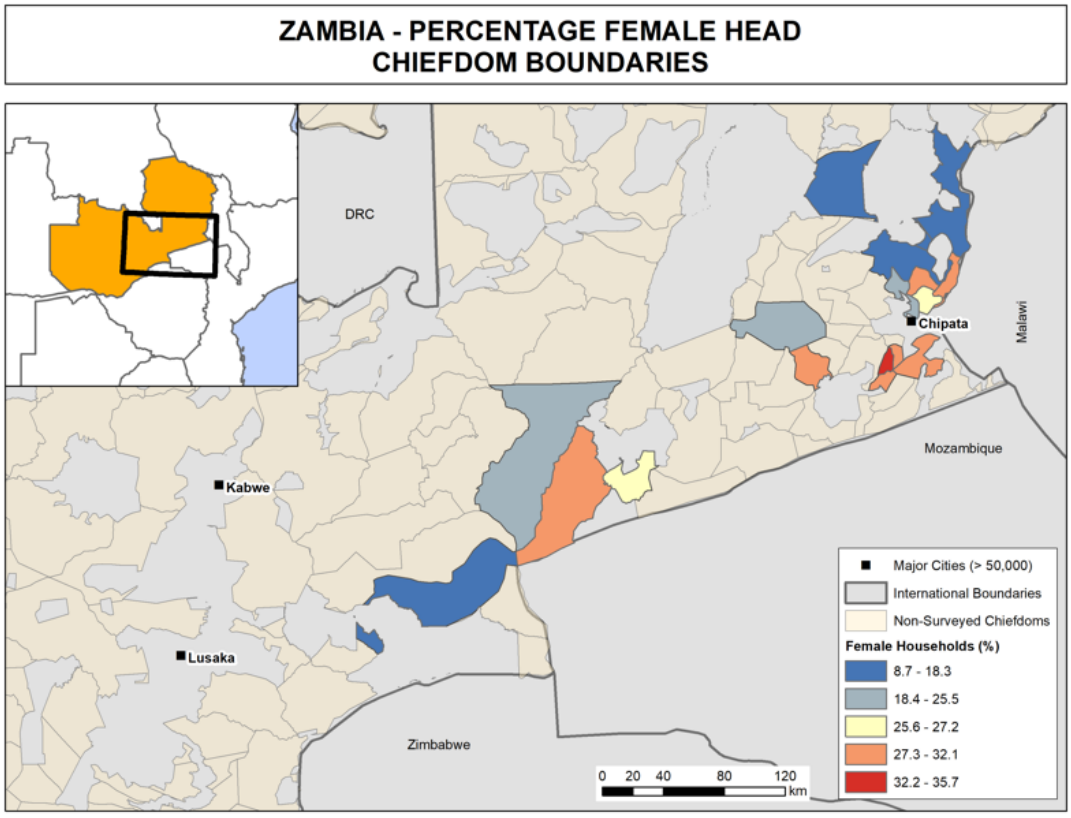


FIGURE 3b.



3.1.1 How do Households Become Female-headed?

In a large majority of cases, female heads of household are separated, divorced, or widowed (Table 3). Since separation, divorce, and widowhood are mainly involuntary, these female household heads are not expected to differ from the population in ways that relate to land acquisition, land quality, and tenure security (when controlling for household wealth and the number of adult household members). A very small percentage of the female household heads have never been married, which we interpret as voluntary. In these few cases, individual characteristics that may increase the chances a woman would remain unmarried may be related to their decisions and outcomes in land acquisition, land quality, and tenure security. The female heads of household who are married are more likely to belong to the matrilineal Chewa tribe in Zambia.

TABLE 3. MARITAL STATUS OF FEMALE HEADS OF HOUSEHOLD (%)

				Zambia		Ethiopia	
Marital Status of Head				**CFP**	**TGCC**	**ELAP**	**ELTAP**
Married			Monogamously Married	0	25.19	1.19	4.92
			Polygamously Married	0	3.82		
			Cohabitating	0.48	0.76	-	-
Not Married	Not Married "By Choice"	3.18	Engaged	0	-	-	-
			Never Married	3.55	3.82	0.60	3.23
	Not Married Not "By Choice"	96.82	Separated	7.94	0.76	-	-
			Divorced	35.02	13.74	32.74	20.74
			Widowed	53.01	51.91	65.48	70.81
			Other*	-	-	-	0.31
		100%		100%	100%	100%	100%

*"Other" may include cohabitating, separated, and/or engaged.

3.1.2 Sources and Quality of Household Land

Inheritance is a major source of land for households in both countries, though more so in Zambia. Customary allocation is the other major source of farmland in both countries. Once land is acquired through customary allocation, purchase, gifts, or clearing new land, it is commonly passed down through inheritance to subsequent generations. Therefore, the portion of farmland indicated as inherited in Figure 4a represents past use of other modes. In both Zambia and Ethiopia, purchase and rental are rarely used in comparison. Note that Ethiopia data does not observe rented and borrowed land at the parcel level. Figure 4b shows the percent of land area possessed by Ethiopian households that is borrowed or rented in. The remainder was acquired through modes displayed in Figure 4a.

FIGURE 4a.

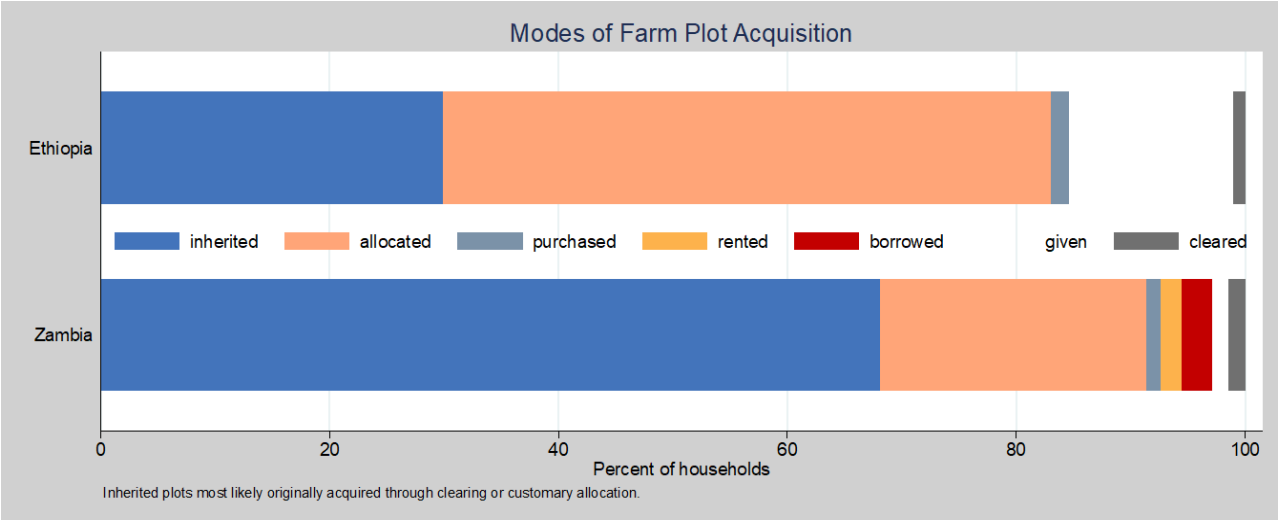
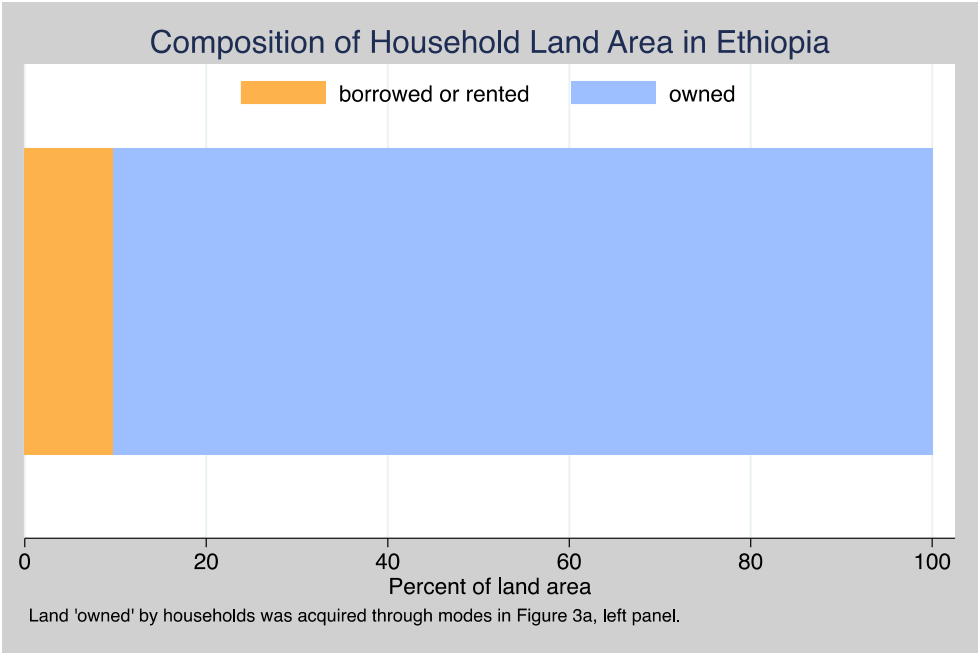
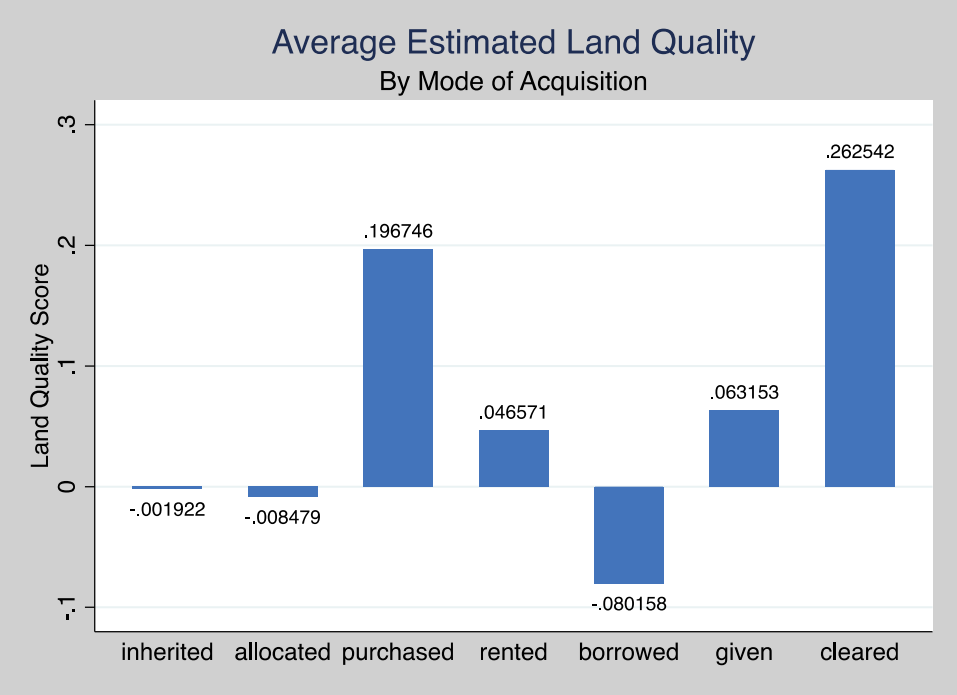


FIGURE 4b.



