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The impact of Ethiopian Land Certification on land Conservation, Maintenance and Tree Planting

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Development Economics

Table of Contents

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ABSTRACT

This study analyses the impact of land registration and certification on rural farm households' investment on conservation, maintenance and tree planting in Ethiopia. I used cross-sectional data collected from Tigray region in 2015. The Instrumental variable approach used to control for endogeneity in certificate ownership shows there is no systematic distribution in certificate ownership or no endogeneity. The estimation results suggest a mixed result with different outcome variables used as proxy for land related investment. There is positive and significant correlation between possession of land certificates and investment in conservation and maintenance or improvement of conservation structures. However, I didn't find a significant correlation between certificate and tree planting. Variables such as distance of farm plots and public investment on plots tend to have a strong and positive effect on farmers decision on land related investments.

Key Words: Land certification, Land-related investments, Land conservation, Maintenance, Farm households, tree planting

List of Tables

1. Background and literature review

1.1 History of tenancy in Ethiopia

Issues related to land policy and tenure system contributed to the fall of imperial regime in 1975. The overwhelming majority of Ethiopian population depends on agriculture, mainly crop production and less of livestock rearing, as a means of subsistence. Hence the overwhelming majority's means of subsistence is a big function of size of land they are endowed with and the level of security they feel about it (Holden and Yohannes, 2002).

Hence, the abdication of the imperial regime and along with it the declaration of '*land to the tiller*' was a significant and very popular move. The fall of the imperial regime was followed by the Dergue regime. Land redistribution moves saw agricultural land away from feudal landlords and in the hands of farm households. However, land administration and redistribution during the Dergue regime wasn't without its problems. Among many factors it is worth discussing resettlement programs and the formation of cooperatives and producers associations.

The resettlement program was aimed at relocating farm households living in less fertile areas to more fertile and productive areas. Cultivation in more fertile areas was expected to boost production while the vacating less fertile areas will give rise to reforestation and regeneration of eroded areas. The program wasn't a success by economic and political measures. However, it has left a real dent on the sense of tenure security felt by small holders.

The other move by the Dergue regime was organizing farm households in to producers' associations. The aim was to facilitate modern agriculture through association level centralized decision making process. It could be safely argued that the move takes away market incentives and replaced them with socialist objectives, which was the official ideology of the Dergue regime. While the move was mainly a failure in terms of boosting production. Abolition of incentives means private returns of high effort were not rewarding. Hence the intended objective of increasing production wasn't achieved. Rather it exacerbates the already precarious tenure security.

Then comes the fall of Dergue regime and a transitional government was established in 1991 and then followed a comprehensive new land proclamation in 1995. The policy introduced in 1995 gives the right of ownership of land to the state. Until today, land is owned by the state; even

though there is some variation of the policy by giving land ownership to regions instead of the federal state.

The existing rural land use proclamation of the Federal Democratic Republic of Ethiopia states that

> *‘‘‘holding right" means the right … to use rural land for' purpose of agriculture and natural resource development, lease and bequeath to' members of his family or other lawful heirs, and includes the right to acquire [sale, exchange and bequeath same] property produced on his land*
>
> *‘‘‘holding certificate," means certificate of title issued by a competent authority as proof of rural land use right’ (*Proclamation No. 456/2005 Page 3133)

The policy gives a use right to every citizen who seeks to participate in agriculture, as far as they adhere to the basic land use and soil conservation requirements. For example, the government or local administration has a right to confiscate a land not cultivated for subsequent two years; or if a house hold (all members) were away from an area for two years.

Land holding is subject to redistribution, as well. A farmer has a constitutional obligation to avail his farmland for communal conservation scheme, construction of roads, schools or health facilities; if these activities happen to fall on his land. Granted communally acceptable compensation, a household has to be willing to give away some of his land in need of redistribution. Along with the dynamics of household dissolving and forming there will be a continuous process of land re-distribution. That is where the issue of tenure security and hence registration and certification comes in to play. Depending on the pressure, or lack thereof, a household may gain or lose agricultural land during redistribution schemes.

1.2 Certification, tenure security, and land conservation investments in Ethiopia

Well-defined property right is widely believed to improve investment, facilitate reallocation of production factors and hence improve allocative efficiency, and allow the development of nonfarm-economy (Deininger et al. 2003).

Ethiopia is characterized by high altitude and steep slope. The short but stiff rainfall season highly degrades agricultural land. And, studies on small holders’ perception of land degradation show

farmers are aware of the problems faced; mainly through reduction in crop loss (Moges and Holden, 2007; Gebremedhin and Swinton, 2003). Hence, improvement on land investment through improved property right could go a long way in improving land productivity (Holden, Deininger, and Ghebru, 2009) and hence assist in poverty reduction.

