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Farm size and gender distribution of land: Evidence from Ethiopian land registry data

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Highlights

- The study uses land registry data from Tigray region of Ethiopia from 1998 and 2016
- Average farm size has declined from 1.15 to 0.90 ha over the time period
- The documented female landholding share is 48.8% in 2016
- The farm size per household Gini increased from 0.38 in 1998 to 0.50 in 2016.
- The farm size per capita Gini increased from 0.42 in 1998 to 0.57 in 2016.

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Abstract

Land is an essential asset for the livelihood and welfare of rural households in agriculture-based rural economies. This study utilizes land registry data from the First and Second Stage Land Registration (FSLR and SSLR) Reforms that took place in 1998 and 2016 in Tigray region of Ethiopia, the first region in Ethiopia to implement land registration and certification. Second Stage Land Registration and Certification (SSLR&C) provided households with parcel-based certificates with names of all holders. We assess the changes in farm sizes and gender distribution of land using mean and median sizes, Gini coefficients, and cumulative distribution graphs. The SSLR data facilitate detailed gender-disaggregated analysis after aggregating parcel data by gender to household level and categorizing households in male- and female-headed households. The data came from 11 municipalities in four districts, covering 78,700 parcels, a total area of about 30,000 ha, allocated to 31,150 households (SSLR). Average farm size declined from 1.15 to 0.90 ha and median farm size from 0.88 to 0.63 ha from 1998 to 2016. The Gini coefficient for land per capita increased from 0.42 in 1998 to 0.57 in 2016. The female landholding share for this land was as high as 48.8% in 2016. Compared to female-headed households, male-headed households had on average 27% and 35% more land per household in 1998 and 2016. The study demonstrates the relevance of land registry data for the monitoring of farm sizes and gender distribution of land and the findings are of relevance for the Sustainable Development Goal 1.4.

Key words: *Land registry data; Farm size distribution; Gender-disaggregated landholding; Cumulative distribution functions; Gini coefficients; Ethiopia*

1. Introduction

Low-cost land registration and certification has started to expand in developing countries after Ethiopia demonstrated that such a reform could be implemented as a broad-scale reform with an order of magnitude cheaper than earlier land titling programs (Deininger et al. 2008; Jacoby and Minten 2007). The establishment of documented land rights through land registries such as in Ethiopia and Rwanda has also contributed to strengthening tenure security, and particularly so for female land holders (Holden et al. 2011; Bezabih et al. 2016; Melesse et al. 2018; Ali et al. 2014). Larger and more representative and reliable surveys, such as the Living Standards Measurement Surveys – Integrates Surveys on Agriculture (LSMS-ISA) which cover seven African countries, can be used to obtain nationally representative and reliable indicators land distribution. However, the samples per community are small with typically 10 households per Enumeration Area while land registry data are complete and can provide much more accurate measures of within-community land distributions. We therefore propose that this added value of land registry data should be taken more advantage of. We demonstrate how such land registry data can be used to assess changes in land distribution over time, including the gender distribution of land. Such data are capable of revealing more of the local heterogeneity of land distribution such as within and between communities, districts and regions.

To our knowledge, our study is the first of its kind in Africa to use complete land registry data as we investigate the documented usufruct land rights of men and women based on two land registration reforms in northern Ethiopia covering changes over a period of 18 years (Doss et al. 2015). The First Stage Land Registration (FSLR) took place in 1998 in Tigray Region and allocated household level land certificates to households in the name of the household head. The Second Stage Land Registry (SSLR) was scaled up from 2014 and it had used modern tools for registration and area measurement. All holders of parcels were registered for all parcels. These data allow us to do a much more detailed gender disaggregated analysis, including assessing the within household share of land held by women, such as the within male-headed and female-headed household cumulative shares of land held by women.

A study using farm household survey data from northern Ethiopia, where land certificates were issued in the name of household heads only, found that female-headed households have 23% smaller landholdings than male-headed households (Dokken 2015). This study draws on household land certificate data from the first stage land registration (FSLR) for a sample of surveyed households. In our study, we provide a more comprehensive assessment by utilizing data from complete land registry data from 11 municipalities in four districts. We are able to assess whether there has been a change in the degree of gender discrimination of female-headed households from the FSLR in 1998 and up to the SSLR in 2016. Some fear that the lack of joint registration of husbands and wives in the FSLR may have consequences for the gender-distribution of land rights also in the SSLR (Lavers 2017).

Reliable gender-disaggregated data on land ownership and/or landholding in developing countries is scarce. Most nationally representative surveys that collect such data are based on households' stated land sizes. The quality of such collected data is poor and should be replaced by more reliable data, for example measured using GPS (Carletto et al. 2013). Formal land registration and titling programs, where they exist, could provide more reliable information on farm sizes and parcel sizes.

The Sustainable Development Goals (SDGs) give emphasis to women's land rights and documenting these. SDG Target 1.4. states "By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property" (UN 2017). The related SDG indicator 1.4.2 to assess the performance is stated as "Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure." Work to operationalize this indicator is ongoing with UN-Habitat and The World Bank in charge of this indicator. Our study contributes to the SDGs by analyzing gender-disaggregated land registry data and thereby assess how equal the documented gender distribution of land is. The registry data does not allow us to assess gender differences in peoples' perceptions of land rights. In other words, the registry data does not also allow us to assess how the documented rights are associated with real decision-power over land. However, a number of studies have shown that the provision of documented land rights in form of

land certificates has substantially improved the perception of tenure security among land holders in Ethiopia (Holden et al. 2011a; Bezabih et al. 2016; Melesse et al. 2018). The FSLC has also contributed to more investment, improved land management, more land renting and improved social welfare in the study region (Holden et al. 2009; 2011a; Holden and Ghebru 2013). Especially female-headed households have become more tenure secure when they obtained certificates in their name (Holden et al. 2011a). Land registration appears also to have created awareness towards more equal division of land after divorce (Kumar and Quisumbing 2015). Having the name on a parcel-level certificate is therefore also likely to contribute to a strengthening of the perceived land rights among those with their name on such certificates. This needs further research, and we do not investigate it here.

Based on the data from the sampled communities and districts in Tigray Region of Ethiopia, this study, therefore, has the following objectives. First, it assesses the overall land distribution and change in land distribution over the 18 years period from 1998 (FSLR) to 2016 (SSLR) for areas that are considered representative of the densely populated highlands in Tigray. Second, it makes a gender-disaggregated analysis of the documented land rights in SSLR data by assessing the across-household and within-household landholding shares of women within and across communities. This includes an assessment of land of male-headed and female-headed households and how this has changed from 1998 to 2016. Third, it assesses the heterogeneity in the farm size and gender distributions in the included districts (*woredas*) and communities (*tabias*).

2. Gender bias in Ethiopia's land tenure systems: past to present

In order to understand the farm size and gendered land distribution changes identified in the land registries since the late 1990s, it is important to look at both the historical and contemporary land tenure arrangements of the country over the last at least 100 years. Here we rely on the existing multi-disciplinary literature and historical records of varying depth and comprehensiveness.

The land tenure system in the pre-1975 imperial period of Ethiopia has been described by many scholars as some of the most complex tenure systems in Africa (Cohen and Weintraub 1975; Rahmato 1984; Joireman 2000; Crewett et al. 2008). Here we only summarize briefly the most relevant elements of these systems in our study areas in Tigray.

2.1. Pre 1975 land tenure system in Tigray

Rist was a communal system, which was widely practiced in parts of northern Ethiopia, based on descent with granted usufruct rights to appropriate the return from the land but with no right to sell, mortgage or bequeath his or her output share outside the family. In the *rist* system, all male and female descendants of an individual founder or occupier were entitled to a share of land (Hoben 1973; Cohen and Weintraub 1975; Rahmato 1984). However, the literature suggests that in reality the *rist* system favored men over women (Hoben 1973; Bruce 1976; Hendrie 1999).

Chiguraf-Gwoses/Chiguraf-Sehabo/Shehena (the names vary across locations in Tigray). This was a mechanism peculiar to Tigray by which accessing land was based on the principle of membership to a community or residence rather than descent (Bruce 1976; Lavers 2017; Weldu 2017). The land allocation under this system was through a committee of elders who allocate each resident household head a landholding called a *gebri* (a tax unit). While female household heads could hold land in their own right, most household heads were male and landholdings were passed down from father to son (Bruce 1976). One of the criteria elders used to allocate land was the ability of households to utilize the land. Since women could not plough and frequently lacked oxen, female-headed households were likely to be given smaller holdings (Bruce 1976). The emphasis on the household head under this system therefore contrasts with the individual rights under the *rist* system to the detriment of women's rights (Lavers 2017).

2.2. Land tenure between 1975 to 1991

Following the fall of the Imperial regime of Haile Selassie, the military government *Derg* declared the agrarian reform program called 'Proclamation No. 31/1975', which was a 'Proclamation to provide for

the Public Ownership of Rural Lands' (PMGoE 1975). The proclamation states all rural land to be the property of the state without any compensation to previous rights holders. It also provided the legal basis for the distribution of usufruct rights to a large number of rural families who had been working under exploitative tenancy contracts for a small group of landlords. The proclamation also prohibits private ownership of land and the transfer of land by sale, lease, mortgage or similar means.

The other provision of the proclamation was that any person who is willing to cultivate land shall be allotted rural land up to a maximum of 10 hectares per household. Following the proclamation, mainly the Peasant Associations (PA) undertook rural land re-distribution. Rahmato (1984) noted that eligibility for access to the land from the redistribution was membership as household head in a PA including young people with the age of 18 and above who prove that they have established a homestead.

Under the then and still prevailing socio-cultural context, it was the oldest male member of the household who was typically entitled as household head. As a result, the male household head was the one registered on behalf of the family in the PA, and received the allocated land in his name. In effect, therefore, rural women were excluded from the PA membership and, consequently, were not able to acquire land in their own right. The exceptions were widows, divorcees, and those whose husbands for one reason or another, temporarily left the community (Rahmato 1984).