Female- and male-headed households also differ in terms of land quality. Variation in the land quality index is apparent between modes of acquisition and between female- and male-headed households (Figure 5). Plots acquired through purchase or by clearing undeveloped land have the highest average land quality score. This may reflect the large upfront costs involved in their acquisition, in that only the best land is worth the expense or effort. Cleared land in particular may also be more nutrient dense if soil degradation on cultivated land is a trend in the region. Borrowed parcels are the lowest in quality. This land is likely the least valuable land belonging to the lender.

FIGURE 5.



Female-headed households have a significantly lower land quality score on average, regardless of mode of acquisition (Figure 6a). A significant gender disparity is also observed for quality of land acquired through customary land allocations in particular (Figure 6b), although it is not greater than in other modes of acquisition. These results are consistent with existing quantitative and qualitative observations of gender disparities in land quality overall and in customary allocation.

FIGURE 6a.

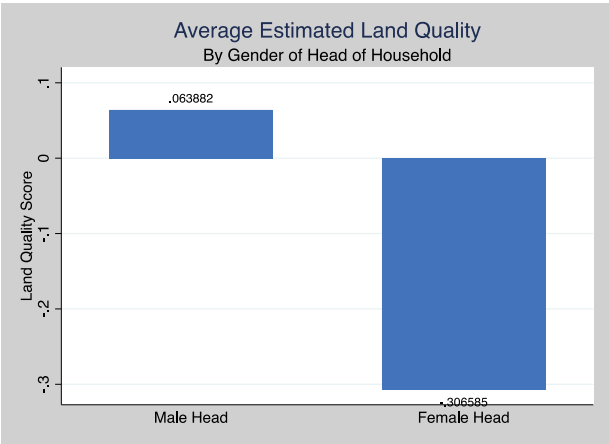
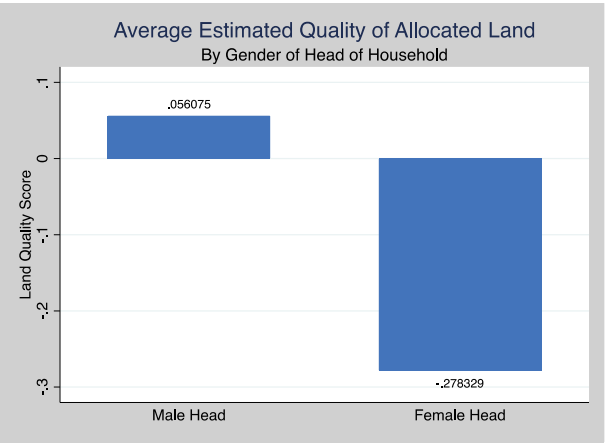


FIGURE 6b.



3.1.3 Supplementing Household Land

About 20% of Ethiopian households and about 9% of Zambian households have only one farm plot in their possession, including those rented or borrowed from other households, but not including those rented or lent out. On average, Ethiopian households with more than one plot acquired at least 66% of their land through a single mode of acquisition. This primary source of land is most likely to be either

customary allocation or inheritance. However, many households have used one or two other modes to supplement their land. Among households that acquired additional land through a mode other than their primary source, gifts of land (28%) and customary allocation (28%) are relatively common, after inheritance (38%), as a secondary source. Households that rely on gifts for acquiring their first plots are more likely than others to also rent or borrow[7] land. However, renting supplemental land for monetary payment is more likely among households that acquired their first plots through customary allocation or purchase. Most renters (92%) only rent one or two additional plots for monetary payment.

Note that the start of a new household in the village may be endogenous to land access, especially through inheritance or customary allocation. If the acquisition of land through inheritance *causes* heirs to head their own household, this increases the probability of observing the use of inheritance within this sample. If the acquisition of land through customary allocation *causes* a newlywed couple or migrant household to start a new household in the village, this increases the probability of observing the use of customary allocation within this sample. For the same reason, newlywed couples that do not successfully acquire land would be left to choose either remaining in their parents' household, taking off-farm work, or migrating away from the village. Migrant households that do not successfully acquire land may take off-farm work or move on to another village. These households are not observed in the data, which has the potential to introduce selection bias in some of the results.

3.1.4 Outcomes of Requests for Customary Allocation

The Zambian data give information about requests for land allocation made to customary authorities and the outcomes of those requests. Only 5.3% of CFP households and 6.04% of TGCC households requested or otherwise "tried to obtain" additional land within the previous three or five years, respectively. Only four TGCC female-headed households tried to obtain land in the past five years. Household heads belonging to a minority tribe in CFP districts were significantly more likely to have requested land than members of a majority tribe, while no such pattern is found for TGCC households. Heads of CFP households requesting land were 36 years old on average, an age at which households may be growing in size and at which the head and spouse tend to be more productive farm workers. Heads of households that did not make a recent request for land were significantly older on average (41 years). No such age differences are found for TGCC households.

Among requesting households, most made their request to a local authority – headman or headwoman (66.67% of CFP and 54.81% of TGCC), Induna (2.94% of CFP and 2.40% of TGCC), or chief (7.84% of CFP and 9.62% of TGCC). Most requesting CFP households (74%) and all requesting TGCC households were granted land. About 87% of requesting CFP households obtained exactly the area of land they asked for, including all requesting female-headed households. About 39% of requesting TGCC households obtained exactly the area they asked for. Households obtaining some other amount of land were almost equally likely to get more (41% of CFP and 58% of TGCC) or less (59% of CFP and 42% of TGCC) than they asked for. Membership in a majority or minority tribe did not influence the probability of the outcome for either CFP or TGCC households. The discrepancies in land area could be due to the discretion of the customary authority or the size of plots available at the time of the request. Note that

[7] Throughout this report, borrowing land refers to using another's land without payment in cash or in kind.

the data does not provide information about households that chose not to make a request for land because they expected to be denied.

4 METHODOLOGY AND RESULTS

In this section, we provide a summary of the empirical methods and present the results of the estimations for each of the four research questions. Since each research question entails different empirical methods, we organize the section by research question, rather than the more standard approach of including two separate sections for methodology and results. In addition, our presentation of the empirical methodology is limited to a brief summary in each case in order to keep the section accessible to non-technical audiences. We present a more thorough and technical discussion of the empirical methods used in an appendix.

RQ1: Are female-headed households less likely to receive customary land allocations? To address this question, we present a comparison of means, followed by estimation results from a probit model in order to determine to what extent use of customary allocation is influenced by gender of the head, rather than other household characteristics. We estimate this model for the full datasets, as well as for the Ethiopia and Zambia samples separately in order to consider the potential for country-specific heterogeneity. The probit model is as follows:

$$\Pr(allocated = 1|X)_{i,p} = F\left(fem_i, * age_i, age_i, wealth_i, adults_i, i.edlevel_i, year_{i,p}, \boldsymbol{G}_i, \varepsilon_{i,p}\right) \quad (1)$$

$$where\ \boldsymbol{G}_i\ contains\ districts\ or\ chiefdoms, depending\ on\ the\ countries\ in\ the\ estimation\ sample.$$

We also consider the potential for selection bias resulting from the fact that many households will opt not to seek customary land allocations for a variety of reasons. Some households that seek to acquire land may believe they have better prospects utilizing other modes of acquisition. Alternatively, households may not request customary allocations because they have low hopes that a customary authority would honor their request. If the reasons behind these decisions are related to individual and household characteristics, then certain types of households eliminate themselves from the list of households who might receive an allocation of land.

To account for this potential source of bias, we also estimated a selection model using the Zambia data as described in the Appendix. The selection model shows no evidence that selection bias is influencing the results of model (1). Thus, our findings are based on the estimations results from model (1).

A simple comparison of means shows that female-headed households are less likely to acquire land through customary allocation compared to male-headed households. On average, female-headed households have fewer parcels acquired by customary allocation (Figure 7a), and a smaller proportion of their parcels have been acquired by customary allocation as compared to other modes of acquisition (Figure 7b), such as inheritance or market purchases.

FIGURE 7a.

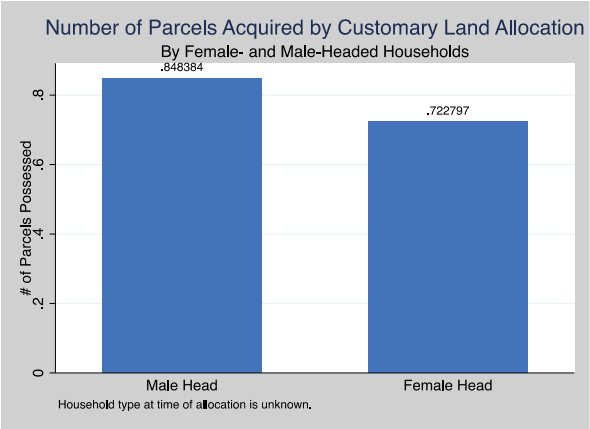
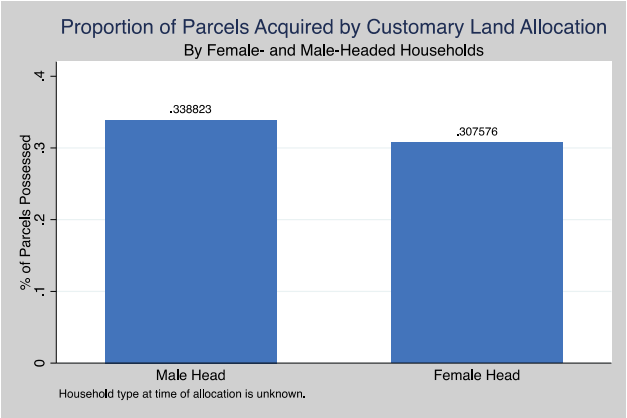


FIGURE 7b.