There are issues with high cost nature of land certification. For example, a study by (Benjaminsen et al 2009) in Mali, Nigeria, and South Africa found that launching of formal certification process led to increased tension and conflict, especially in high population pressure areas of

Another line of challenge has been the doubt on the effectiveness of land certificates on improving productivity. This mainly emanates from the fear that formal processes of land registration and certification may crowd-out informal property right schemes that have been in place for long periods (Holden and Yohannes, 2002). For example, (Omura, 2008), documented the preference of informal property rights among smallholders in Philippines over formal ones.

Nevertheless, Ethiopia is credited with one of the largest, fastest and most cost effective land certification (Deininger et al. 2008).

The effect of improved tenure security can be different on different types of investment. For example, (Deininger et al. 2003) found that improved tenure security improves terracing (long term investments) but has a negative effect on tree planting (short-term investment). (Holden, Deininger, and Ghebru, 2009) however found an overall improvement in investment; including on investments considered as short term. (Amare 2013) also found that certification improved investment, such as planting of trees, an investment considered in (Deininger et al. 2003) as short term.

The suggestion by the authors is that in the presence of tenure insecurity household will focus more on security enhancing activities, such as tree planting, than long-term productivity enhancing yet less visible activities. The same result is also found by (Gebremedhin and Swinton, 2003). They found that long-term investments such as stone terraces are more common among more tenure secure households while short-term investments are more common among less tenure secure households.

Land certification can have a tremendous positive impact in rural Ethiopia, especially among disadvantaged groups. It could be a guarantee for disadvantaged social groups such as women. A

study by (Bezabih, Holden and Mannberg, 2012) for example, shows the heterogeneous effect of land certification. Female-headed households, who were otherwise more vulnerable to tenure insecurity, benefited more from land certification.

(Hosaena and Stein, 2013) find that land certification appears to have contributed to enhanced calorie availability (calorie intake), and more so for female-headed households, either through enhanced land rental market participation or increased investment and productivity on owner-operated land.

Evidence by (Sebastian Galiani and Ernesto Schargrodsky 2011) shows clear land rights also lead to increases in productivity and farm earnings. They find little empirical evidence to suggest that land-titling programs enhance the development of land markets.

Reduce conflict and improve governance. A study by (Holden, Deininger and Ghebru, 2011) shows that well-devised property right tools reduce the border conflicts, and the effect increases with the quality of the property right scheme. Allows flourishing and better functioning of land market. These factors could lead to productivity enhancing and thus poverty reduction (Deininger, et al. 2008).

(Holden and Yohannes, 2002) and found a considerable proportion of tenure insecurity (about 17% of smallholders) in southern Ethiopia. And the tenure insecurity is higher especially among land rental market participants. This is likely to negatively affect factor input redistribution from factor endowed (labor and oxen) to less endowed and limit production to less Pareto-optimal efficiency level. They found no significant effect on short term input use specifically on use of purchased inputs, however.

While, some evidence suggests that land titling induces changes in household structure that foster human capital accumulation and may help to increase the incomes of future generations. The effects of land titling are also likely to depend on whether land registration or land-titling programs are sizable enough to trigger scale effects (Galiani and Ernesto 2011).

Two important conclusions can be derived from the few but very detailed studies regarding land certification in Ethiopia. First, almost all the studies indicate that the land certification process in Ethiopia can be regarded as a success. Second, the certification has brought a significant sense of

security among small holders. There are also evidences, however limited, of positive welfare effects: increased productivity and poverty reduction.

In this paper, I contributed to the existing literature with some new aspects. The first contribution is the timing. It has been more than a decade since the launching of certification program. Hence, this gives me a chance to see the long term and enduring effect.

The land policy stipulates that certificate holders have an obligation to cooperate in the expansion of different government projects; such as roads, schools, and land redistribution from increased population pressure. Over the past decade and half, there is a good chance that these households went through land redistribution. Possession of certificate allows better governance (Holden et al. 2011) and certified owners can have a chance to observe real (in addition to perceived) benefits of holding a land certificate.

Another contribution of this paper is to investigate the effect of certification on the quality of investments. Studies (Deininger et al. 2003) have shown that investments on land can stem insecurity, as well. And similar studies have stated investments due to this reason are more of superficial. Hence, assessing the quality of investments can shed light whether the investments as a result of certification are indeed from a sense of security and hence aimed at improving productivity.