During the *Derg* period, some parts of Tigray, particularly the rural areas, were under the control of the Tigray Peoples Liberation Front (TPLF). Similar to the *Derg's* land reform, TPLF also abolished the nobility's rights to extract tributes and tax from the rural population. However, some argue that there were differences between the two in undertaking the reform within Tigray in their respective areas under their control. In contrast to the top-down approach pursued by the *Derg*, the TPLF used land reform to mobilize the peasantry and deliberately involved communities, including women, as active participants (Young 1997; Chiari 2004; Berhe 2008). Furthermore, the TPLF did not start with a blank canvas. Hoben (2001) argues that the TPLF reforms were broadly consistent with *Chiguraf Sehabo*, while Chiari (2004) claims

that TPLF reforms were directly inspired by *Chiguraf Sehabo.* Some also argue that TPLF built on the principle of *rist*, under which land rights were held individually by both men and women rather than by households, in its effort in providing emphasis to land rights of women (Hendrie 1999, p.79-80; Hoben 2001; Chiari 2004). It is also worth noting that women in Tigray took an active part in the civil war against the Derg regime and they may have gained a stronger social status for that reason as well (Behre 2008, p.290-292)

2.3. Post 1991 land tenure system

Following the fall of the *Derg* regime in May 1991, the Transitional Government of Ethiopia in its November 1991 declaration of the economic policy, stated no change to land policy of the *Derg* regime (TGE 1991). Later in 1995, the new constitution of the country confirmed state ownership of land in Ethiopia (FDRE 1995). It also states that any transfer of land is prohibited and land shall not be subject to sale or other means of exchange. There was no significant change in rural women's access to land in the country following the 1995 constitution and its proclamation on land at least in practice. This is because it rather confirmed the land policy of the *Derg* regime in which most rural land allocated to the smallholder farmers has been in the name of male household heads.

A number of studies revealed that the Ethiopian land redistribution policy during the *Derg* that redistributed land from relatively land-rich to relatively land-poor households created tenure insecurity and this could have negative investment effects (Alemu 1999; Holden and Yohannes 2002; Hagos and Holden 2002; Deininger and Jin 2006). To address these the government has been implementing land registration and certification reforms on a grand scale in most parts of the country as an assurance of the use rights to land (Deininger et al. 2008). Tigray is the first of the four regions that started implemented rural land registration and certification. The first land registration and certification reform of Tigray started in 1998 and unlike the practice of TPLF land reform in the 1970s, landholders were registered solely in the name of the household head. Lavers (2017) argues that the FSLR in Tigray actually threatened the land rights of

women in male-headed households. This is what we investigate in this study by inspecting the land distribution by gender in the SSLR from 2016 in the region.

3. Rural land registration and certification in Ethiopia

Ethiopia has implemented two successive rural land registration and certification reforms since the late 1990s. The first reform, First Stage Land Registration and Certification (FSLR&C) is characterized as one of the largest, fastest and most cost-effective land registration and certification reforms in Africa (Deininger et al. 2008). Though the cost of the first stage land registration was very low, a number of studies reported its positive impact in enhancing tenure security. This enhanced tenure security has contributed to a reduction in land-related disputes, increased investment on land, improved land productivity, and enhanced land rental market activity (Deininger et al. 2008; Deininger et al. 2011; Holden et al. 2009; Holden et al. 2011a; Holden et al. 2011b; Bezabih et al. 2016; Ghebru and Holden 2015). Female-headed households have in particular benefitted from the improved tenure security and this made them more able to rent out their land through sharecropping contracts (Holden et al. 2011a). This has made them more food secure and has resulted in improved child nutrition (Holden and Ghebru 2013; Ghebru and Holden 2013).

The four regions of Ethiopia (Tigray, Amhara, Oromia, and Southern Nations and Nationalities and Peoples (SNNP) had implemented the FSLR&C. These regions have also started implementing the SSLR&C. Tigray Region was the first region to implement FSLR&C in 1998 and from 2014 the region started scaling up SSLR.

The First Stage Land Certificates (FSLC) were allocated to households and provided information for the parcels households possessed user rights to. The SSLR&C aims to upgrade land registries with modern low-cost technologies, and it provides landholders parcel-level certificates with maps and modernizes rural land administrations with computerized and map-based land registries that facilitate land use planning.

The FSLR was a broad-scale registration that covered large number of communities and millions of plots of land within a short period of time (Deininger et al. 2008) through a participatory process with

the involvement of locals in the identification and demarcation of plot boundaries, with neighbors aiding as witnesses. It was primarily the individual household farmland that was included in this registration. An earlier study (Bezu and Holden 2014) noted the strengths and weakness of the FSLR&C. The strengths include the fact that it did not require skilled surveyors, it is a low-cost registration and certification process in terms of both resources and time required, and transparent for it involved broad participation of the locals. It had also a conflict resolution system in place, based on existing systems in the communities, in cases of disputed plots. The demerits include that the registration was done on registry books that were hand-written, making it difficult and cumbersome to update records in the event of land inheritances, gifts or divisions due to divorce. Unique identification numbers were provided to households rather than plots and the certificate did not include maps of the farm plots. Moreover, the data is paper-based and is not easily accessible for the purpose of land administration and policy analysis (Bezu and Holden 2014).

Based on the learning experience from the weaknesses and strengths of the FSLR&C, Ethiopia has been piloting a SSLR&C since 2005. The objective of the SSLR&C is to enhance tenure security and create records of registered and certified land that could be maintained and updated as well as to facilitate land use planning (Bezu and Holden 2014). The SSLR is based on geo-referenced registration including the geographical locations and sizes of all land in the communities, including individual plots of land, both farm plots and homesteads, as well as plots of land held by local public utilities and religious organizations. The system uses technologies such as GPS, satellite imagery or air photos. Unlike in the FSLR&C, rural households receive parcel-level certificates with maps rather than the household level FSLCs. The owners of each parcel are registered, allowing for multiple owners and the name and sex of each owner are registered. This opens for a much more detailed gender-disaggregated analysis of the SSLR data than was feasible for the FSLR data where land was registered only in the name of the head of the household in Tigray region while the name of the spouse and sometimes children were included on the household level certificate in the other regions.

It is possible that the Family Law has had some impact on how land registration and certification has been implemented. The law came in year 2000, which was after FSLR&C had been implemented in

Tigray but before FSLR&C was implemented in the Amhara, Oromia and SNNP regions[1]. The Family Law of Ethiopia in articles 57 and 58 of Proclamation No. 213/2000 (FDRE 2000) states that the property, which the spouses acquired on and after the day of their marriage by succession or donation, shall remain their personal property. Property acquired by onerous title, by one of the spouses after marriage shall also be personal property where such acquisition has been made by exchange for property owned personally, or with monies owned personally or derived from sale of property owned personally. However, this applies when the court, at the request of one of the spouses, has decided that such spouse shall own the property acquired personally. The Family Law has statements about the common property of spouses, more specifically:

Article 62.1: "All property acquired by the spouses during marriage by an onerous title shall be common property unless declared personal and approved by court."

Article 63.1: "All property shall be deemed to be common property even if registered in the name of one of the spouses unless such spouse proves that he/she is the sole owner thereof."

One of the implications of the Family Law is that the names on the certificates or in the registry may give the full information about the land rights in cases when persons with such land have married after the land registration or did not claim individual rights to the land at time of marriage. The Family Law may, however, strengthen the rights of married women beyond the documented rights in cases when their names are missing on the parcel-level land certificates of their husbands. We do not know the extent to which this part of the Family Law is enforced through local court decisions or is recognized locally.

Kumar and Quisumbing (2015) indicate that the Family Law together with the land registration has contributed to more favorable outcomes for women in asset distribution after divorce with possible long-term distributional and welfare implications. They found that women's perceptions on the right of women to share land equally upon divorce is strengthened from 1997 to 2009.

[1] It is possible therefore that the Family Law contributed to the inclusion of the names of wives on the land registries and certificates in the regions implementing FSLR&C after that but we have not come across any documentation that can confirm this.

4. Household land allocation and propositions

The distribution of land and other assets within rural societies are determined by many factors including agro-ecological, farming system, technology, market, cultural norms, power structure and government laws and regulations. Most land is possessed by agricultural households who are the decision-makers and rely on land as a major source of livelihood. The distribution of land and rights to land have been central to radical policy reforms in many countries, including Ethiopia.

Changes in the distribution of land over time within a society depend on the mechanisms of redistribution. The three primary mechanisms are political/administrative redistributions, market transfers, and bequeath/inheritance. After the radical 1975 land reform in Ethiopia, administrative redistributions were the dominant form of land transfer as all land was state property. With the introduction of the FSLR&C the land rights of individual households were strengthened and opened for bequeath and inheritance of land as the main transfer mechanism as administrative redistributions should be drastically reduced while land sales remained illegal.

On the overall evolution of farm sizes and equality of land distribution we have the following propositions to assess with the data:

Proposition 1a: *Due to population growth and sub-division of land, farm sizes have been reduced from 1998 to 2016.*

Proposition 1b: *The change in farm sizes over time has resulted in more unequal farm size distribution over time (increasing Ginis for land per capita over time among land holders).*

While land may be managed individually within households in some countries, in the case of Ethiopia land management and control is typically centralized to the household head (Fafchamps and Quisumbing 2002). Fafchamps and Quisumbing (2002) noted that this is consistent with Boserup's (1965) hypothesis that as households move from hoe to plow cultivation, farm management becomes centralized because of returns to scale in production. Plow cultivation dominates in our study areas. We therefore

organize our gender-focused analysis by comparing land distribution across and within male- and female-headed households.

FSLR&C was in the name of household heads in Tigray region, unlike in the other regions where FSLR&C was in the names of both husband and wife in married households. We question whether this could have marginalized the wives and women in terms of documented land rights in our study areas as the majority of households were male-headed in the FSLR&C. This could lead to a strong gender bias in allocation of land in the SSLR&C (Lavers 2017). We therefore propose:

Proposition 2a: *Males have the lion's share of the documented land rights after SSLR.*

Administrative reallocation of land in the period before FSLR was also primarily to young males who typically married after they had been allocated land and they thereby brought land into marriage and became household heads with decision-power over the household's productive assets (Fafchamps and Quisumbing 2002). Fafchamps and Quisumbing (2002) used household survey data from 1997 and found that two-thirds of household land was obtained through administrative allocation made by local Peasant Associations. Most inherited land held by households was brought in from the husband's family.