Results for the estimation of these probit models are indicated with the sign and significance level of the coefficient in Table 4. There is no significant relationship between the gender of the current head of household and the probability that a parcel was acquired through customary allocation. The implication is that the gender disparity found in the comparison of means reflects disparities in other household characteristics, rather than explicit discrimination. In models for Ethiopia and the full sample, we do find that while the probability increases with age of head overall, it does so to a lesser degree for female heads. Without further analysis, it is not clear whether the negative age effect for current female heads is enough to fully cancel out the age effects for current male heads, all else equal. We find that current household wealth is not a significant factor in the probability that land was acquired through customary allocation. The number of adults currently in the household significantly decreases the probability that land was allocated in Zambia, but significantly increases the probability in Ethiopia and overall. An explanation for these country differences may lie in the specific rules of their customary land systems.

TABLE 4. PROBABILITY OF ACQUIRING LAND THROUGH CUSTOMARY ALLOCATION (1)			
	(1) Zambia Only N=7,799	**(2) Ethiopia Only N=10,741**	**(3) Full Sample N=18,540**
fem	-	-	-
age*fem	+	- ***	- ***
age	+	+ ***	+ ***
i.edlevel			
No education			
Primary	+	- **	-
Secondary	-	- **	-
Post-secondary	+ **	+	+
wealth	+	+	+
adults	- **	+ ***	+ ***
year acquired	+ ***	- ***	+ ***
chiefdom	Y	N	N
Mguya	- **		
Mkanda	- *		
fem*Mkanda	+ **		
i.district	Y	Y	Y
p>0.1 *, p>0.05 **, p>0.01***			

In two Zambian chiefdoms, the probability that household land is acquired through customary allocation is lower. In Mguya chiefdom, both female- and male-headed households are less likely to have acquired their land through customary allocation than in other chiefdoms. In Mkanda chiefdom, customary allocation is also less often used than in other chiefdoms, but within the chiefdom customary allocations are more likely among currently female-headed households than male-headed households. This chiefdom is led by a female chief, a common occurrence in a region characterized by matrilineal society.

RQ2: Does the land that female-headed households receive through the customary system have less productive potential compared to land of male-headed households?

Addressing RQ2 entails two important empirical challenges. The first is in measuring land quality. As described in Section 2, the productive potential of land is determined by a variety of factors (e.g. size, soil type), and the relationship between these factors and productive potential varies across different agricultural crops and systems. However, comparing the productive potential of land belonging to female- and male- headed households requires a consistent measure that can be applied across all of the different farming systems in the sample. The second empirical challenge is the potential for selection bias in the mode of acquisition that different households use to acquire land, similar to the challenge described for RQ1.

i. Measuring Land Quality

Our approach to measuring land quality is to use *residuals* from the *production function*. A production function is an economic model that relates the quantity of output to the quantities of the various inputs that go into producing it. The residual is the portion of output that cannot be accounted for by the inputs we observe, and therefore is due to other factors. We use a household-level agricultural production function to determine how variation in the quantity of different agricultural inputs, along with other characteristics of the household, ultimately affects the value of the agricultural output households produce. Maps illustrating the spatial characteristics of land quality are presented in Figures 8a. and 8b.

The concept of our land quality measure is to use the model to predict how much output a typical household *should* produce, given the information we have about the household in our data. Our data gives us two types information about the household to incorporate into the model. The first is the farm inputs that the household has applied in production, such as labor, fertilizer, farm equipment, and the size of its landholding. The second is other relevant characteristics of the household, which include farming knowledge, remoteness, and local agro-ecological conditions. A complete list of inputs is summarized in Table 5.[8] We use a statistical regression model to estimate how much each of these inputs and characteristics contributes to the value of agricultural output at the margin. Thus, for each household, we can predict how much we would expect it to produce given the inputs it has used and its other relevant characteristics. We can then compare that prediction to what our data that tells us that the household actually produced. The difference between how much a household should have produced according to the model, and how much it actually produced according to the data, is our measure of land quality.

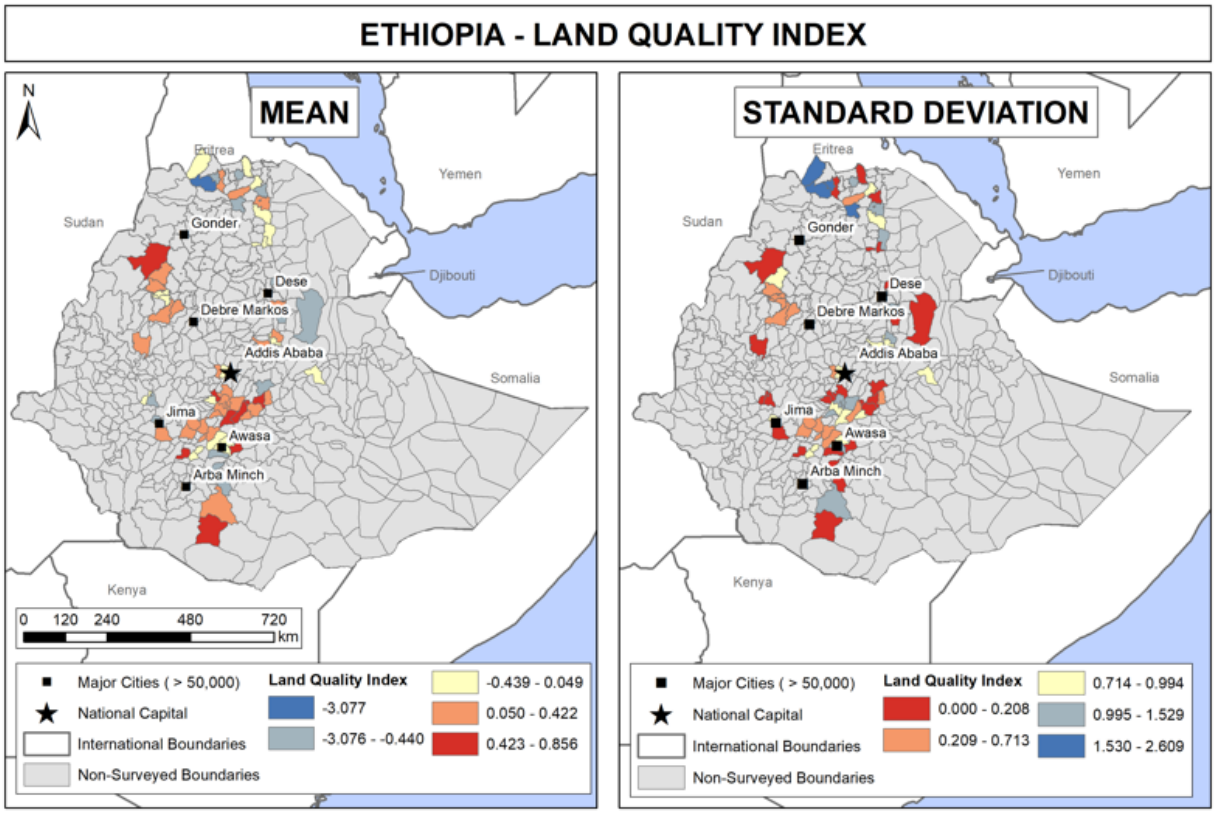
TABLE 5. INPUTS IN THE HOUSEHOLD FARM PRODUCTION FUNCTION
Labor
Seeds
Fertilizer
Pesticide/Herbicide
Land area
Farm implements
Education level of head
Number of household plots
Local average land productivity
Local average soil fertility
Local average precipitation
Distance to road from homestead

Thus, if a household's levels of input use and other characteristics suggest it should have produced more than it actually did, we take that as an indication that the household's land quality is poor. By contrast, a

[8] A more detailed description of the production function is given in the technical annex.

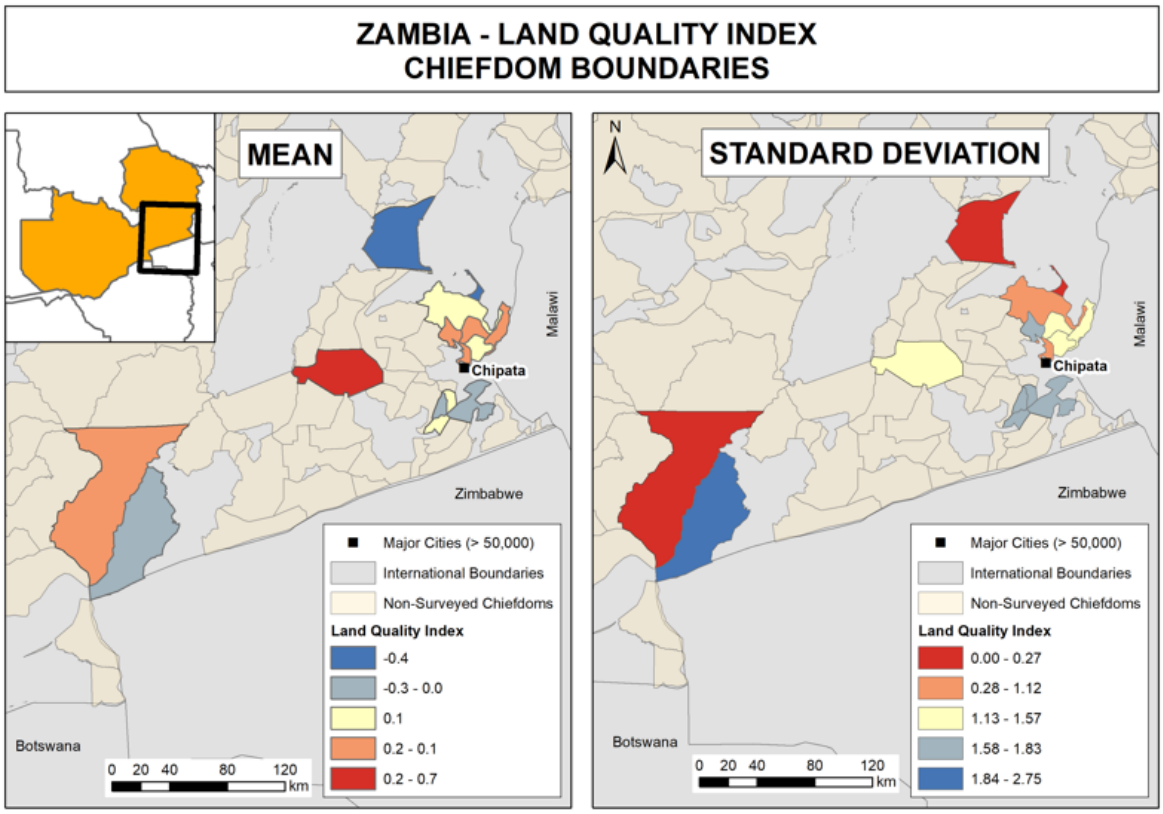
household that is able to produce more than the model would predict is inferred to have land of particularly high quality. Figures 7a and 7b show the distribution of land quality scores between study regions. Negative scores indicate the average household is producing below expectations and positive scores indicate the average household is producing above expectations.[9]

FIGURE 8a.