2. Data and Methods

2.1 Study Area and Data Source

The study is conducted in the Tigray region, one of the nine administrative regions of Ethiopia. Tigray region is found in the northern part of Ethiopia with 12.1 to 15.02 degrees north and 36.46 to 39.97 degrees east. According to census conducted in 2007, Tigray region has a total population of 4.3 million. An overwhelming majority of the population, 80.47% of the total, lives in rural areas where the main means of livelihood is small-scale agriculture.

The Norwegian University of Life Sciences, in collaboration with Mekelle University of Ethiopia conducted household surveys in different rural areas of Tigray region. Sample areas are purposively selected to include different agro climatic zones of the region. Along with that, the sample includes 12 Woredas: 3 from the Central zone, 3 from Eastern Zone, 2 from South Eastern, 2 Western, and 2 from Southern zone.

The survey was initially launched in 1998, and since then six rounds of panel and cross sectional data is collected in 1998, 2001, 2003, 2006, 2010 and 2015. In this study, I use a cross-sectional data from the survey in 2015.

According to the administrative structure of the region, the lower unit next to Woreda is Tabia. From 12 Woredas, 23 Tabias were selected from which a sample of 632 households were included. Average family size of households is 4.98 and a total population of 3422 is included in the sample.

The relevant part of the survey for this study is mainly the plot level questionnaire. We have collected 2557 plot level data: size of plots, distance of each plot from residence, perceived levels of fertility and other physical characteristics of the plots, investments made on plots, land certification status, and a host of variables related to crop production and operation.

2.2 Data collection Methods

A structured questionnaire is used to collect data. The method of collection involves interview by trained enumerators. The questionnaire is divided in to three main parts: household questionnaire (which emphasizes on household demography, consumption, crop selling, livestock ownership), plot questionnaire (which is about plot level data; plot size, type of soil, investments on plots,

distance of plots from residence area), and perception questionnaire (which is about the households' perception about land policies, land contractual arrangements, and tenure security).

The mode of data collection chosen is interview by trained enumerators. Fluency in local language, previous experience and performance in data collection are the main criteria's used in selection of enumerators.

2.3 Empirical review

The study focuses on the link between the land registration program and land tenure security and investment in land conservation. In particular, the study hypothesized that the land registration program increases the sense of security among farmers and investment towards conserving the land. It allows the households to substitute the time and effort previously allocated to safeguard their land rights to activities that increases production and conservation of land.

Holden and Yohannes (2002), defines Tenure insecurity is defined here as the perceived probability or likelihood of losing ownership of a part or the whole of one's land without his/her consent.

And improvement in tenure security is defined as a reduction in the probability of being evicted or otherwise losing land rights

The main issue with regards to assessing the impact of tenure security on land investment is endogeneity. This endogeneity may arise from the following factors. The first issue is the possible two way causality between investment and security. Was it investment that led to land security or vice versa? Moreover, farmers may have other constraints that may affect their investment on conservation. Holden and Yohannes (2002)finds that users of larger farms were more likely to purchase farm inputs and to plant perennials, indicating that poverty and subsistence constraints may limit the ability of small farmers to intensify production by the purchase of inputs or the investing in perennials. In addition, the poor may have low opportunity cost of labor and thus, may be able to invest on conservation while the rich may have higher opportunity cost of labor and thus, invest less on conservation.

One can argue that the allocation of property rights across households is usually not random but is instead based on wealth, family characteristics, individual effort, previous investment levels, or other mechanisms built on differences between the groups that acquire property rights and the

groups that do not. Deininger et al. 2008 used an indicator of certification at the community level in Ethiopia and argued that there is little reason to worry about endogeneity because the sequence of rolling out of the program was determined at the Woreda level based on non-economic criteria. This argument may not however carry over to household level analysis since certificate allocation within Kebeles may depend on community and household characteristics. However, The use of maximum likelihood fixed effect probit models estimation can controls for these (Tadesse 2013)

Meanwhile, household level unobserved heterogeneity may be another source of endogenous certificate ownership. However, using plot level panel data by applying household fixed effect would control for this.

Galiani et.al., 2011 states that as title acquisition and title maintenance involve costs, it is likely that farmers will tend to register land parcels in which the level of investment is higher or that registered farms will be those that have better profitability conditions that justify such expenditures. However, as Holden et.al., 2013 praises the Ethiopian land certification as low cost approach, this might not be an issue.

Public investments on stone terracing, mainly through the productive safety net program have reduced investment by individual households (Gebremedhin and Swinton, 2003).