Our second proposition is therefore;

Proposition 2b: *A large share of land held by male-headed married households is in the name of husbands or male family members only in the SSLR data.*

Female-headed households may be widows, divorced or single women. Fafchamps and Quisimbing (2002) found that very few female-headed households had inherited their land from their family. Female-headed households may have retained their family's land if widowed. However, there was more variation in the share of household land allocated to the wife in the case of divorce. They were more likely to receive at least half of the land when husbands were at fault of the divorce (48%), than when it was nobody's fault (44%), or when it was their own fault (12%) (ibid.).

Dokken (2015), using household survey data from Tigray region collected in 2010, found that female-headed households have 23% smaller landholdings than male-headed households. Based on this, we propose the following proposition;

Proposition 2c: *Female-headed households are more land-poor than male-headed households are and this remains the case after correcting for household size differences (assuming that household sizes in female-headed households on average are smaller than in male-headed households).*

There can be various ways to strengthen the land rights of women. One of these is through better legal documentation of their rights. By introducing joint land registration and certification of husbands and wives in some regions in Ethiopia where low-cost land registration and certification was implemented, women's land rights may have been strengthened and such land registry data may potentially be used to investigate the gender distribution of land rights (Holden and Tefera 2008; Bezabih et al. 2016; Melesse et al. 2018). A study based on FSLR in Amhara Region in Ethiopia, where joint certification of husbands and wives was practiced, provides evidence that 29% of the land was registered in the name of women, 33% in the name of men, and 39% was jointly registered in the names of husbands and wives (Teklu 2005).

The land registry data do not allow us to establish the underlying causes of the (variation in) land distributions. Historical factors such as tenure systems and political land allocation mechanisms, impacts from the FSLR on the SSLR, and the Family Law may all have influenced the outcomes seen in SSLR data. Related to this ambiguity we want to assess the following:

Proposition 2d: *In the SSLR, land is shared equally by gender in married male-headed households.*

This may be the result of the traditional strong role of women in Tigray, the Family Law as well as the influence and emphasis on joint certification of land through the government land registration and certification program. This proposition is opposing the previous propositions 2a, 2b and 2c.

Fafchamps and Quisumbing (2002) found that there was large variation in the land allocation practices across locations in Ethiopia. Northern locations were more generous towards women. Average disposition rules within communities were the best predictors of allocation, consistent with community norms having a strong influence on asset distribution locally. However, their sample was not large enough to investigate the extent of within-region variation from community to community. Our detailed land registry data allow us to make such an assessment of the extent of between community variation in land allocation by gender within male-headed and female-headed households. We test:

Proposition 3: *The gendered land distribution is relatively homogenous across communities (tabias) within Tigray region.*

This region is homogenous in terms of ethnicity and religion and we therefore expect there to be small differences in norms for land allocation by gender across communities within the region. However, in one of our included districts, Raya Azebo, both orthodox Christian and Muslim religions are practiced widely and the district is also home to people whose ethnic origin is Oromo. We assess this proposition by inspecting the variation in key variables across districts and across communities within districts.

5. Data and methods

We have established a good working relationship with the Federal and Regional Land Administrations in Ethiopia, which provide us access to the land registry data. We have sampled the following *woredas* (districts) with one to four *tabias* (municipalities) to represent the highlands of Tigray where smallholder agriculture dominates: Raya Azebo (3 *tabias*), Degua Tembien (3 *tabias*), Seharti Samre (4 *tabias*), and Kilite Awlalo (1 *tabia*) (Fig.1). These *woredas* and *tabias* capture important variation in agro-ecology, market access, population density, and irrigation access in the highlands of the region. We obtained access to the FSLR and SSLR data of the 11 *tabias* from the four districts' Land Administration Offices.

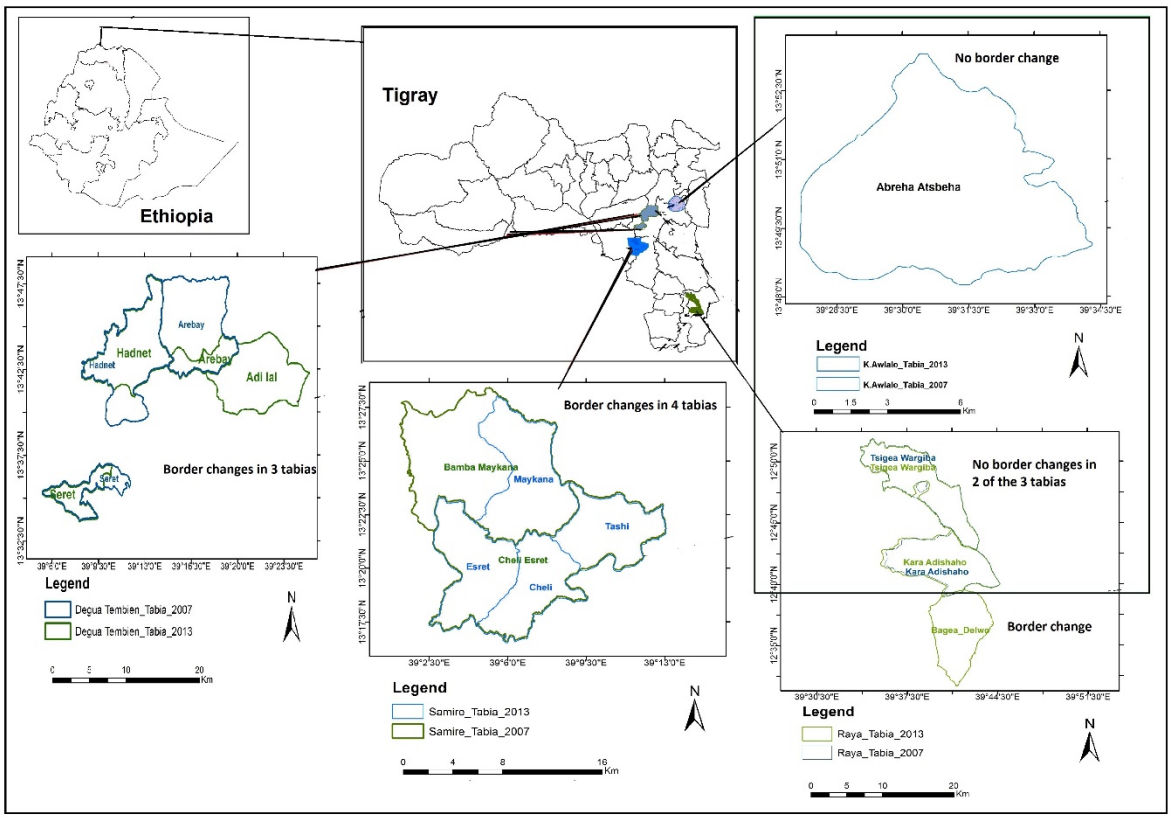

Fig. 1. Map of districts (*woredas*) and communities (*tabias*)

We used the complete SSLR data to measure the share of land area with documented land rights that is held by women. Each parcel can have a number of holders. We have left out public land and look only at land allocated to households. For parcels of land with more than one holder, we divide the area by the number of holders, assuming each holder has an equal share of the parcel. We know the gender of all holders and can based on this calculate the share of each parcel that is held by women. We aggregate this information to household level after having identified parcels that belong to the same household in the registry. The share of household land that is formally held by women can then be uniquely identified. By identifying different types of households, such as male-headed and female-headed households, we can assess the within-household type variation in gender distribution of land for each of these household types. The land registry data also include information about the family size of the landholders in most

communities. This information helps us to further classify household types by household size and gender. We use this for further robustness assessment of the gender-disaggregated measures of land distribution.

By utilizing the full registry, we get very accurate measures of local land distribution as we use the complete registry data for included communities where all registered parcels were carefully measured.

The FSLR data for the selected *woredas* and *tabias* were available only in hard copies on the land registry books at the *woreda* Land Administration Offices. We computerized this information into Excel files by preparing a template containing all the information available on the land registry books. As indicated in section 3 above, although the FSLR and certification process was described as a broad-scale and cost-effective process, it is important to acknowledge the limitation it had in terms of measurement precision. The accuracy of area measurements in the FSLR can be questioned, as only traditional tools, like rope, were used for the measurement. Such measurement error may particularly be large in difficult terrain. We assessed the reliability of the FSLR data in two ways; a) a farm plot level sample comparing FSLR parcel sizes with measurement tape-measured parcel sizes, and b) by comparing household farms that had not changed household heads or farm sizes from FSLR to SSLR, see Appendix A1 for the detailed analysis.

The second challenge was to map parcels and their holders into households within communities. The data had to be sorted by the names of the holders and into household types (male-headed and female-headed households) based on gender of holders. We also utilized the information on family size that is given for each parcel in the registry data and the combination of names on SSLR parcels. The names of holders were also used to match households in the FSLR and the SSLR data. We found there to be few cases where several persons had exactly the same name within a community.

Not all male-headed households may be married and we do not have the marital status of households. Single person male-headed households may be unmarried, widowed and divorced single males and vice versa for females. The cultural norms with a strict gender division of labor and husbands taking the roles as heads of households have strong impact on how individuals organize themselves in households. It is rare that men live alone compared to women in rural areas in Ethiopia where men usually do not cook. Divorced men also for that reason tend to remarry quite quickly. We therefore categorize households as

male-headed and female-headed and inspect the gender distribution across and within each of these categories. The strict gender division of labor with ploughing of land with oxen considered as a male task causes female-managed plots to be a rare case in the oxen-based farming system in Ethiopia compared to in some other African farming systems. It also results in many female-headed households with shortage of male labor and oxen renting out their land to households with such resources (Holden et al. 2011a).

To reduce the eventual bias in intra-household land distribution due to the inclusion of single person households, we also ran the analyses for households with household sizes greater than one and greater than two. The overall results for intra-household distribution of land by gender within male-headed households was not very sensitive to these modifications in the sample due to the small share of such single-person male-headed households. We further ran the analyses for households in six communities with reliable family size data in which the community-level average family sizes are four and above and found consistent results.