[9] While figures 7a and 7b show local average land quality scores for clearer data visualization, each household has an individual land quality score.

FIGURE 8b.



ii. Accounting for Selection Bias

As was the case for RQ1, comparing the quality of customarily allocated land between female- and male-headed households entails the potential for selection bias. Land-seeking households desire land with enough productive potential, net of any land costs, to leave them better off than alternatives. Alternatives include continuing to cultivate their existing stock of land, taking off-farm work, or migrating to another village. In the search for land, the household makes a request to a customary authority or any landowner who is likely to offer them suitable land. If the household does not expect that a customary authority or landowner would make them a suitable offer, or any offer at all, they do not make a request. Through this process, self-selection is expected to introduce bias in a model for land quality.

We estimate selection models for land quality in order to estimate how much of this observed gender difference in land quality is attributable to the gender of the household head, as opposed to other decisions that household heads make as part of the land acquisition process. In addition to land that has been acquired via customary allocation, we also apply this approach to land that has been acquired by each of the other means (inheritance, purchase, borrowing, gifts, and clearing own land) as a reference point[10].

[10] As described in the technical annex, we estimate different models for land acquired by inheritance and rental. For inheritance, the factors that determine the probability that a household has inherited land have more to do

The models we estimate are as follows:

$$landqual_{i,p} = \alpha + \beta_1 fem_i + \beta_2 fem_i * age_i + \beta_3 age_i + \beta_4 year_{i,p} + \gamma_1 married_i + \gamma_2 i.edlevel_i + \gamma_3 wealth_i + \gamma_4 hhsize_i + \gamma_5 i.district_i + \rho\sigma_\varepsilon \lambda(Z\xi) + \varepsilon_{i,p} \quad (2)$$

With the selection correction:

$$\Pr(m = 1|X)_{i,p} = F\left(wealth_i, adults_i, i.edlevel_i, area_{i,p}, year_{i,p}, i.country_i, \xi_{i,p}\right) \quad (3)$$
$$where\ m \in (allocated, purchased, rented, borrowed, given, cleared)$$

In addition, we estimate a model without the selection correction. As described below, comparing the findings yields insight on the extent to which gender disparities are due to direct as opposed to systemic discrimination. This uncorrected model is as follows:

$$landqual_{i,p} = \alpha + \beta_1 fem_i + \beta_2 fem_i * age_i + \beta_3 age_i + \beta_4 year_{i,p} + \gamma_1 married_i + \gamma_2 i.edlevel_i + \gamma_3 wealth_i + \gamma_4 hhsize_i + \gamma_5 i.district_i + \varepsilon_{i,p} \quad (4)$$

Table 6 shows the results from the main models for each mode[11]. The key result is that there is substantial gender bias in the quality of land acquired by customary allocation, as shown by the statistically significant coefficient of -0.589 on the female-headed household dummy variable in the first column of the table. The lack of statistical significance on the female*age coefficient shows that older women face similar disparities as compared to younger women. The results also show that less educated households heads and larger households tend to receive more favorable customary land allocations, suggesting that customary authorities consider the household's needs and capabilities in deciding what land to allocate to them. Conversely, the wealth of the household is positively associated with quality, but that may be the result of higher quality land leading to greater wealth over time.

Looking at the results for other modes of acquisition, we also find substantial gender bias in the quality of land that has been borrowed or given. In both cases, the gender bias is stronger for younger women as compared to older women. Conversely, we do not find statistically significant evidence of gender bias in land that has been inherited, purchased, cleared, or rented. One interpretation of these results is that social networks are important for acquiring land by borrowing or gifting, with women and particularly younger women being disadvantaged in this regard. In terms of the other control variables, we do not see consistent patterns in the relationships to land quality across the different modes of acquisition.

with intrinsic characteristics of the household rather than decisions made by the household head, and thus differ from the other modes. For rented land, we do not find evidence of selection bias, and thus estimate an uncorrected model.

[11] Details on the choice between corrected and uncorrected models are provided in the methodology annex.

TABLE 6. LAND QUALITY OUTCOMES AND GENDER BY MODE							
	(2) Allocated N=16,967	**(2) Inherited N=17,027**	**(2) Borrowed N=7,663**	**(2) Given N=11,040**	**(2) Purchased N=18,797**	**(4) Rented N=104**	**(2) Cleared N=11,228**
female	-.589 **	-.113	-3.053 ***	-.969 ***	.570	-.463	-.969
female*age	-.002	.001	.046 ***	.017 **	-.011	.007	-.002
age	.001	-.001	.002	-.003	.011 **	-.005	.005
year acquired	.003 *	-.001	-.100	.007 *	.007	.002	.007
married	-.111	.098	.167	.329 ***	.191	.155	-.504 *
education Level							
no education							
primary	-.179 ***	-.011	-.303	.259 *	-.225	-.127	.099
secondary	-.282 ***	-.046	.018	-.158	-.649	-.526 **	
post-secondary	-.078	-.046		-.332	.406		
wealth	.047 ***	.005	-.060	.078 ***	.175 **	.025	-.090
household size	.040 ***	-.001	-.029	-.021 **	.068 ***	-.012	.061 *
intercept	-6.458	1.518	203.385	-15.475	-18.200	-4.549	-11.999
selection correction	Y	Y	Y	Y	Y	N	Y
p>0.1 *, p>0.05 **, p>0.01***							

RQ3: Do female-headed households perceive their land tenure security as weaker compared to male headed households—both for parcels acquired by customary allocation and otherwise? Are female-headed households more likely to experience land-related disputes compared to male-headed households?

Methods

To address RQ3, we must first establish measures of perceived tenure security and dispute incidence that can be applied consistently across our datasets. A score for perceived land tenure security is constructed using responses to multiple survey questions about the probability that a specific parcel (TGCC, CFP) or any household land (ELTAP, ELAP) will be lost to encroachment, expropriation, or reallocation. Each question is answered on a 4-point Likert scale. The perceived land tenure security score is a continuous measure of perceived risk, with higher values indicating higher perceived risk. The second security outcome variable, an index for incidence of land-related disputes and land expropriation or reallocation, is constructed using principal components analysis (PCA). A higher score indicates more of such incidents on household land in the past. The construction of these tenure security measures is explained in greater detail in Appendix B.

Our analysis includes a simple comparison of descriptive statistics for each of the two indices, as well as econometric modeling to control for other factors that might explain differences between female- and male-headed households. For the latter, we use an Ordinary Least Squares regression model as follows:

$$insecurity_{i,p} = \alpha + \beta_1 fem_i + \beta_2 age_i + \beta_3 fem_i * mode_{i,p} + \beta_4 i.mode_{i,p} + \gamma_1 married_i + \gamma_2 minority_i + \gamma_3 year_{i,p} + \gamma_4 document_{i,p} + \gamma_5 area_{i,p} + \gamma_6 landqual_{i,p} + \varepsilon_{i,p} \quad (5)$$

$$where\ insecurity\ \in (perceived\ risk, dispute\ index)$$

Explanatory variables include several characteristics of the household head and the land in their possession. A dummy variable indicating minority tribe affiliation is available for Zambian observations and is omitted from alternative specifications for both measures of insecurity. All models include a dummy variable indicating whether the household has documentation for their land. Note that parcel-level data is not collected for rented and borrowed land in ELAP and ELTAP, so these sources of land are not represented in the tenure security models.

Results

A simple comparison of descriptive statistics for the perceived tenure security variable is presented in Figures 9 and 10. The figures show that on the whole, male heads perceive their risk of expropriation to be higher than female heads for all household land (Figure 9a), and for land acquired by customary allocated land in particular (Figure 9b). The differences are statistically significant. Conversely, figures 10a. and 10b. show that female-headed households have a significantly higher incidence of disputes and reallocations on all household land than male-headed households on average. Female-headed households also have a higher average incidence of disputes and reallocations on land that was acquired through customary allocation. The difference on allocated land is not statistically significant, possibly due to low statistical power in this subset of observations. Disputes and reallocations are not observed in high numbers among sample households.

FIGURE 9a.

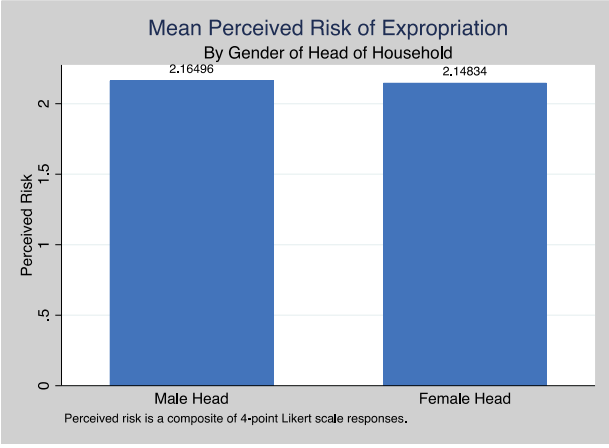


FIGURE 9b.