Steep slope increase the need and intensity of soil conservation activities (Gebremedhin and Swinton, 2003).

Remoteness from market areas increase the intensity, measured by hours spent, of soil conservation activities (Gebremedhin and Swinton, 2003). The authors suggest the limited chance of off-farm activities in remote areas and hence low opportunity cost of undertaking conservation activities as the reason for the difference.

Holden and Yohannes (2002), find that the relationship between farm size and tenure insecurity is site specific, and that the land redistribution policy, through its effect on tenure insecurity, has little impact on the intensity of use of purchased farm inputs, even in areas with a positive correlation between farm size and tenure insecurity. Users of larger farms were more likely to purchase farm inputs and to plant perennials, indicating that poverty and subsistence constraints may limit the ability of small farmers to intensify production by the purchase of inputs or the investing in perennials. Tenure insecurity also appeared not to affect whether farmers planted perennial crops.

3. Model Specification

3.1 Instrumentation Models for Land Certificate

For determining which households have certificate three alternative model were formulated as follows based on Holden et.al 2009 .

(1) $C_{hp} = \alpha_{10} + \alpha_{11}Q_{hp} + \alpha_{12}D_v + \alpha_{16}\tau_{hp} + u_{1hp}$

(2) $C_{hp} = \alpha_{20} + \alpha_{21}Q_{hp} + \alpha_{22}D_v + \alpha_{23}Z_h + \alpha_{26}\tau_{hp} + u_{2hp}$

(3) $C_{hp} = \alpha_{30} + \alpha_{31}Q_{hp} + \alpha_{36}\tau_{hp} + u_{3hp}$

where

C_{hp} = {0,1} is equal to 1 if plot is on the certificate, 0 otherwise

Q_{hp} = a vector of plot specific biophysical characteristics

D_v = a vector of community dummies

τ_{hp} = years since certification

Z_h = a vector of observable household characteristics

u_{1hp}, u_{2hp}, u_{3hp} = the error components for the three alternative models

Three estimations are used to in order to predict for the likelihood of certificate ownership of a specific plot.

I) Certificate ownership is predicted using village dummy, years since certification and observable plot characteristics with village fixed effect.

II) In the second model, likelihood of certificate ownership is estimated using observable household and plot characteristics.

III) In the third approach, determinants of having certificate are estimated using household fixed effect with observable plot characteristics to capture for unobserved household heterogeneity.

3.2 Investment models Specification

The model for investment on farm plot based on Holden et.al 2009 and Deininger et.al 2008 stated as follows:

$$I_{hp}^{p} = \alpha_0 + \alpha_1 Q_{hp} + \alpha_2 C_{hp} + \alpha_3 I_{hp}^{F} + \alpha_4 Z_h + \alpha_5 Z_v + u_h$$

where

I_{hp}^{p} = indicates either the amount of land-related investment or a dummy for whether or not investment was undertaken. This includes

Conservation: is a dummy for land related conservation investments[1]. It takes one if the land is conserved and zero, otherwise.

Investment Time: amount of hours spent on farm plot investment

Maintenance: is a dummy for maintenance or improvement of conservation structures. It takes one if conservation structures are maintained on the plot, zero otherwise.

Type of Maintenance: a ranked value for the type or level of maintenance undertaken. [2]

Planted trees: the amount of trees planted on the plot with in past five years before the survey.

Stock of trees: total number of trees on the plot at the time of the survey.

Q_{hp} = is a vector of plot level biophysical characteristics including:

Distance: negative coefficient is expected as farmers may be insecure to invest on distant plots.

Farm size: a positive relationship is expected between farm size and land related investment.

Farm land slope: more investment is expected on sloppy lands.

C_{hp} = is a dummy for certificate variable. It takes 1 if plot have certificate or 0 otherwise. A positive result is expected as security enhances investment.

[1] These includes stone terraces, soil bunds, bench terraces, grass strips, gully control, life hedge, irrigation canal, pond, shallow well and tree planting,

[2] 1= Improved; 2=well maintained; 3= Partially maintained; 4= Not maintained; 5=partly removed; 6= totally removed

I_{hp}^{F} = is a public investment dummy on plot p of household h. It is expected to have a positive coefficient when farmers invest more on publicly developed plots or negative coefficient if households transfer their resources to plots that are not developed through public cooperation. In the case of tree planting, it may have negative coefficient as it is prohibited to grow trees on arable lands for food security issue.