Non-agricultural land was excluded such that only agricultural land was included in the analyses of farm size distributions. The female held share of agricultural land is calculated for each parcel as explained earlier. We assumed that each holder has an equal share of a jointly held parcel independently of whose name is stated as the first name on the parcel-level land certificate[2]. Female held land within a household is then the aggregated shares of female held land across parcels (weighted by parcel size) within the household. Further aggregations of female and male held land to community, district and total sample are done to obtain the total shares of female and male held land. In order to assess the distribution of female and male held land across households within communities, districts and the total sample, Gini-coefficients were calculated together with mean and median land sizes. Similarly, farm size distributions across and within female-headed and male-headed households were assessed using mean and median sizes and Gini-distributions. The farm size distributions were also illustrated with cumulative density functions (CDFs). Such functions were also used to assess the variation in farm size distributions across districts and

[2] While this assumption can be questioned, we have no better way to deal with it if we want to assess the within-household gender distribution for households holding several plots and the names of holders vary across plots.

communities as well as to assess the variation in women's shares of landholdings within household types for different household types and communities. This included the variation in the gender distribution within male-headed and female-headed households as well as the variation in the gender distribution of land within male-headed households across communities. Robustness checks were made by dropping single person households.

6. Results and discussion

6.1. Overall farm[3] size distribution

We start our analysis by assessing the overall land distribution and how it has changed over time from 1998 to 2016. We use the land registry data to assess the first two Propositions 1a and 1b.

Table 1.
Farm size and farm size distribution by year of land registration

	Average farm size	Median farm size	No of households	Gini-cofficient Household farm size
1998 (FSLR)	1.146	0.875	12532	0.377
2016 (SSLR)	0.897	0.625	31150	0.497

Source: Tigray Land Registry data from District Land Administrations. Only agricultural land included in SSLR data, non-agricultural land was not included in FSLR. The data are from the same districts and communities for the two years.

In order to assess the homogeneity or variation across districts and communities in our sample (Proposition 3) for the farm sizes and changes over time we report community (*tabia*)-level figures in Table 2. Our Proposition 1b that the farm size distribution has become more skewed from FSLR to SSLR cannot be rejected. For the total sample, the Gini has increased from 0.38 to 0.50. The change in borders for many of the communities implies that this comparison is not "clean" and this may explain why the mean and median farm sizes have increased in some communities[4]. We also notice the large increase in the number

[3] By a farm we mean the combined agricultural parcels held by a household. We do not have information on the rental status of parcels and can therefore only measure the total agricultural land area registered in the name of household members and not the area they are actually farming themselves.
[4] The exception is Abreha Atsbeha where there has been substantial conservation investment that may have contributed to land reclamation.

of households over this time period which mostly is explained by the high population growth rate. Table 2 gives the disaggregated Ginis for each community in the FSLR and SSLR data, together with mean and median farm sizes.

Table 2.

Farm size distributions in FSLR and SSLR, by community (*tabia*).

District (*Worda*)	Community (*Tabia*)	---------- FSLR ----------				----------SSLR----------			
		Mean	Median	Gini	N	Mean	Median	Gini	N
Raya Azebo	Bagea Delewo	1.114	0.750	0.314	1283	0.931	0.660	0.399	4324
	Kara Adisheho	1.325	1.125	0.337	2673	0.912	0.725	0.483	4623
	Wargiba	1.599	1.375	0.367	1584	1.155	0.892	0.557	2710
Degua Tembien	Seret	1.264	1.063	0.356	932	0.470	0.350	0.471	2918
	Arebay	1.165	1.000	0.495	656	0.667	0.470	0.538	1686
	Adilal	1.176	1.000	0.399	909	1.143	0.850	0.436	2610
Kilit Awlalo	Abreha Atsbeha	0.728	0.688	0.304	888	0.875	0.681	0.532	1728
Seharti Samre	Cheli	0.824	0.625	0.281	723	1.524	0.962	0.535	1815
	Tashe	0.703	0.625	0.28	1523	0.824	0.529	0.47	3347
	May Kana	0.934	0.869	0.374	1010	0.839	0.526	0.492	2803
	Esre	1.701	1.500	0.312	351	1.240	0.751	0.431	2593

Source: GoE Land Registry Data, own calculations.

Table 2 shows that the median farm sizes have been reduced in 10 out of 11 communities over the period. The Ginis have increased in all communities with the Ginis in the range 0.28-0.50 in FSLR to the range 0.40-0.56 in SSLR. If we inspect the three *tabias* that have not had any change in their borders in this period (Kara Adishebo, Wargiba and Abreha Atsbeha), we see that the Ginis for farm sizes have increased from 0.28-0.49 to 0.40-0.56. This is evidence in support of Proposition 1b. The data are also demonstrating limited variation across sites in favor of our Proposition 3.

One issue is, however, whether the measurement of farm sizes during FSLR was accurate enough to provide reliable estimates. We assessed this in Appendix A1. There we can see that rounding errors were common in parcel measurement (Fig. A1.1) and there was a tendency that farm sizes were underestimated, particularly for larger farms (Tables A1.2 and A1.3, and Fig. A1.1 in Appendix A1). This implies that the

estimates of farm size reduction in Tables 1 and 2 from FSLR to SSLR may be underestimated. We compared the Ginis for a matched sample of farms with the same household heads in 1998 and 2016. For the FSLR data the Gini=0.392 and for the SSLR data the Gini=0.389. This indicates that measurement error cannot explain the large change we see in Gini coefficients over time.

6.2. Gender distribution of land

Next, we look at the gender distribution of land in the SSLR data to assess Propositions 2a-2d. A detailed overview is given in Appendix A2, Table A2.1. Overall, the female landholding share for the total land area of 30,000 ha is as high as 48.8% and indicates considerably less skewness in the distribution between men and women than we had imagined. There is little variation in this share across the districts. The largest area of this land (46.7%) has been registered in the names of one male and one female as joint landholders. Parcels registered with single male holders account for 26.1% of the total registered land area and parcels with single female holders account for 24.2%. Further details for the distribution of the land registry data for the 11 communities is presented in Table A2.1 and A2.2. This evidence seems therefore to lend little support for our two Propositions 2a and 2b, while it is more in line with Proposition 2d. Women are less disadvantaged in documented land rights than we had expected.

In Table 3 we go further in the analysis of land distribution in male-headed and female-headed households by utilizing also household size data where that is available. For the FSLR data, we used the gender of household head for the household level certificates to classify households into female-headed and male-headed households. We compare farm size for the two types of households as well as farm size per capita for them.

A sensitivity analysis is made, leaving out single person households; see Table A2.5 in Appendix A2. We expect household sizes to be smaller on average for female-headed households than for male-headed households. Our Proposition 2c states that female-headed households have less land than male-headed households, even when it comes to land per capita (Fafchamps and Quisumbing 2002; Dokken

2015). Based on the table we calculated that female-headed households have a farm size that is about 27% lower in the FSLR data and 35% lower in the SSLR data than that of male-headed households. This can be compared with the 23% that was reported in an earlier study (Dokken 2015) from the same region based on a smaller sample utilizing FSLR data. After we have corrected for family size, the difference is down to 5-8% in the favor of male-headed households in the FSLR data and down to 8-12% in the SSLR data. The range captures the variation between the full sample and the sub-sample of six *tabias* with more reliable family size data. For the FSLR data, we had more reliable family size data in six out of the 11 *tabias*. We therefore made the calculations of farm size and land per capita for this sub-sample of *tabias* with the FSLR as well as the SSLR data as a robustness check (Table A2.4). This gives evidence in favor of our Proposition 2c that female-headed households have less land per capita. The figures seem also to indicate an increase in the gap in the farm size and land per capita between female-headed and male-headed households from the FSLR and to the SSLR.

Table 3.

Farm land size and land per capita for male- versus female-headed households in 1998 and 2016

	Statistic	Male-headed		Female-headed		Total	
		Farm size	Farm size per capita	Farm size	Farm size per capita	Farm size	Farm size per capita
1998 FSLR full sample	Mean	1.237	0.553	0.906	0.510	1.146	0.541
	Median	1.000	0.375	0.750	0.375	0.875	0.375
	St.error	0.009	0.005	0.010	0.007	0.008	0.004
	Gini	0.376	0.391	0.348	0.428	0.377	0.419
	N	9100	9044	3432	3407	12532	12451
2016 SSLR full sample	Mean	1.001	0.321	0.663	0.283	0.897	0.309
	Median	0.690	0.181	0.532	0.157	0.625	0.172
	St.error	0.007	0.004	0.006	0.004	0.005	0.003
	Gini	0.502	0.565	0.436	0.567	0.497	0.566
	N	21479	15297	9669	7186	31148	22483

Source: Tigray Land Registry data from District Land Administrations. *Note:* This table includes data from all male-headed and female-headed households independent of family size. Agricultural land per capita is calculated based on average family size across parcels within households (some discrepancy in these may be a source of error, see Table A3 in the Appendix for a comparison).

When it comes to how inequitable the land distribution is among male-headed households and among female-headed households we see, like for the female-held versus male-held land across households,

that the Gini is higher among male-headed (0.38 in the FSLR versus 0.50 in the SSLR) than among female-headed households (0.35 in the FSLR versus 0.44 in the SSLR). After correcting for family size, we find the Ginis to be higher for both male- and female-headed households, increasing from 0.39 and 0.43 in the FSLR to 0.57 and 0.57 in the SSLR for the full sample with family size data (Table 3). The sub-sample with more reliable family size data gave slightly higher Ginis, especially in the SSLR data (Appendix Table A2.4).

To get an idea of the sensitivity of these data to inclusion of single-person households we made the same analysis as in Table 3 but dropped single person households for the SSLR data. The average family size used in Table 3 is associated with some uncertainty in the SSLR data as it was quite often found to vary across parcels within households. We therefore replaced it with the maximum family size across parcels within households.

To get a better visual perspective of the farm size distribution of 21,481 male- and 9,669 female-headed households in the SSLR data, we present their cumulative distributions in Fig. 2 after subtracting non-agricultural land holdings for all households. We see there are very few households with farm sizes that are more than 5 ha. More than 80% of the farm sizes with female heads are below one ha while more than 60% of the farms with male heads are below one ha. The graph indicates that about 10% of the households in the land registry have no farmland (slightly more male-headed than female-headed households have no farmland). These households are in the registry because they have non-agricultural land that is registered there. Landless households would otherwise not be in the registry and land registries cannot be used to assess the extent of landlessness. A separate census or survey would be required for that.