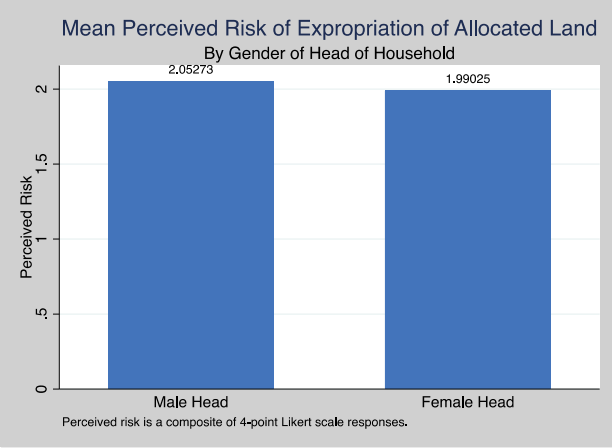


FIGURE 10a.

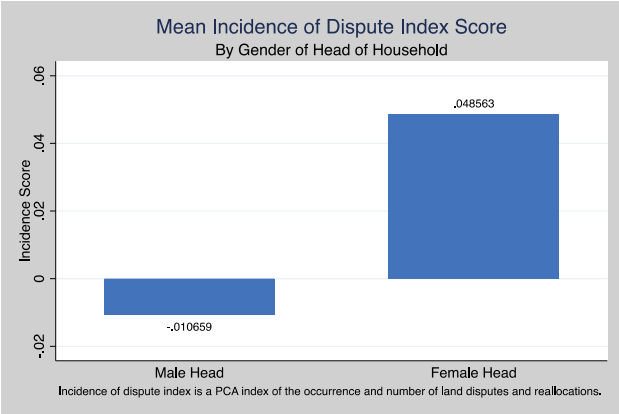


FIGURE 10b.

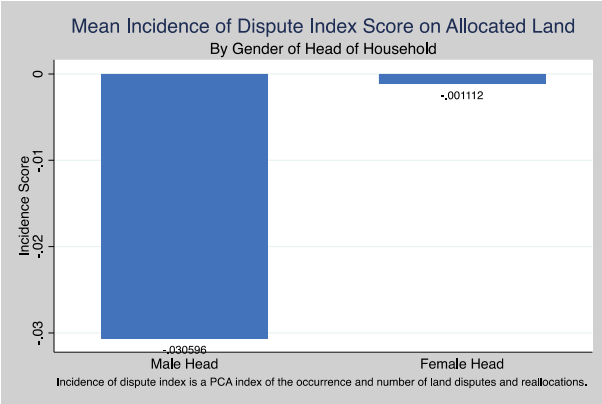


Table 7 presents the econometric results for perceived tenure security and incidence of disputes. We do not find statistically significant evidence of gender disparity; controlling for other factors, female household heads do not tend to perceive their tenure as less secure than male household heads. We discuss the interpretation of this finding in the next section. Disaggregating by mode of acquisition, we do find evidence of gender disparity for land that has been received as a gift. For female-headed households, land that has been received as a gift tends to be perceived as less secure compared to land that has been acquired in other ways. Conversely, male-headed households tend to see gifted land as more secure compared to other modes of acquisition. This finding is difficult to interpret, but may illustrate that women and men tend to receive land as a gift under different circumstances. Land quality is negatively associated with perceived risk. Perhaps surprisingly, possession of formal documentation of land rights is associated with greater perceived tenure insecurity. This could reflect a selection effect, whereby households that perceive their tenure to be risk respond by seeking out and obtaining documentation, as opposed to a causal relationship between documentation and tenure insecurity.

We do find some evidence of gender disparity with regard to incidence of disputes. The last column in Table 7 illustrates that female headed households are 14.9% more likely to have experienced a dispute, though this result is statistically significant only at the 10% level. We also find that female-headed households are less likely to have experienced a dispute on land that they have purchased, relative to other modes of acquisition. Finally, documentation is associated with greater incidence of disputes, similar to the relationship between documentation and perceived tenure security described above; this finding may reflect a selection effect rather than a causal relationship between documentation and incidence of disputes.

TABLE 7. LINEAR MODELS FOR LAND TENURE INSECURITY (5)		
	Perceived Risk (Full Sample) N=12,916	**Disputes (Full Sample) N=7,980**
Fem	-.014	.149 *
Age	.001	.000
Fem*mode		
*Fem*inherited*		
Fem*allocated	.017	-.055
Fem*purchased	.154	-.542 ***
Fem*rented	-.098	-.071
Fem*borrowed	-.268 *	
Fem*given	.170 ***	-.095
Fem*cleared	-.289	-.233
Mode		
inherited		
Allocated	-.012	-.064**
Purchased	.016	.081
Rented	-.026	.044
Borrowed	.064	.046
Given	-.048 **	.046
Cleared	.063	.123
Married	.007	.055
Minority		
Plot area	.003	.039
Land quality	-.024 ***	-.004
Document	.614 ***	.104***
Year acquired	.000	-.001
Intercept	1.949	1.598
p>0.1 *, p>0.05 **, p>0.01***		

RQ4: To what extent are female-headed households able to use sales and rental markets to obtain land?

Methods

Finally, we consider whether female-headed households are able to utilize land sales and rental markets in order to mitigate gender disparities in customary allocation. To do so, we investigate gender disparities in the likelihood that a household has acquired any of its parcels via markets. Similar to the previous research question, we present a simple comparison of means, followed by a more rigorous econometric model to isolate underlying gender disparity from the influence of other factors that might differ between female- and male-headed households[12]. We utilize a probit model of the form:

[12] As an extension of RQ3, we also investigated the extent to which those female-headed households that face particularly large disadvantages in customary allocation would be able to utilize land markets as a mitigation measure. The results were inconclusive, and did not provide evidence that female-headed households that are disadvantaged in customary system have particularly favorable or unfavorable access to land through sales or rental markets. Methods and findings for this extension are included in the technical appendix.

$$\Pr(m = 1|X)_{i,p} = F\big(fem_i, fem_i * \widehat{landqual}_i, \widehat{landqual}_i, wealth_i, adults_i, i.edlevel_i, area_{i,p}, soil_{i,p}, \xi_{i,p}\big) \quad (6)$$

$where\ m \in (purchased, rented)$
$and\ \widehat{landqual}_i\ is\ the\ household's\ predicted\ land\ quality\ under\ customary\ allocation$

Results

We present a simple comparison of descriptive statistics in Figures 11a. and 11b. Figure 11a. indicates that purchasing land is relatively rare in the study population[13], but that male-headed households tend to purchase land more often than female-headed households; approximately 0.3% of parcels possessed by female heads of household were acquired by purchase, as compared to 0.5% of parcels possessed by male heads. By contrast, figure 11b. shows that land rentals are more common and are utilized by male and female headed households at similar rates. Approximately 1.8% of parcels possessed by both female and male heads are rented.

FIGURE 11a.

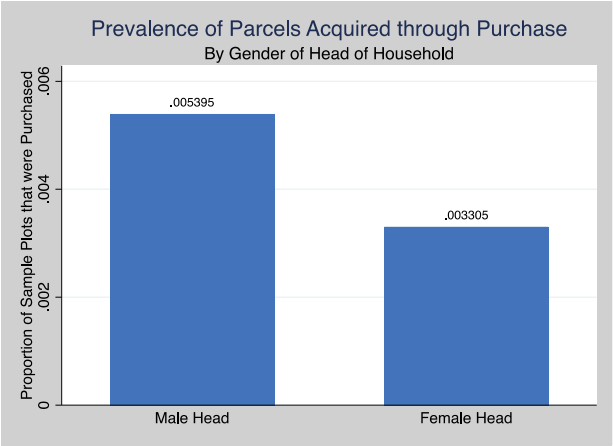
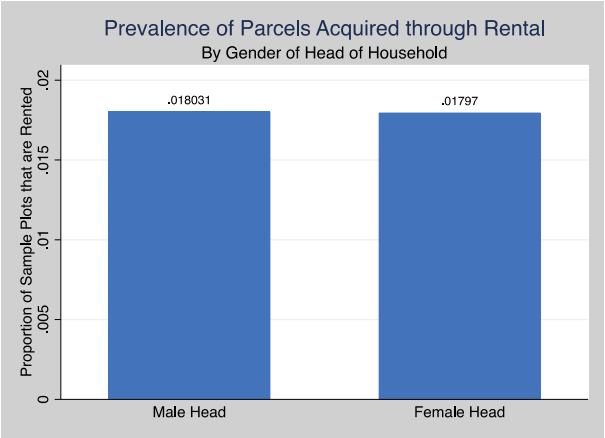


FIGURE 11b.



The probit regression results are displayed in Table 8. Plots possessed by currently female-headed households are significantly less likely to be acquired through rental than parcels possessed by currently male-headed households. When any household is predicted to obtain high quality land through customary allocation, its land is more likely to have been acquired through rental. An explanation for this result is unclear. The probability that a parcel is rented increases for female-headed households if they are predicted to obtain high quality land through customary allocation. This result is in conflict with the mean comparison above and is likely due to controlling for other important factors in which there are gender differences.

[13] This rarity is explained in part by the fact that all land in Ethiopia is owned by the state, and cannot be legally bought or sold.

When any household is predicted to obtain low quality land through customary allocation, its land is more likely to have been acquired through purchase. This suggests some households have used purchase to improve their land quality outcomes over customary allocation, though as described above the use of purchase at all is very limited in our samples. We do not find a statistically significant relationship between the gender of the current head of household and utilization of purchase to acquire land. This may be the result of low statistical power resulting from the rarity of land purchases in the data.

TABLE 8. PROBABILITY OF LAND MARKET UTILIZATION (6)

	Purchased N=7,288	**Rented N=7,408**
fem	-.776	-.543 *
fem*predicted land quality	1.171	1.200 *
predicted land quality	-.767 **	1.160 ***
i.edlevel		
no education		
primary	.086	.060
secondary	.021	.182
post-secondary		
wealth	-.065	.032
# adults	.054	-.009
plot area	-.000	-.308 ***
soil type		
clay		
sandy	.006	.134
loamy	.117	.075
silt	-.064	-.048
gravel		.144
p>0.1 *, p>0.05 **, p>0.01***		

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

In drawing conclusions from the findings, it is important to bear a couple of limitations in mind. First, our datasets include study areas in Ethiopia and Zambia only, and thus the extent to which the findings can be generalized may be limited. Secondly, our analysis is limited to gender disparities faced by female-headed households, as the data do not allow us to investigate these issues for married women.