Z_h = is a vector of household characteristics such as

Total labor force: [3]a positive coefficient is expected, as households with more work force will have more resource to invest

Household Head Sex: Male headed households may be more secured to invest on their land.

u_h = is the error term

[3] In this study, individuals in the age group between 15-65 were considered as the labor force.

4. Results and Discussions

4.1 Descriptive Analysis

Only 20% of the sample faces higher land insecurity compared to the 51% in the baseline survey inn 1998. In addition, 85% of the respondents believe that having a certificate protects there land from encroachment by neighbors while 89% of respondents say having a certificate increases the possibility of obtaining compensation in case the land is taken compared to 78% in 2006 survey. These indicates that tenure insecurity among farm households have reduced.

While 70% of households in the sample have land certificate, only 51% of the plots in the sample are listed on certificate. Basic Statistics of the variables are presented as follows.

Table 1: Variable Descriptions

Variable	Description	Obs	Mean	Std Dev.
Dependent Variables				
Conserved	1= yes 0 = No	2557	0.28	0.45
Maintained	1= yes 0 = No	2557	0.17	0.40
Maintenance level	1= Improved; 2=well maintained; 3= Partially maintained; 4= Not maintained; 5=partly removed; 6= totally removed	2557	3.74	0.67
Investment time	Number of days	2557	13	240
Planted Eucalyptus	Number of planted Eucalyptus trees	2557	7.57	96.4
Planted other trees	Number of planted other tree seedlings	2557	6.56	99.7
Stock Eucalyptus	Number of total Eucalyptus trees	2557	9.3	75.24
Stock other trees	Total number of other types of trees	2557	9.57	75.21
Explanatory Variables				
Certificate	1= yes 0= No	2557	0.49	0.5
Public Investment	1= yes 0= No	2557	0.04	0.21
Plot size	Plot size in hectare	2057	2.58	101
Farm size	Total farm size in hectare	2557	6.08	115
distance	Distance to farm plot, minutes	2557	32.49	28.91
Total labor	number	2439	3.86	1.72
Female labor	number	2439	1.86	1.05
Male labor	number	2439	2	1.33
Household head age	years	2517	57.88	14.6
Household head sex	1= female 2= male	2548	1.8	0.39
Household head education	0=illiterate, 1=read and write, 2=elementary, 3= church education, 4= secondary, 5=other	2386	0.94	1.53
oxen	Oxen per farm size	2529	0.37	0.57
Livestock	Livestock per farm size	2529	1.56	2.65
Shallow soil	Shallow Soil depth	2557	0.31	0.46

Medium deep soil	Medium Soil depth	2557	0.67	0.94
Deep soil	Deep soil depth	2557	0.63	1.22
Flat slope	Flat, valley bottom slope	2557	0.72	0.44
Low hill	Low hill slope	2557	0.2	0.60
Medium hill	Medium hill slope	2557	0.1	0.55
Steep hill	Steep hill slope	2557	0.03	0.37
Soil type Cambisol	Soil type Cambisol= Baekel	2557	0.16	0.37
Soil type Vertisol	Soil type Vertisol= Walka	2557	0.32	0.46
Soil type Regosol	Soil type Regosol= Hutsa	2557	0.12	0.33
Soil type Luvisol	Soil type Luvisol= Mekayih	2557	0.25	0.43

4.2 Econometric Estimations

Most of the decision variables[4] including the certificate variables had fewer observations. Thus, I have replaced the missing values with zero in order to increase the degree of freedom. It was done on the assumption that it is a data collection error where the values are ignored in the case the respondents have not implemented that activity. For distance variable, average distance where used in place of missing observations.

4.2.1 Certificate Estimations

To address the possible endogeneity of certificate ownership, Instrumental variable (IV) approach was conducted.

In the first IV approach, certificate ownership is predicted using village dummy, years since certification and observable plot characteristics with village fixed effect. Village dummy and years since certification do not have an effect on certificate ownership.

In the second IV model, likelihood of certificate ownership is estimated using observable household and plot characteristics.

In the third IV approach, determinants of having certificate are estimated using household fixed effect with observable plot characteristics to capture for unobserved household heterogeneity. Years since certification has no effect on both models and the village dummies are also

[4] The variables include: certificate, public investment, conserved, maintained, investment time, planted and stock of trees.

insignificant; it shows that there is no significant administrative endogeneity that results in lack of certificate ownership.

Numerous calculation were done by using the cutoff point at 0.5 and 0.63, the fraction of plots with certificate, as a benchmark to improve prediction. The estimated prediction shows that there exists a significant randomness in plots having a certificate and the instruments used to identify these.