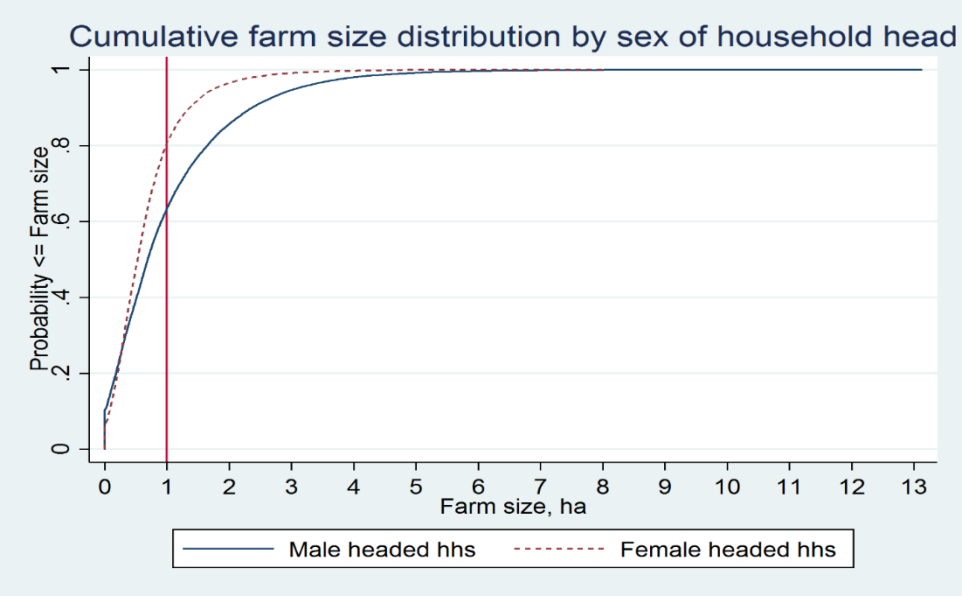

Fig. 2. Farm size distribution of male and female-headed households in SSLR, full sample (31,150 households)

Next, we assess the cumulative within-household variation in share of total land that is held by females, giving equal weight to each of the 31,150 households in the total sample in Fig. 3. The figure sorts and aggregates households by increasing share of the land held by female family members. Fig. 3 shows that about 26% of the households have land purely held by males (vertical line from 0=female share on the x-axis). Similarly, we see that about 30% of the households have land purely held by females (vertical line from 1=female share on the x-axis). About 12% of the households have a female share between zero and 50% whereas about 27% have a 50-50 share between the genders (vertical line at 0.5=female share on the x-axis), while only about 4% have a female share between 50 and 100%. We may recall that the parcel-level analysis found that 46% of the parcels had 50-50 sharing of land by a female and a male holder.

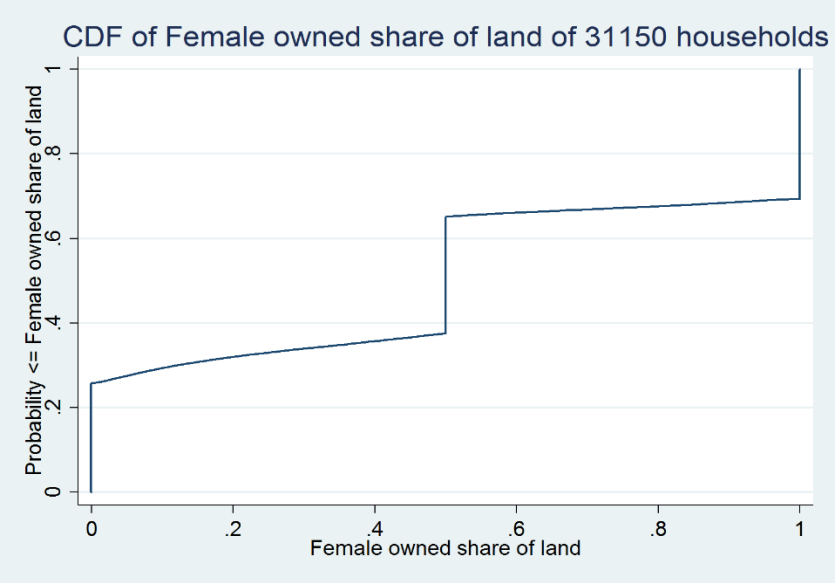

Fig. 3. Cumulative distribution function for females' share of household land based on SSLR data from 31,150 households across four districts in Tigray

Fig. 4A and 4B show the cumulative within-household variation (cumulative distribution function – CDF) in share of land held by females where total private land is divided in non-agricultural and agricultural land**.** Fig. 4A shows that about 60% of non-agricultural land is split 50-50, whereas 20% is split 0:100 and the remaining 20% is split 100:0 between women and men, indicating no overall gender bias among those having non-agricultural land. In Fig. 4B we see that 50-50 split is less common for agricultural land than for non-agricultural land (only about 25% compared to the 60% in non-agricultural land). It is more common with pure male landholding (33%) or pure female landholding (30%), but also more common to have deviations from the corner solutions and the 50-50 split for agricultural land.

In Fig. 5A and 5B, we investigate the variations in these patterns of within-household distributions across districts and communities. We see there is no big variation across districts but somewhat stronger variations across communities. The share of farms with females with no landholding right varies from 20 to 40% across communities while the share of males with no landholding right varies from 20 to 35%. The share with 50-50 split varies from 20 to close to 50%. This is informative related to our Proposition 3.

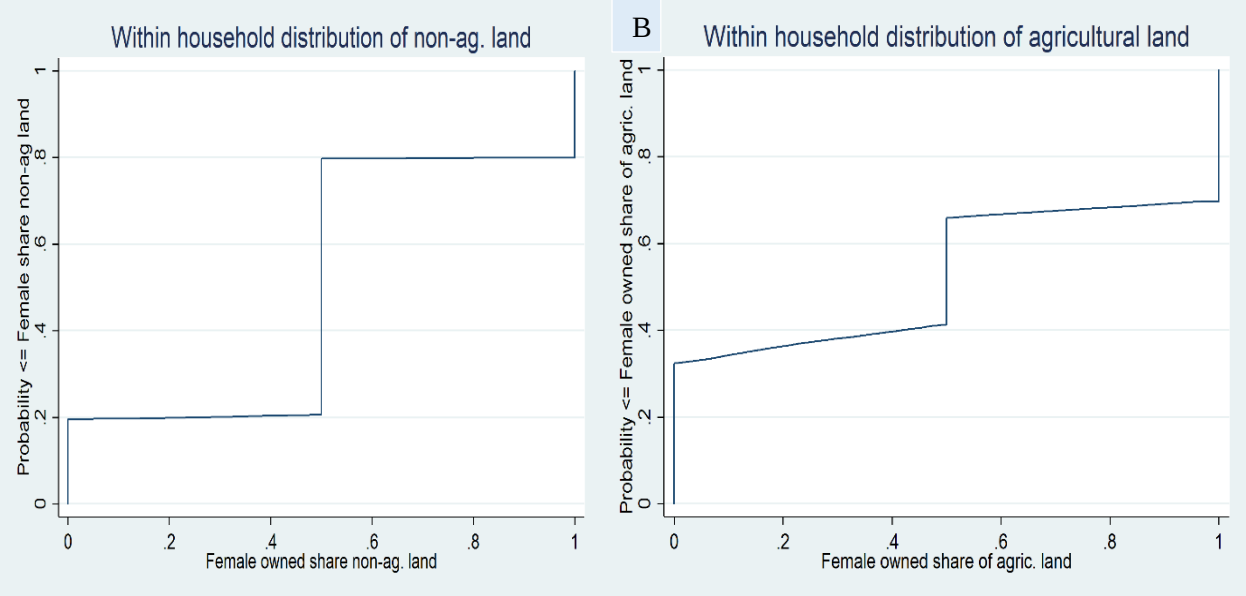

Fig. 4A and **4B.** Cumulative distribution functions for female share of non-agricultural and agricultural land

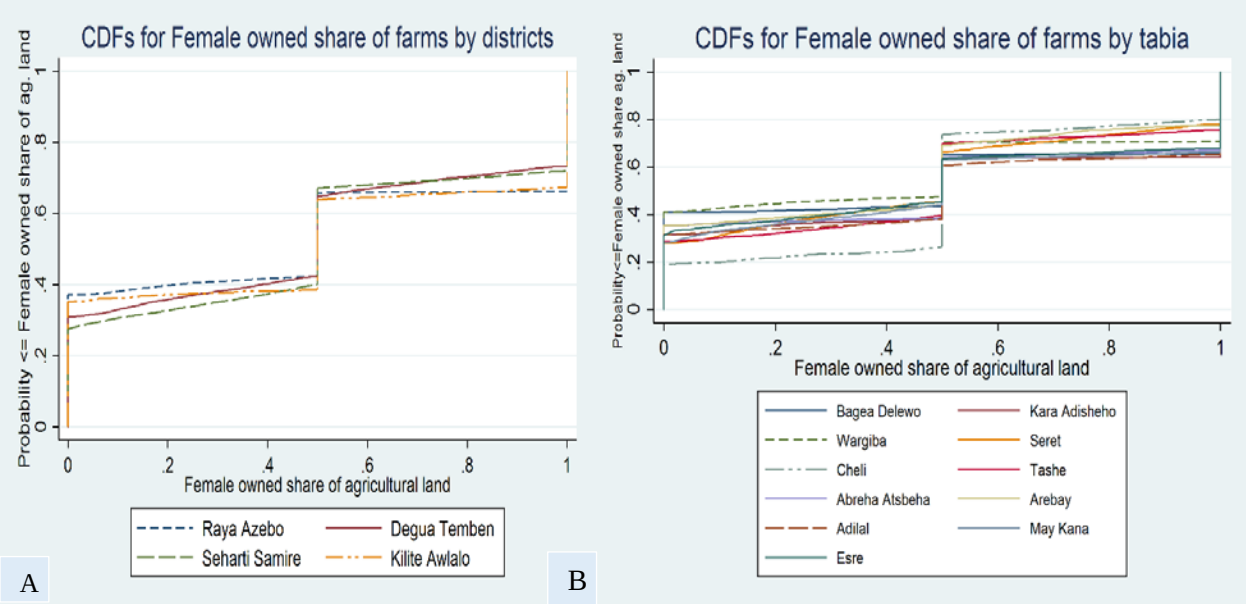

Fig. 5A and **5B.** Cumulative distribution functions of farms based on females' share of farm holdings based on SSLR by *woreda* (district) and by *tabia* (municipality)

Next, we investigate the gender distribution of land within male-headed and female-headed households (see Fig. 6). The figure shows that close to 45% of male-headed households have zero female land landholding while close to 35% have 50-50 sharing of land among the genders. Close to 15% have a female landholding share between zero and 50%, and only about 5% have a female landholding share between 50 and 100%. For female-headed households the female share is 100% for more than 90% of the households. We should

remember that male-headed households consist of married couples as well as single male households, however. We therefore carried out the same analysis after removing the single person households from the sample. However, this created only a very small change in the graph because the single-person male-headed households is such a small share of the total number of male-headed households (graphs are available from the authors upon request).