5.1.1 RQ1: Prevalence of Customary Allocation

Female-headed households are less likely than male-headed households to have received customary allocations of land. Male-headed households have 0.85 parcels on average that have been acquired via customary allocation, compared to 0.74 parcels for female-headed households. Our econometric

results suggest that this disparity is explained by differences in other household characteristics that tend to disadvantage female headed-households, rather than explicit discrimination. For example, larger households and parcels that were acquired further in the past are associated with a higher likelihood of customary allocation. Both of these characteristics are also more common in male-headed households, which accounts for much of the observed difference between female- and male-headed households.

5.1.2 RQ2: Land Quality Outcomes

When female-headed households receive customary land allocations, our results show that they receive land with less productive potential compared to male-headed households. Other factors that are associated with higher quality customary land allocations are years since the parcel was acquired, less educated household heads, and both wealthier and larger households. Even after accounting for differences between female- and male-headed households in terms of these characteristics, we still find substantial gender disparity in quality of customarily allocated land. We observe greater gender disparities in the productive potential of land that has been borrowed or gifted, but we do not observe statistically significant gender disparities in other modes of acquisition.

5.1.3 RQ3: Tenure Security Outcomes

We do not find evidence of gender disparity in terms of our subjective survey measures of perceived tenure security. On land that has been acquired by customary allocation, female-headed households do not perceive themselves to be at any greater risk of encroachment, expropriation, and reallocation than male-headed households. This is somewhat contrary to expectations, but it is worth noting that other analyses of survey perceived tenure security have tended not to find that women typically indicate greater insecurity than men. One potential explanation is that survey questions about perceived tenure security are difficult to frame, and often considered sensitive by respondents, and may be subject to considerable error and bias as result. This may limit interpretation of the results in some respects, such as gender comparisons.

We find weak evidence that female-headed households tend to experience more disputes than male-headed households on land that has been acquired by customary allocation. Female-headed households are 14.9% more likely to have experienced a dispute overall, though this result is only statistically significant at the 10% level. For male households, land acquired via customary allocation is less likely than other modes to be subject to disputes, but this is not the case for female households. As the prevalence of disputes in the data is relatively rare, it is difficult to draw firm conclusions on this topic.

5.1.4 RQ4: Women's Use of Land Markets

We do not find evidence that female-headed households are able to use land sales or rental markets to mitigate the disparities they encounter in customary land allocation. Land sales markets are rare throughout the sample, and do not constitute a significant means of acquiring land for either female- or male-headed households. Rental markets are more common, and the raw data show that female- and male-headed households utilize them as similar rates, with both renting approximately 1.8% of their land on average. However, after accounting for other differences in household characteristics, we find that female-headed households have substantially less access to rental markets compared to male-headed

households. A parcel in a female-headed household is 54% less likely to have been acquired by rental compared to an otherwise identical male-headed household.

5.2 RECOMMENDATIONS

Our findings lead to three main recommendations:

First, it is essential for programs seeking to formalize aspects of customary land governance systems to take cognizance of the potential for gender bias in customary land allocation systems. While the importance of harmonizing formal and informal land tenure systems is widely recognized, our findings show that customary systems can also reflect substantial gender bias. Thus, careful attention to potential gender bias is needed in legitimizing and codifying aspects of customary systems into law so that women are not placed at a disadvantage.

The appropriate approach to addressing gender bias in any particular case will depend on a range of contextual factors. Options may include outreach and sensitization to customary authorities to influence social norms related to gender, or alternatively formalization programs to enable women to access land outside of the customary system. In the latter case, our findings caution that formalization alone may be insufficient to empower women to use land markets to access land, and thus complementary interventions may be needed.

Our second recommendation relates to the process of assessing gender bias in land rights and allocation for the purposes of program design or policy advice. Our findings show that female-headed households are somewhat less likely to receive customary land allocations, and when they do receive land, the productive potential is lower. Thus, it may not be sufficient for assessments of gender bias to consider only whether or not women are able to access land and the size of their landholdings. Instead, such assessments should also carefully consider the productive potential of land as another potential source of disparity.

Finally, we recommend that future data collection efforts should consider including surveys of all husbands and wives within the household, focusing on intra-household dynamics and decision-making processes. Such data would allow for the investigation of gender disparities facing married women in addition to female-headed households, overcoming a key limitation of our analysis.

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APPENDIX A: ACCOUNTING FOR SELECTION BIAS IN THE USE OF CUSTOMARY ALLOCATION

The information in the data about customary allocation outcomes is limited to land households successfully acquire, suggesting the risk of selection bias in a model for the use of customary allocation. We test for the presence of selection bias. As shown in Table A1, we find that no selection bias exists in the main model for customary allocation.

The suspected bias in the relationship between household characteristics and the probability that a parcel was acquired through customary allocation stems from households' choices in the land search process. Not all households are certain to seek land through the customary system. Some may be able to find more desirable land elsewhere, while others may have low hopes that a customary authority would honor their request. As a result, some heads may choose not to make a request. If the choice to make a request related to individual and household characteristics, then certain types of households self-select out of the set of households that might receive an allocation of land.

We first estimate a selection equation using Zambia data, which identifies recent requests for land allocation. The probability that a household makes a request is given by

$$\Pr(request = 1|X)_i = F\left(fem_i, fem_i * age_i, age_i, married_i, minority_i, children_i, adults_i, wealth_i, i.chief_i, \xi_{i,p}\right)$$

$$where\ minority_i = 1\ if\ the\ head's\ tribe\ is\ a\ numerical\ minority\ in\ the\ chiefdom.$$

We then estimate an outcome equation for the probability that their land was ultimately acquired through customary allocation, correcting for the probability that the household made a request. The probability that a household acquires land through customary allocation is given by

$$\Pr(allocated = 1|X)_{i,p} = F\left(fem_i, fem_i * age_i, age_i, married_i, minority_i, i.district_i, i.chief_i, \rho\sigma_\varepsilon\lambda(Z\xi), \varepsilon_{i,p}\right) \quad if\ year_{i,p} > cutoff$$

$$where\ cutoff = 2008\ for\ TGCC\ households\ and\ cutoff = 2010\ for\ CFP\ households.$$

We conduct a Wald test of independent equations to determine whether selection is relevant in the outcome equation. The result of the Wald test is summarized in Table A1. We fail to reject the null hypothesis that the equations are independent.

TABLE A1. RESULTS OF WALD TEST OF INDEPENDENT EQUATIONS IN PROBABILITY OF CUSTOMARY ALLOCATION	
ρ	**Interpretation**
-.1595206	No bias detected, use uncorrected model

p>0.1 *, p>0.05 **, p>0.01***

Null hypothesis H_o: The outcome equation and selection equation are independent, or $\rho = 0$, where ρ is the correlation of the errors in the outcome and selection equations.

APPENDIX B: MEASURING LAND QUALITY WITH A PRODUCTION FUNCTION

An ordinal measure of land quality is constructed using a household production function, controlling for four spatially correlated variables. Land quality is defined as the residual term. We use a Cobb-Douglas production function with coefficients constrained for constant returns to scale. The non-control variables are the natural log of inputs and outputs, The base production function is given by

$$\ln(Y)_i = \alpha + \beta_1 \ln(labor)_i + \beta_2 \ln(seeds)_i + \beta_3 \ln(fert)_i + \beta_4 \ln(pest)_i + \beta_5 \ln(area)_i + \beta_6 \ln(implements)_i + \gamma_1 i.edlevel_i + \gamma_2 i.nplots_i + \gamma_3 NDVI_i + \gamma_4 carbon_i + \gamma_5 rain_i + \gamma_6 distance_i + \varepsilon_i$$

$$where \sum_{i=1}^{6} \beta_i = 1$$

TABLE B1. PRODUCTION FUNCTION VARIABLE DEFINITIONS

Output:	Value of total production quantity at median market prices	
Labor:	• Number of person-days worked (TGCC) • Number of adults in household (ELTAP, ELAP, CFP)	
Seeds:	• Quantity in kg (TGCC) • Whether planted improved seed (ELTAP, ELAP) • Expenditure (CFP)	
Fertilizer:	• Quantity in kg (TGCC) • Quantity in kg/ha (ELTAP, ELAP) • Expenditure (CFP)	
Pesticide/Herbicide:	• Number of applications (TGCC) • Quantity in kg/ha (ELTAP, ELAP) • Expenditure (CFP)	
Land capital:	Cultivated land area	
Implements:	• Specification 1: None • Specification 2: Count of farm implements and structures • Specification 3: PCA index of farm implements and structures	
Controls		
Education level of head (proxy for knowledge, allocative efficiency):	• No formal education • Primary	• Secondary • Post-secondary attainment
Number of household plots (measure of dispersion):	• One • Two	• Three • Four or more plots
Land productivity in local area:	Mean NDVI in 1km radius of homestead	
Soil fertility in local area:	Mean soil organic carbon content in 1km radius of homestead	
Precipitation:	Mean rainfall in 1km radius of homestead	
Market access:	Distance to road from homestead	

Variable definitions are summarized in Table B1. We use sample median sale prices to construct a standard value for all household production, even if not all of the harvest is sold. Three different specifications vary by the definition of $\ln(implements)_i$. Several variables are observed only at the

household level in three of the datasets, producing household-level land quality estimates. A similar household-level estimate is produced for TGCC by aggregating plot-level values.

Each model specification was estimated for each subsample using constrained linear regression. We trim outliers with total land area above the 99th percentile for TGCC, ELTAP, and CFP, and above the 95th percentile for ELAP. We trim outliers with labor above the 99th percentile for ELTAP, ELAP, and CFP, and in the top and bottom 2.5% for TGCC.

We select the specification that best fits each individual dataset, with results displayed in Table B2. The primary criterion for fit is the number of positive coefficients, as the quantity of inputs increases the quantity of farm production. Where multiple models produce all positive coefficients, a secondary criterion is the number of significant coefficients. Labor inputs are most likely to be insignificant. This is consistent with a low off-farm wage or job scarcity in the local labor market, which increases household members' supply of their own labor to cultivation even when it has little impact on the harvest. Pesticide input is most likely to be negative, suggesting pesticide use is correlated with pest problems that reduce farm productivity. The data do not allow for controlling for pest problems or crop losses due to pests.