Thus, the result shows that lack of certificate is a random occurrence and there is no reason to worry about endogeneity. Therefore, the use of actual certificate variable was a better strategy.

4.2.2 Effects of Certificate on Maintenance or Improvement of Conservation Structures

To test for the hypothesis land certificate have enhanced maintenance or improvement of Conservation Structures, two estimations are conducted. First determinants of maintenance plot is estimated using whether plot is maintained or not as a dependent variable. Household fixed effect linear regression is used to control for unobserved household heterogeneity. The complete estimation is presented on Appendix 2.

Table 2 shows that certificate ownership has a positive significant effect in line with the expectation. Farmers tend to maintain plots with certificate. Public investment has also positive significant effect. Unlike Holden et al. 2009 findings, plots have more likelihood of maintenance if the structure was built through public activities. Farmers maintain less distant plots.

Table 2: Impact of Certification on maintenance and types of maintenance Improvement of Conservation Structures

VARIABLES	Maintenance 1= maintained 0= Not maintained	maintenance level Ologit
Certificate	0.108***	-0.0256
	(0.0407)	(0.125)
Public investment	0.147***	-0.430
	(0.0458)	(0.263)
distance	-0.000995***	0.00339*
	(0.000275)	(0.00205)
Plot size	-3.43e-06	0.000486
	(7.00e-05)	(0.000945)
Farm size		-0.000314**
		(0.000135)
Livestock		-0.0509*

		(0.0282)
Oxen		0.141
		(0.142)
Joint Significance of Household characteristics (chi2(5)		16.72**
Joint Significance of plot characteristics F(8, 1261)	1.8*	14.72*
Constant cut1		-4.177***
		(0.539)
Constant cut2		-2.851***
		(0.526)
Constant cut3		-2.009***
		(0.522)
Constant cut4		5.148***
		(0.637)
Constant cut5		6.403***
		(0.874)
Constant	0.105**	
	(0.0523)	
Observations	1,817	1,798
R-squared	0.038	
Number of hhid	544	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Maintenance Level

Second, proportional odds (Ordered logit) models are used with maintenance/ improvement of conservation structures variable as a dependent variable. The dependent variable measures the level of improvement / maintenance taken place. Appendix one shows the basic statistics for maintenance types.

While both Land certification and public investment have a significant effect on the decision to maintain the plot or not, neither of the two variables affect the type of improvement undertaken. May be, since I used cross sectional data, I don't have the data for extent of maintenance done over the past as it will affect current maintenance level/ type. Moreover, I don't have the data to see if there is systematical difference on maintenance level needed between certified & non-certified plots or between publicly and privately constructed conservations. This issue requires further investigation using panel level data overtime.

Maintenance was better in the presence of large farm size and livestock animals indicating wealthy

farmers construct better improvements. Moreover, maintenance was better in less distant plots.

4.2.3 Effects of Certificate on Land Conservation Investment

Two outcome variables were used to evaluate the impact of certificate ownership on land conservation investment. First whether plots are conserved or not is estimated using household fixed effect linear regression. The results are presented on table 3.

In line with the expectation, farmers conserve more on certified plots. Plots with sloppy lands, shallow and medium soils are more conserved. Far distant plots have less likelihood of getting conservation.

Table 3: Impact of certificate on Conservation Investment

VARIABLES	Conservation 1= conserved 0= Not conserved	Time Spent on Investment Tobit
Distance	-0.00118***	0.0819
	(0.000276)	(0.145)
Plot size	0.000111	-0.00265
	(7.47e-05)	(0.0401)
Certificate	0.0860**	6.330
	(0.0413)	(11.00)
Shallow soil	0.0513**	2.238
	(0.0260)	(12.74)
Medium deep soil	0.0315**	7.822
	(0.0125)	(6.178)
low hill	0.0512**	-3.223
	(0.0254)	(13.89)
Flat slope	0.0326	-2.788
	(0.0467)	(25.22)
Medium hill	0.0564***	-1.879
	(0.0214)	(11.66)
Soil type cambisol	-0.000802	1.556
	(0.0262)	(13.45)
Soil type vertisol	-0.0124	11.60
	(0.0219)	(11.59)
Soil type regosol	0.0244	-2.633
	(0.0304)	(15.40)
Male labor		1.390
		(4.488)
Female labor		-4.063
		(5.450)
Household head sex		9.633
		(15.48)
Household head age		0.301

		(0.419)
Household head education		-3.399
		(3.724)
Farm size		-0.000921
		(0.00516)
Livestock		0.714
		(2.726)
Oxen		-8.216
		(12.47)
Constant	0.191***	-27.26
	(0.0502)	(41.21)
Observations	2,057	1,798
R-squared	0.036	
Number of hhid	628	540

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Investment time

In addition, Investment time, the amount of time farmers spent investing on their lands, were used as another indicator for land related investment. I used both linear probability and Tobit models to estimate the effect of certificate on invested times. Both models gave same results in terms of sign and significance. Thus, Tobit model works better as the variable is a limited dependent variable. Table 3 presented the result. Though certificate ownership affects the decision to whether conserve the land or not, I could not find a systematic difference between certified and non-certified plots in terms of investment hours allotted on them.