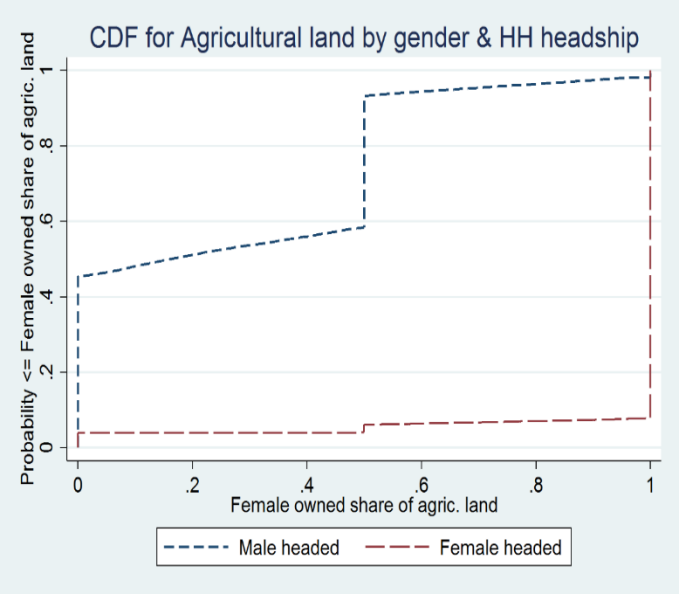

Fig. 6. Gender distribution of agricultural land within male-headed and female-headed households, full sample

Fig. 7 shows the variation in gender distribution of land within male-headed households across the 11 *tabias*. We see that the share with zero female landholding right varies from 25 to about 60% and the share of households with 50-50 split also varies from about 25 to 60%. Of the remaining 15%, most have between zero and 50% shares. Also for this graph, we assessed how robust the results were to removal of single-person male-headed households. Again, we detected only small changes in the distribution across communities, with a few exceptions (see Fig. A2.1 in the Appendix). This leads us to question Proposition 3 and we think this indicates that there exists substantial local variation in community norms for gendered land allocation within Tigray region.

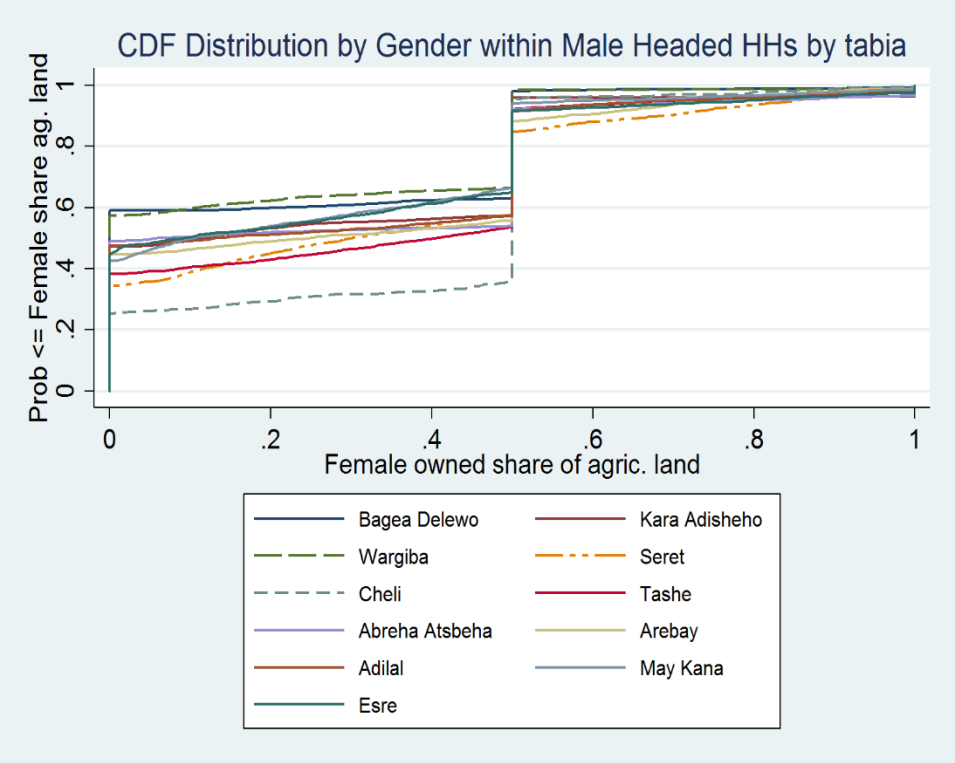

Fig. 7. Within male-headed households gender distribution of agricultural land by *tabia*.

7. Overall discussion

To our knowledge, this is the first comprehensive study of this nature utilizing complete land registry data from two points in time in Africa to assess changes in land distribution over time and how equal the distribution of land is among men and women in female- and male-headed households. The study areas should be quite representative for the highland areas of Tigray Region in northern Ethiopia where most of the population lives. Land registry data are likely to become more important for the monitoring of land distribution in the future, as land registration has started to expand in Africa in recent years due to the dramatic reduction in costs of land registration and increasing land values associated with population growth and economic development. Our approach to using land registry data for the assessment of the gender distribution of land is relevant in other regions of Ethiopia and other countries where formalization of land rights have taken place, and are organized in land registries. Technological developments in

computer technology, mapping and digitalization have tremendously reduced the costs of land registration and certification and made such investments affordable in poor countries. Several other African countries have therefore started or are planning such formal land registration. This type of analysis also provide useful inputs for the assessment of the compliance with SDG1.4 in terms of the distribution of documented land rights by gender. It needs to be accompanied with complementary studies to be able to tell how such documented land rights affect tenure security and decision-power of landholders by gender to get closer to the full assessment of SDG1.4. Having the name on the certificate for a parcel does not mean that all with their name on the certificate have equal decision-power over the parcel. Such power is likely to be stronger for the (male) head of the household.

Overall, we found declining farm sizes and increasing Ginis over the 18 years period from 1998 to 2018 in line with our Propositions 1a and 1b. With the median farm size down to 0.625 ha in 2016 farm sizes are becoming alarmingly small and barely provide the basis for sustainable household livelihoods in this semi-arid environment in the face of climate risks and change. Continuing population growth implies further pressures on farm sizes and growing landlessness.

The overall assessment of the gender distribution of land distribution suggests close to gender equality in the distribution of documented usufruct right to rural land in the study areas with 48.8% of the land being in the name of females (based on the equal sharing principle in data aggregation). It is, however, likely that males have stronger rights over jointly held land with females (Doss et al. 2018), and 46.7% of the land was jointly held by one female and one male holder. 24.2% of the land was held by a single female holder, and 26.1% was held by a single male holder. Farm sizes and land per capita were still larger in male-headed than female-headed households and this difference had not been reduced from 1998 to 2016. A large share of land registered to females is belonging to male-headed households. It is a very positive finding that female family members to a large extent were included on the parcel certificates for such households in the SSLR after the farms were registered in the names of their male heads only during FSLR. This finding

indicates less negative distributional consequences of the FSLR approach in Tigray than was anticipated by Lavers (2017).

The land registry data do not tell anything about the effects of women having their names on the parcel level certificates in terms of their decision power over land. Further studies are needed to investigate this. The fact that rural land laws (proclamations) back the land registration is likely to contribute to a strengthening of the land rights of those having their names on land certificates. In Tigray Region Holden et al. (2011a) found that having a FSLC strengthened the perceived tenure security of female as well as male household heads and this made female-headed household more willing to rent out their land. In southern Ethiopia, Holden and Bezu (2014) found that women who got their name on the land certificate in male-headed households have become more aware of their land rights and more able to influence land renting and crop choice decisions within the household. The land laws in southern Ethiopia state that consent from the family is required before land can be rented out. It is not unreasonable to assume that the inclusion of names of other family members than the household head on the parcel-level certificates implies a more secure right also for these additional household members in our study areas. We recommend further research on this issue.

The existing Family Law implies that land registered in the name of the male household head remains his property if he was allocated the land before the marriage and his spouse has no usufruct right to this land. Therefore, the gender bias in the distribution of land will remain unless there is some change in the family law that will enhance equal land use rights among men and women in male-headed households, which is the dominant household type in rural Ethiopia.

Certainly, we cannot generalize about the gender distribution of land in Africa based on our study area in northern Ethiopia. It is possible that it is indicative of what we may find in other regions of Ethiopia but that needs further verification. Land registry data exists making this feasible. Rwanda also has recent land registry data that could be used for a gender-disaggregated analysis as we have done with the SSLR data.

Land tenure systems in Africa are very diverse. There is therefore a need to carefully examine the tenure systems in each country before one can decide on how best to assess and promote more gender equity in land distribution.

8. Conclusions

We have carried out the first comprehensive comparative assessment of First Stage (FSLR) and Second Stage Land Registry (SSLR) data in Ethiopia. We assess the changes in farm size and gender distributions of land based on registry data from four districts and 11 communities in Tigray Region of Ethiopia over the 18 years period from 1998 to 2016. The study areas represent the densely populated semiarid highlands in northern Ethiopia. We organized the analysis around a number of propositions and the conclusions follow.

The findings strongly support Proposition 1a that population growth has contributed to subdivision of farms and average and median farm sizes have been substantially reduced from 1998 to 2016. The subdivision of farms has also resulted in increasing Ginis for within-community farm size distributions in most of the communities in the same time period, in line with Proposition 1b. A median farm size of 0.625 ha in 2016 in the study areas is alarmingly small in this semi-arid environment where most households do not have access to irrigation.