TABLE B2. PRODUCTION FUNCTION RESULTS

	TGCC (Spec. 3)	**CFP (Spec. 2)**	**ELTAP (Spec. 2)**	**ELAP (Spec. 1)**
		ln(value of production)		
ln(labor)	.3433 ***	-1.1035	.1761 ***	-.1649 **
ln(seeds)	.2111 ***	-.1169	.3985 ***	.4907 ***
ln(fert)	.1564 ***	.1850	.0835 ***	.0708 ***
ln(pest)	.1898 **	-.1565	.0443 **	.0952 *
ln(area)	.0639	1.6076 **	.0650 ***	.5081 ***
ln(physical capital)				
count	-	.5844	.2326 ***	-
index	.0355	-	-	-
i.edlevel				
none				-
primary	-.0678	-	-	.2013 **
secondary	-.0129	.1768	-	.2294
post-secondary	.7889	8.4654	-.1166	.4450
i.nplots				
one				
two	-.5663***	-5.2756 **	.3448 ***	.0341
three	-.6426 ***	2.7508	.5287 ***	.0602
four or more	-.6250 ***	-	.6188 ***	.1341
NDVI	.5974	12.8165	1.1295 ***	2.5594 ***
carbon	-.0199	-.1962504	-.0035	.0284 **
rain	-.0193	.1771415	.0035 ***	-.0025
distance	-.0530	-.2278361	.0447 *	-.0032
intercept	7.1384	-10.79131	6.1428	7.3270

p>0.1 *, p>0.05 **, p>0.01***

This approach assumes households choose the crop mix with the highest returns given all of the plot's characteristics and local conditions. This crop mix is the most efficient use of household resources, including its land. By this assumption, the unmeasured variation in farm production value is interpreted as the overall quality of the land.

Note that CFP data present a problem for inferring land quality. Respondents were asked about farm input variables in the most recent planting season, while they were asked about farm outputs in the previous season. Production function results for CFP are largely insignificant. However, in the main analysis for RQ2, only 28 of observations are CFP households and their inclusion does not affect the results.

APPENDIX C: ACCOUNTING FOR SELECTION BIAS IN LAND QUALITY OUTCOMES

Observations of rural land are limited to the land households successfully acquire, suggesting the risk of selection bias in the model for land quality. For each mode of acquisition, we test for the presence of selection bias and estimate a corrected model if selection bias exists. We use the same selection equation for all modes except inheritance, which has its own selection equation. As shown in Table C1, we find that no selection bias exists in land rental but is present in all other modes.

Customary Allocation, Land Markets, Borrowing, Gifts, and Clearing New Land

Selection bias can occur through self-selection or through selection imposed by others, including discrimination. In the search for land, the household makes a request to a customary authority or a landholder who is likely to make a suitable offer. If the household does not expect a suitable offer from a mode, or any offer at all, they do not make a request. Households accept the best offer. Through this process, self-selection is expected to introduce bias in a model for land quality. Whether a customary authority or landholder is likely to make an offer, and which plot they offer, depends in part on their own biases toward or against a particular household.

We observe accepted offers in the data, while rejected land offers are censored. As a consequence, unobserved offers have lower average land quality for several reasons. These can include discrimination, or factors in the "fair" exchange of land, such as the distribution of land quality available nearby or the household's ability to afford land market prices. Discrimination can also influence the quality of the best offers. This occurs when discrimination in other modes lowers the bar for the best offer.

The probability that a plot was acquired through the first set of modes is defined as

$$\Pr(m = 1|X)_{i,p} = F\left(wealth_i, adults_i, i.edlevel_i, area_{i,p}, year_{i,p}, i.country_i, \xi_{i,p}\right)$$
$$where\ m \in (allocated, purchased, rented, borrowed, given, cleared)$$

Wealth proxies a household's ability to pay for land on the market, which can influence their choice to rent, buy, or use a non-market alternative. Land area relates to the value of the land available in that mode. The number of adult household members, as a proxy for labor, measures the household's capacity to extract value from the land (Holden, Otsuka, & Place 2009). Education level of the household head may proxy to some extent for the household's capacity to extract value. It also proxies for the head's off-farm wage and therefore their level of dependence on cultivation for food or income. The year acquired and country dummy control for time and location trends in the use of each mode.

It is less clear which factors might increase the probability that a parcel was received as a gift. Households in need may be more likely to receive gifts of land. Parcels acquired as a gift could also be categorized as inheritance. Without knowing the extent of this potential overlap or misclassification, there is no clear justification for changing the specification of the selection equation for "given land."

Inheritance

The factors that determine the probability that a household has inherited land have more to do with intrinsic characteristics of the household and extended family rather than decisions made by the household head. However, the quality of land inherited may still be affected by selection. Foremost, customary inheritance laws are gendered in their design or enforcement. In addition, the probability of acquiring inherited land may be influenced by the number of household members eligible to receive an inheritance, or the amount of land possessed by extended family that could be inherited. We do not observe either of these directly. We proxy for these factors using the number of household members and household wealth, which is assumed to correlate with extended family wealth and thus landholdings. Since land is inherited without cost, it is expected that households will choose inheritance over other offers whenever it is available. The probability that a plot is acquired through inheritance is defined as

$$\Pr(inherited = 1|X)_{i,p} = F\left(fem_i, age_i, wealth_i, hhsize_i, area_{i,p}, year_{i,p}, i.country_i, \xi_{i,p}\right)$$

The age of head correlates with the probability that a relative, especially parent, passes away at any time. If a larger inheritance is divided between heirs on the basis of favor, land area may influence the distribution among heirs. The year acquired and country dummy control for time and location trends.

We estimate each of the above selection equations along with the land quality outcome equation

$$\begin{aligned} landqual_{i,p} = \alpha + \beta_1 fem_i + \beta_2 fem_i * age_i + \beta_3 age_i \ + \beta_4 year_{i,p} + \gamma_1 married_i \\ + \gamma_2 i.edlevel_i + \gamma_3 wealth_i + \gamma_4 hhsize_i + \gamma_5 i.district_i + \rho\sigma_\varepsilon \lambda(Z\xi) + \varepsilon_{i,p} \end{aligned}$$

For each mode, we conduct a Wald test of independent equations to determine whether selection is relevant in the outcome equation. The results of the Wald tests are summarized in Table C1. Only for rental do we fail to reject the null hypothesis that the equations are independent. Very few rented household plots are observed in the data. It is possible that the Wald test for rental lacks the statistical power to detect true selection bias.

TABLE C1. RESULTS OF WALD TEST OF INDEPENDENT EQUATIONS IN LAND QUALITY

Mode	ρ	Interpretation
Customary allocation	.09129***	Bias detected, use corrected model
Purchase	.9596027***	Bias detected, use corrected model
Rental	.32143	No bias detected, use uncorrected model
Borrowing	-.87054***	Bias detected, use corrected model
Gifts	.9150288***	Bias detected, use corrected model
Clearing	-.82421***	Bias detected, use corrected model
Inheritance	.0894764***	Bias detected, use corrected model

p>0.1 *, p>0.05 **, p>0.01***

Null hypothesis H_o: The outcome equation and selection equation are independent, or $\rho = 0$, where ρ is the correlation of the errors in the outcome and selection equations.

APPENDIX D: CONSTRUCTING PERCEIVED TENURE SECURITY VARIABLES

Perceived Risk of Encroachment, Expropriation, or Reallocation of Household Land

This measure of perceived tenure security is an aggregation of responses on a Likert scale. Responses are coded so that higher values indicate more risk. For each household, we compute the mean of response codes for each question, producing a continuous ordinal measure of perceived risk. The scores are then standardized at the sub-sample level.

ELTAP and ELAP
Response Options:

1. "Strongly Agree"	2. "Agree"	3. "Disagree"	4. "Strongly disagree"

Questions:

- I believe that the land that is currently under my possession will remain within my control or that of my wife/husband or that of my children's' during the coming 15 years.
- I am fully convinced that I will stand to benefit in the future from whatever soil and/or water conservation measures I may undertake on my land at present.
- I am fully convinced that I will NOT stand to benefit in the future from trees that I may plant on my land at present. (reverse coded)
- I feel that renting out my land for money or on sharecropping basis EVEN FOR ONE CROPPING SEASON is a risky business that I should avoid unless and otherwise I have no other options of overcoming my difficulties. (reverse coded)
- I feel that renting out my land for money or on sharecropping basis FOR 5 CROPPING SEASONS is a risky business that I should avoid unless and otherwise I have no other options of overcoming my difficulties. (reverse coded)

TGCC and CFP
Response Options:

1. "Impossible/would never happen"	2. "Highly unlikely"	3. "Likely"	4. "Very Likely"

Questions:
In the next one to three years / beyond four years from now[14],

- How likely do you think it is that other households within your village may try to cross-over your boundaries (step on your side) and take or use some of this field?
- How likely do you think it is that elites/big people may take this field without your permission/agreement?
- How likely do you think it is that people from a neighboring community with encroach/cross-over to use this field?

[14] Only TGCC households are asked to respond for "beyond four years from now." All Zambian sample households are asked to respond for "the next one to three years."

- How likely do you think it is that the chief will give this field up for investment purposes?
- How likely do you think it is that the village headman will re-allocate some or all of this field to another household or for other purposes?
- How likely is it that someone from within your extended family will take over the use of this field?

Incidence of Disputes and Encroachment, Expropriation, or Reallocation of Household Land

This measure of the incidence of disputes over, or loss of rights to, household land is an aggregation of responses to a variety of discrete variables. For each subsample, we construct an index for the number of incidents using PCA. Each household's score on the index is relative to the subsample. Larger values indicate more disputes or more parcels lost to encroachment, expropriation, or reallocation. We us responses to the following survey questions to construct the index:

ELTAP and ELAP

- Did you lose land because of other reasons, e.g. expropriation of part of the land for public purposes or for investors, etc.?
- Did your household involve in any land related dispute, during the last two years?
- If yes, in how many land related disputes did your household involve in during the last two years?

TGCC

- Whether each scenario of land encroachment, expropriation, and reallocation in the perceived land tenure security questions above is "Happening right now."
- Have you ever experienced a land dispute on this field?
- In the past three years, how many land disputes have you experienced on this field?

CFP

- Whether each scenario of land encroachment, expropriation, and reallocation in the perceived land tenure security questions above is "Happening right now."
- Have you experienced any land disputes relating to this field over the past 3 years?