4.2.4 Effect of Certificate on tree planting

Tree planting

Both Eucalyptus and other tree types variables are used separately to test whether certificate ownership enhanced tree-planting activities using household level random effect panel tobit investment models as estimated on Holden et al. 2009 & 2012 . The results of the correlated random effects (Mundlack- Chamberlin estimator) are presented on table 4.

Relative distance matters within a household when planting eucalyptus trees. Farmers tend to plant eucalyptus trees on their nearest plots. However, distance does not affect farmers decision regarding planting other tree seedlings. According to Holden et al. 2009, eucalyptus are most profitable to grow for rural households, thus, planting them on the nearest farms for security.

However, distance does not affect tree-planting decisions across households.

Relative soil depth of plots were taken into consideration when planting trees. Households plant trees on shallow depth plots.

Nevertheless, both certificate and public investment have no effect on tree planting decisions within and across households. This may be related to the restrictions on tree planting on food growing lands related to food security issue. The full estimation is presented on Appendix 3.

Table 4: The impact of land certification on tree planting.

VARIABLES	Planted Eucalyptus	Planted other tree types
dev[5] certificate	-11.63	-1.104
	(13.37)	(6.069)
m[6] certificate	10.14	-1.723
	(11.18)	(2.896)
m farm size	0.000259	0.000279
	(0.00452)	(0.00108)
dev Public Investment	4.667	-1.409
	(15.92)	(8.698)
m Public Investment	-10.33	-2.119
	(28.06)	(7.917)
dev distance	-0.424***	-0.0563
	(0.102)	(0.0559)
m distance	-0.0626	-0.0132
	(0.231)	(0.0632)
dev Plot size	-1.24e-07	9.56e-08
	(2.34e-06)	(1.32e-06)
m plot size	1.42e-08	1.51e-07
	(7.10e-06)	(1.89e-06)
m Oxen	-10.40	-0.755
	(9.707)	(2.935)
m livestock	1.330	-0.626
	(2.198)	(0.646)
Joint Significance of Household characteristics (chi2(5)	9.13	7.40
Joint Significance of plot characteristics (chi2(16)	20.91	31.77***
Constant	43.57	-7.442
	(36.89)	(11.15)
Observations	1,696	1,696
Number of hhid	534	534
Left censored Obs	0	67

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

[5] Deviation of the variable from the household mean

[6] Mean of the variable in the household

Stock of trees

It is known that fixed effect estimation have a major drawback in case of limited dependent variable; incidental parameters problem. While the alternative random effect estimation requires a strong independence assumption, random effect panel tobit estimator provides a better alternative by relaxing the strong independence assumption (Schunck, 2013).

Current stock of trees at the time of the survey were estimated using random effect panel tobit investment models (Mundlak- Chamberlin approach). Table 5 presented the results. There was no significant correlation between certificate and stock of trees. Similar to tree planting estimation, distance affects stock of eucalyptus trees only, strengthening lower tenure security argument on distant plots for the valuable tree type. Male labor endowed households and shallow depth farm plots had significantly more eucalyptus trees. The full estimation is presented on Appendix 4.

Table 5: The impact of land certification on Stock of trees.

VARIABLES	Stock of Eucalyptus trees	Stock of other trees
Dev plot certificate	12.35	2.276
	(10.79)	(3.049)
m plot certificate	-5.933	0.386
	(5.158)	(1.459)
m farm size	5.64e-05	4.30e-05
	(0.00193)	(0.000538)
Dev public investment	-9.382	-2.530
	(15.43)	(4.422)
m public investment	3.548	-1.407
	(14.03)	(4.046)
Dev distance	-0.380***	-0.0190
	(0.0993)	(0.0285)
m distance	-0.161	-0.0405
	(0.112)	(0.0322)
Dev plot size	2.25e-08	4.03e-08
	(2.37e-06)	(6.61e-07)
m plot size	-9.62e-07	4.92e-08
	(3.40e-06)	(9.46e-07)
m oxen	1.536	-0.817
	(5.217)	(1.470)
m livestock	-0.122	0.438
	(1.135)	(0.323)
Joint Significance of Household characteristics (chi2(5)	22.69***	9.68*