Regarding the gender distribution of land it was less skewed than stated in our Proposition 2a. Females had documented land rights to as much as 48.8% of all privately held land (assuming equal sharing among registered holders) in our study areas and we found little variation in this distribution across districts. 24.2% of all land was held by a single female holder and 46.7% was jointly held by one female and one male holder. When assessing the gender distribution of land within male-headed households we found somewhat larger variation across communities than across districts. The share of male-headed households with no female landholders varied from 25 to 60% across communities and this fairly high share remained in the range of 22-58% after dropping the single-person (unmarried) male households. Our Proposition 2b stating

that a large share of land held by male-headed married households is in the name of husbands only, is therefore finding stronger support in some communities.

Male-headed households had on average 27% more land than female-headed households in the FSLR data but this was reduced to 5-8% in terms of land per capita. This provides some support for Proposition 2c that female-headed households are more land-poor than male-headed households. These differences in land per household and per capita between male- and female-headed households also increased from the FSLR to the SSLR data.

Overall, we find a gender bias in the distribution of land rights in northern Ethiopia but the bias is lower than what we had expected given the traditional patriarchal system and dominance of men in agriculture. This may be because the customary tenure systems and norms in Tigray and the political redistributions in the region emphasized equal sharing of land based on family needs. We cannot rule out that the Family Law also has played a role and contributed to enhancing the joint registration of holders in the SSLR in Tigray and in the FSLR as well as SSLR in the other regions where SSLR was implemented after the Family Law was enacted.

The land registry data of Tigray and other regions of Ethiopia is the result of investments by the government, donors and development partners of the country. It is potentially an important resource for operationalizing the reporting of national achievements on documented land rights by gender as an input in monitoring SDG 1.4, and for research and future policy analysis in the rural land sector. Further research is needed to investigate how instrumental such documented rights are towards strengthening women's real decision-power over land shared with men. We recommend similar analyses in other African countries where households and persons have been given documented land rights such as through joint registration and certification of husbands and wives as an input into the monitoring of SDG 1.4.

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Appendix.

A1. Assessment of farm size reliability in FSLR data

To get a better picture of potential measurement error in FSLR data, we used own household and parcel survey data where we have collected data from housholds' FSLCs and measured the same parcels with measurement tape for a sample of 780 parcels in 16 communities. Table A1.1 and Fig. A1.2 show the correspondence between FSLR measured and tape measured parcel sizes in this sample.

Table A1.1 shows that tape measured parcel sizes were on average about 16% larger than the FSLC measures of the same parcels. Measurement errors were substantial. "Rounding errors" were common in FSLR as parcel sizes were usually given in whole *tsimdi*[5] units. Fig. A1.1 illustrates the concentration of FSLR parcel sizes at whole *tsimdi* units.

Table A1.1.

Assessment of reliability of parcel sizes in FSLR&Cs

Stats	FSLC size	Measured with tape (M)	Difference (M-FSLC)
Mean size in *tsimdi*	1.050	1.220	0.169
Standard deviation	0.926	1.244	0.911
Standard error (mean)	0.033	0.045	0.033
N	780	780	780

Source: NMBU-MU household survey 2006. Areas measured in *tsimdi*, 1 *tsimdi*=0.25 ha.

We have assessed the effect of the downward bias in parcel and farm sizes by matching FSLR and SSLR data for all households that have not changed household heads or farm sizes from 1998 to 2016 in the 11 communities for which we had access to FSLR and SSLR data. The distributions of these farm sizes are

[5] One *tsimdi* is the area that a pair of oxen can cultivate in a day, and is usually about 0.25 ha (our conversion factor).

presented in Fig. A1.2. We see the tendency that the FSLR data underestimated farm sizes and particularly so for the larger farms. This implies that our assessment (Tables 1 and 2) of farm size changes from 1998 to 2016 in terms of a reduction in farm sizes is underestimated. This strengthens our conclusion about a substantial reduction in farm sizes over this period for households that have changed household heads. This rests on the assumption that farm sizes for farms that have changed holders from 1998 to 2016 were underestimated in a similar way as those presented in Fig. A1.2 and that had not changed over this period.

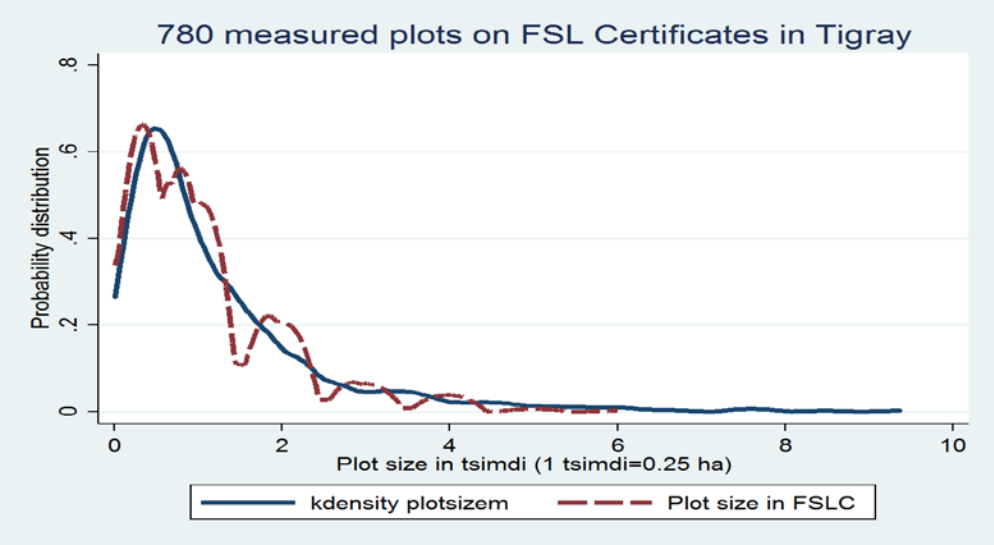

Fig. A1.1. Kernel density graphs (probability distributions) for FSL Certificate parcel sizes versus tape-measured parcel sizes.

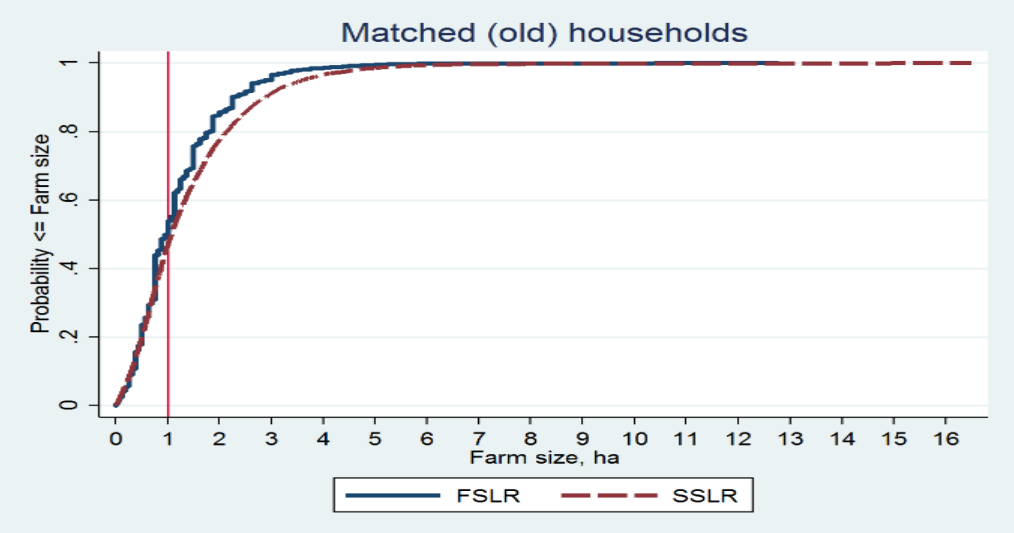

Fig. A1.2. Farm size distributions for matched unchanged farms in FSLR and SSLR.

A2. Overview statistics of the gender distribution of land

The parcel-level distribution of land by gender for the total land registry data from the SSLR is given in Table A2.1 from the 11 *tabias* in four *woredas* in Tigray. It includes all private registered land in these communities, including agricultural and non-agricultural land. The total sample of close to 78,700 parcels represents an area of 30,000 ha. The largest area of this land (46.7%) has been registered in the names of one male and one female as joint landholders. Parcels registered with single male holders account for 26.1% of the total registered land area and parcels with single female holders account for 24.2%. The remaining 3% of the land area has been registered in the names of joint landholders that are both males, both females, and three to eight persons with different gender compositions as join landholders (Table A1). If we look at the first three most important categories of land holders (one male, one female, and joint holders of male and female), mean parcel size is 0.34 ha/parcel for the land registered in the name of single female holder. Whereas 0.36 ha/parcel for single male held parcels and 0.42 ha/parcel for joint male and female held parcels.

Next, as land is held at household level and households typically hold more than one parcel of land, we have aggregated the data from the parcel level and up to household level. Households are classified in two types, male-headed and female-headed, based on our household categorization method, utilizing names, gender and household size information for parcel-holders from the land registries (SSLR data). We assess the distribution of land across all households and across male- and female-headed households within communities (*tabia*), within districts (*woreda*) and for the total sample. This was done after non-agricultural land, which are parcels that we know are for non-agricultural use based on the registry data, had been separated out. Table 2 shows the overall results by district and for the total sample. The analysis identified 31,150 households with a mean farm size of 0.9 ha and a median farm size of 0.63 ha and with little variation in these sizes across districts. Gini-coefficients are computed for the total sample of farms.