APPENDIX E: PREDICTED LAND MARKET OUTCOMES FOR FEMALE-HEADED HOUSEHOLDS DISADVANTAGED IN CUSTOMARY ALLOCATION

In the main analysis of RQ4, we investigate whether female-headed households are using land markets to improve the quality of their land over customary allocation. To do this, we estimate the extent to which predicted land quality under customary allocation influences the probability that a household has actually acquired land through the land market, and how that influence differs by gender.

In addition, we investigate whether female-headed households might be able to acquire higher quality land by using land markets rather than customary allocation. To do this, we estimate the correlation between observed land quality under customary allocation and predicted land quality if households were to use purchase or rental instead. A negative relationship would provide some evidence that female-headed households with low quality land obtained through the customary system could improve their land quality outcomes through land market alternatives.

FIGURE E1.

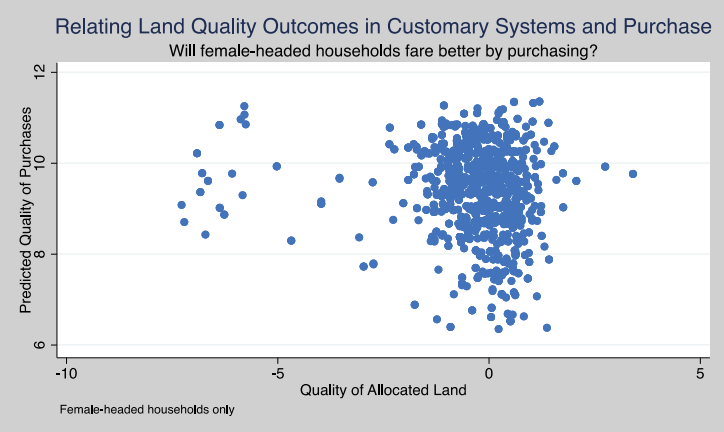
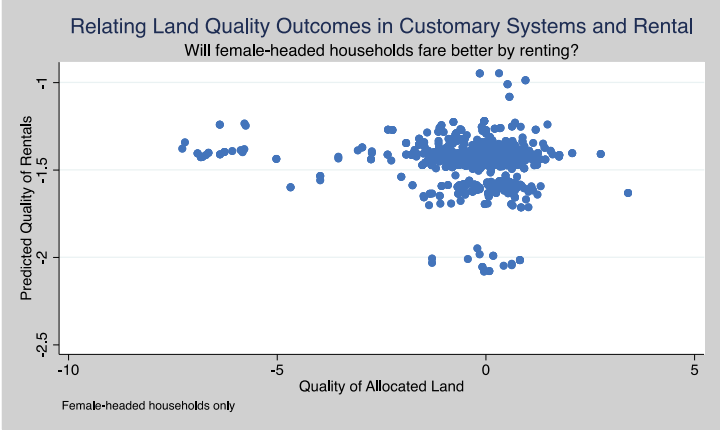


FIGURE E2.



Figures E1 and E2 show scatter plots of observed land quality under customary allocation and predicted land quality through purchase and rental, respectively. The correlation for purchase is $\rho = -0.0482$ and the correlation for rental is $\rho = 0.0876$. While both correlation coefficients are significantly different from zero at the 1% level, the magnitudes indicate no correlation. This result does not provide evidence that female-headed households that are disadvantaged in customary system would fare better or worse with land market alternatives.

APPENDIX F: ENVIRONMENTAL VARIABLE CONSTRUCTION AND SPATIALIZATION OF KEY HOUSEHOLD SURVEY VARIABLES

Environmental Variables Definitions

For each country and year of completed household surveys, we created variables that describe rainfall patterns during the mean growing season. We downloaded monthly rainfall estimates from the Climate Hazards Group Infrared with Stations Data (CHIRPS) ftp site as individual raster files in GeoTIFF format. This dataset covers the entire extent of Africa at a spatial resolution of 0.05 decimal degrees (~5 kilometers) and measures rainfall in millimeters. To create rainfall datasets for the mean growing season, we averaged the data from each monthly raster file by stacking them together and calculating the mean of the full stack.

The Normalized Difference Vegetation Index (NDVI) is one of the most common and efficient vegetation indices by which to remotely measure vegetation productivity. Following the same acquisition times as the precipitation data, we downloaded monthly eMODIS NDVI raster datasets for the Eastern and Southern African region from the USGS FEWS data download portal. Each monthly zipped file contains three dekadal (10-day) files. These data are derived from the Moderate Resolution Imaging Spectroradiometer's (MODIS) AQUA and TERRA satellite sensors and is processed to 250-meter spatial resolution by USGS. Given the equation used for NDVI, the valid value range is commonly -1 to 1, but can be transformed for specific use cases. The USGS processing protocol applies a linear stretch to the data, so we applied the reverse calculation to transform the values back to the value range -1 to 1. Like the precipitation data, we averaged the data from each raster file to produce the mean growing season raster dataset.

The Africa Soil Information Service (AfSIS) was used to obtain soil data. Specifically, SoilGrids250m - Soil organic carbon content (fine earth fraction) (g/kg) at 5 cm soil depth product was used in this analysis.

Open Street Maps data were downloaded for Ethiopia and Zambia. Roads data were projected to WGS UTM 37N for Ethiopia and UTM 36S for Zambia.

Environmental Variable Construction

Precipitation, NDVI, and soil data were resampled to 250 m spatial resolution. A 1 km buffer was created around each household (HHID) to establish a polygon from which to extract rainfall (mm), NDVI, and soil organic carbon content (g/kg) values. Mean and standard deviation of rainfall, NDVI, and soil were calculated using the Zonal Statistics 2 tool from the Spatial Analyst Supplemental Toolbox (available at https://www.arcgis.com/home/item.html; this supplemental tool was needed because the standard Zonal Statistics tool available in ArcGIS is not capable of handling many overlapping polygons). Additionally, the coefficient of variation was calculated for rainfall, NDVI, and soil organic carbon content. The coefficient of variation describes the heterogeneity inside the defined area, i.e. how variable rainfall, NDVI, or soil organic carbon content is within the defined buffer. The final mean, standard deviation, and coefficient of variation for rainfall, NDVI, and soil organic carbon content were joined to the HHID. Next, a distance to roads variable was calculated from each HHID to the nearest road using the Near tool. An additional field was added that lists the Open Street Maps Identification Number (osmid). The osmid can be used to search additional attributes about the roads including whether they are primary/secondary, paved/unpaved, etc. Finally, all final data was compiled individually for ELTAP and ELAP and jointly for all Ethiopia data in both spatial and tabular format.

The modeling process used for Ethiopia was replicated for Zambia. TGCC and CFP were modeled separately, with all final data being compiled individually for TGCC and CFP and jointly for all Zambia data in both spatial and tabular format.

Spatialization of Key Household Survey Variables

ArcGIS ModelBuilder was used to build the geospatial model that aggregated all data to the administrative level 3 (adm3) boundary level. First, survey data were joined to the household locations. Percent female owned households were calculated at the adm3 level (Figure F1). The modeling process used for Ethiopia was replicated for Zambia and data were aggregated to the administrative level 2 (adm2) and chiefdom boundary levels. Below are the resulting maps for the percent female at the chiefdom level (Figure F2).

FIGURE F1.

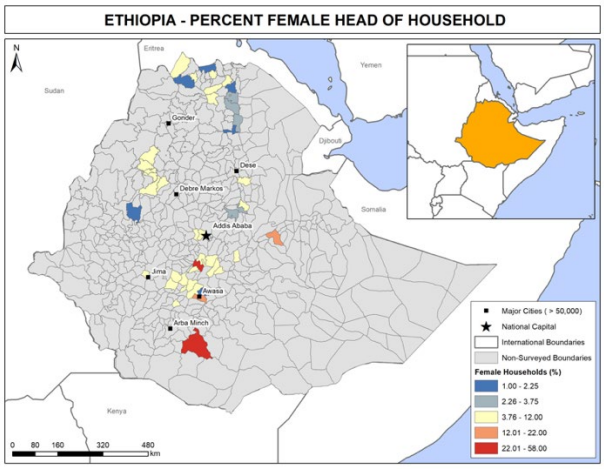
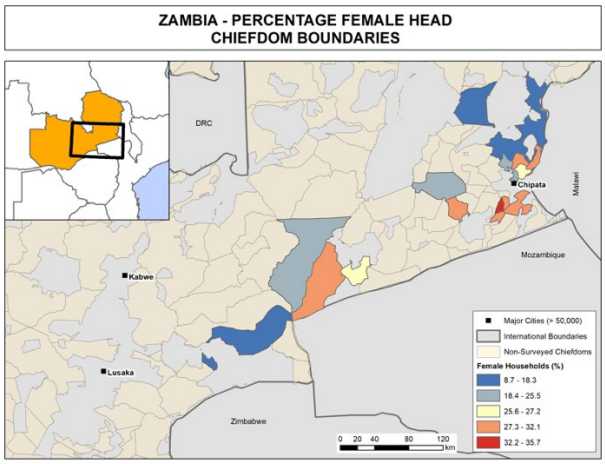


FIGURE F2.



ArcGIS ModelBuilder was used to build the geospatial model for documenting the land quality index at the adm3 boundary level (Figure F3). To get a representation of land quality at the adm3 boundary level, the household level data were spatially joined to the adm3 boundaries and the mean and standard deviation of the land quality index taken within each adm3. The modeling process used for Ethiopia was replicated for Zambia. The land quality index was represented at the chiefdom boundary level (Figure F4).

FIGURE F3.

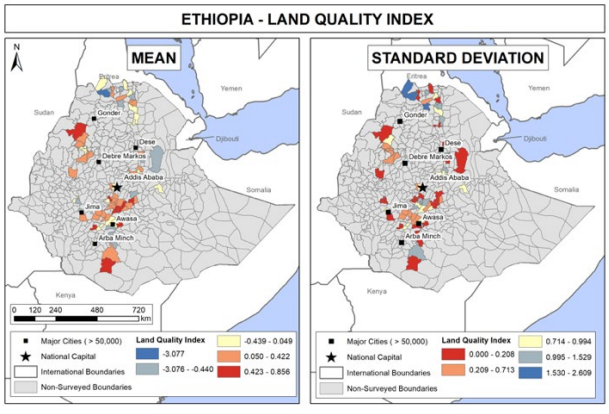


FIGURE F4.