Table A2.1. SSLR Parcel based land registry data gender disaggregated

Woreda	Variables	Number and gender of land holders						Total	Female land in ha	Male land in ha	Female share	Number of tabias
		One male	One female	One male & one female	Two males	Two females	Three to eight persons					
Raya Azebo	Land area in ha	3179	2931	4786	184	149	3	11232	5475	5758	0.487	3
	Number of parcels	5773	5538	6430	268	221	4	18234				
	Mean ha/parcel	0.551	0.529	0.744	0.685	0.675	0.742	0.616				
	Gini-coefficient	0.371	0.361	0.426	0.417	0.229	0.386	0.398				
Degua Tembien	Land area in ha	1738	1445	2761	80	24	117	6165	2903	3262	0.471	3
	Number of parcels	6588	6341	10771	253	104	327	24384				
	Mean ha/parcel	0.264	0.228	0.256	0.317	0.233	0.358	0.253				
	Gini-coefficient	0.516	0.501	0.472	0.501	0.349	0.492	0.489				
Seharti Samre	Land area in ha	2653	2474	5706	109	49	102	11093	5426	5666	0.489	4
	Number of parcels	7846	7469	13100	232	137	201	28985				
	Mean ha/parcel	0.338	0.331	0.436	0.469	0.358	0.508	0.383				
	Gini-coefficient	0.516	0.482	0.543	0.495	0.522	0.396	0.528				
Kilite Awlalo	Land area in ha	273	409	748	25	23	34	1512	824	688	0.545	1
	Number of parcels	1564	2341	2913	80	98	89	7085				
	Mean ha/parcel	0.175	0.175	0.257	0.314	0.237	0.381	0.214				
	Gini-coefficient	0.467	0.467	0.507	0.574	0.536	0.480	0.499				
All	Land area in ha	7842	7259	14001	398	246	256	30002	14628	15375	0.488	11
	Number of parcels	21770	21689	33214	833	560	621	78687				
	Mean ha/parcel	0.360	0.335	0.422	0.477	0.439	0.413	0.381				
	Gini-coefficient	0.489	0.488	0.538	0.479	0.480	0.517	0.514				

Source: Tigray Land Registry data from District Land Administrations. [a]Total land includes agricultural and non-agricultural land.

Table A2.2. Overview of parcel data, farm size data and household numbers in FSLR and SSLR

Woreda	*Tabia*	No. of parcels of land 1998	No. of parcels of land 2016	Total land area in ha, 1998	Total land area in ha, 2016	No. of households 1998	No. of households 2016
Raya Azebo	B. Delewo	2015	6220	1429	4027	1283	4324
	K. Adisheho	4463	7400	3308	4222	2572	4624
	Wargiba	2545	4614	2144	2983	1416	2710
Degua	Seret	2355	11810	557	2056	829	2909
Temben	Arebay	3179	4681	767	1125	657	1687
	Adilal	4451	7893	989	2984	948	2610
Seharti	May Kana	1069	7331	943	2351	1010	2803
Samre	Esret	856	7433	1366	3219	838	2593
	Cheli	754	5203	596	2765	723	1815
	Tashe	1572	9018	1070	2757	1523	3347
Kilit Awlalo	A. Atsbeha	4334	7084	646	1512	888	1728
Total		27593	78687	13814	30002	12687	31150

Table A2.3. Family size data and its completeness in the land registry data

Tabia	FSLR: Family size			SSLR: Mean Family size			SSLR: Max Family size			Total households		% with family size	
	Mean	p50	N	Mean	p50	N	Mean	p50	N	FSLR	SSLR	FSLR	SSLR
B. Delewo	1.53	1	1283	3.92	4	4161	4.06	4	4161	1283	4324	100.0	96.2
K. Adisheho	1.74	2	2673	4	4	1	4.00	4	1	2673	4623	100.0	0.0
Wargiba	1.97	2	1584	3.53	4	94	3.53	4	94	1584	2,710	100.0	3.5
Seret	4.06	4	932	3.53	3.2	2918	4.23	4	2907	932	2,918	100.0	100.0
Cheli	4.28	4	687	4.79	5	1728	5.45	6	1728	723	1815	95.0	95.2
Tashe	2.91	2	1495	4.56	4.5	3117	4.98	5	3117	1523	3347	98.2	93.1
A. Atsbeha	4.59	4	887	4.55	4	1646	4.73	5	1646	888	1728	99.9	95.3
Arebay	4.6	4	656	4.75	5	1662	5.09	5	1662	656	1686	100.0	98.6
Adilal	4.48	4	905	3.77	3.04	2610	4.08	4	2609	909	2610	99.6	100.0
May Kana	2.84	2	1000	4.91	5	2716	5.41	6	2716	1010	2803	99.0	96.9
Esre	4.03	4	351	4.46	5	2593	4.94	5	2593	351	2593	100.0	100.0
Total	2.91	2	12453	4.28	4	23246	4.69	5	23234	12532	31157	99.4	74.6

Source: GoE Land Registry data, own calculations. Mean family size is the mean across parcels within households; Max family size is the Maximum family size across parcels within households.

Table A2.4. Farm size and land per capita for male- versus female-headed households for communities with reliable family size data

	Statistic	Male-headed		Female-headed		Total	
		Farm size	Farm size per capita	Farm size	Farm size per capita	Farm size	Farm size per capita
FSLR sub-sample	Mean	1.163	0.292	0.841	0.276	1.088	0.288
of 6 ***tabias*** with	Median	1.000	0.250	0.688	0.208	0.875	0.241
family size data in	St.error	0.015	0.004	0.019	0.007	0.012	0.003
FSLR	Gini	0.378	0.402	0.372	0.376	0.384	0.383
	N	3414	3384	1045	1034	4459	4418
SSLR sub-sample	Mean	1.089	0.338	0.707	0.310	0.972	0.329
of 6 ***tabias*** with	Median	0.700	0.187	0.510	0.160	0.620	0.179
family size data in	St.error	0.013	0.006	0.012	0.007	0.010	0.005
FSLR	Gini	0.540	0.587	0.482	0.582	0.536	0.586
	N	9252	8631	4098	3763	13350	12394

Source: Tigray Land Registry data from District Land Administrations. *Note:* Agricultural land per capita is calculated based on average family size across parcels within households (some discrepancy in these may be a source of error, see Table A3 in the Appendix for a comparison).

Table A2.5. Robustness assessment of farm size and land per capita for male-headed and female-headed households, excluding single person households (Family size Max>1)

Statistic	---------- Farm size ----------			---------- Land per capita ----------		
	Male-headed	Female-headed	Total	Male-headed	Female-headed	Total
Mean	1.064	0.695	0.956	0.214	0.165	0.200
Median	0.751	0.561	0.675	0.136	0.113	0.129
St. error	0.008	0.007	0.006	0.002	0.002	0.002
Gini-coeff.	0.49	0.424	0.487	0.540	0.499	0.534
N	19131	7959	27090	13767	5409	19176

Source: GoE Land Registry data, own calculations. Note: Using maximum family size across parcels within households (upper limit of family size in the registry data).

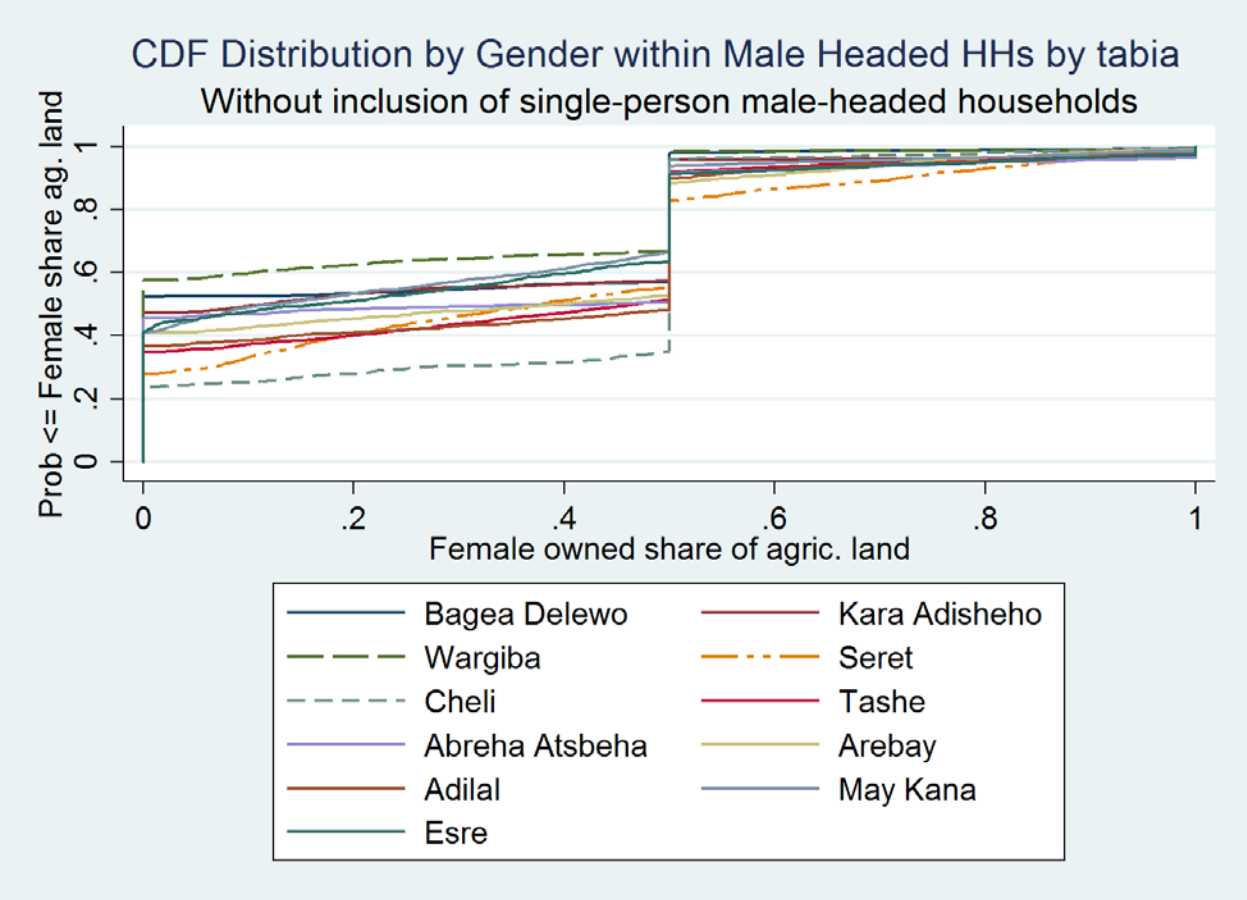

Fig. A2.1. Robustness check: Within male-headed household gender ownership distribution of agricultural land by *tabia*, after dropping single-person households (compare with Fig. 6)