Joint Significance of plot characteristics (chi2(16)	15.72	16.14
Constant	11.21	-2.308
	(19.76)	(5.615)
Observations	1,696	1,696
Number of hhid	534	534
Left censored observations	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

5 Conclusions

The study attempted to examine the impact of land certification on investment in land conservation, maintenance or improvement of conservation structures and tree planting on private plots of samples of rural households in the Tigray Region of Ethiopia.

Cross Sectional data collected from 632 households in 2015 is used. The analysis is made at a plot level, I was able to use a household level fixed effects model allowing me to control for unobserved household heterogeneity.

The result shows that land certification has varying effect regarding different variables used as a proxy for land related investment. It has a strong positive effect on conservation and maintenance or improvement of plots while it does not have significant effect on the amount of investment time spent and the type of maintenance undertaken. Moreover, the study could not find any evidence on the impact of land certification on tree planting and stock of trees.

As expected, public investment on private plots has a strong positive effect on land conservation indicating the important contribution of mass based conservation schemes. In addition I found no evidence of crowding out effect by public investments. Time spent by individuals on conservation of private lands shows no reduction as a result of assistance from public investments. The results suggest that farmers spent the equivalent time saved through public investments on maintaining and improving conservation structures built through public investment. In contrary to the hypothesis, public investment on plots do not affect tree-planting activities on the plot.

These results suggest that land certificates have an enduring positive effect on land conservation investment. The types of investments, specifically absence of significance effect on tree planting, is an evidence against the claim that investment can be made as a need for demarcation.

I found no evidence to suggest that certification brings changes on the quality of investment. Further study is recommended to identify ways channeling improved tenure security through certification towards more quality conservation schemes.

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7 Appendix

Appendix 1: Basic statistics for maintenance/ Improvement of Conservation Structures.

Type of maintenance	Not maintained	maintained	Total
1= Improved	0	71	71
2=well maintained	0	148	148
3= Partially maintained	0	210	210
4= Not maintained;	2,120	0	2120
5=partly removed	0	5	5
6= totally removed	0	3	3
Total	2,120	437	2,557

Appendix 2: Impact of Certification on maintenance and types of maintenance Improvement of Conservation Structures

VARIABLES	Maintenance 1= maintained 0= Not maintained	type of maintenance
certificate	0.108***	-0.0256
	(0.0407)	(0.125)
Public investment	0.147***	-0.430
	(0.0458)	(0.263)
distance	-0.000995***	0.00339*
	(0.000275)	(0.00205)
Plot size	-3.43e-06	0.000486
	(7.00e-05)	(0.000945)
Shallow soil	0.0144	0.141
	(0.0260)	(0.164)
Medium deep soil	0.00152	-0.0268
	(0.0123)	(0.0792)
Low hill	0.0455*	-0.0944
	(0.0264)	(0.192)
Flat slope	0.0319	0.0665
	(0.0487)	(0.356)
Medium hill	0.0288	-0.224
	(0.0222)	(0.146)
Soil type cambisol	0.0429	-0.170
	(0.0262)	(0.170)
Soil type vertisol	-0.0144	0.100

	(0.0214)	(0.158)
Soil type regosol	-0.0111	0.131
	(0.0299)	(0.204)
Male labor		-0.0439
		(0.0474)
Female labor		-0.105*
		(0.0577)
Household head sex		-0.420**
		(0.186)
Household head age		0.00591
		(0.00480)
Household head education		0.120***
		(0.0451)
Farm size		-0.000314**
		(0.000135)
Livestock		-0.0509*
		(0.0282)
Oxen		0.141
		(0.142)
Constant cut1		-4.177***
		(0.539)
Constant cut2		-2.851***
		(0.526)
Constant cut3		-2.009***
		(0.522)
Constant cut4		5.148***
		(0.637)
Constant cut5		6.403***
		(0.874)
Constant	0.105**	
	(0.0523)	
Observations	1,817	1,798
R-squared	0.038	
Number of hhid	544	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix3: The impact of certification on tree planting

VARIABLES	Planted eucalyptus	Planted other trees
Dev certificate	-11.63	-1.104
	(13.37)	(6.069)
M certificate	10.14	-1.723
	(11.18)	(2.896)
m farm size	0.000259	0.000279
	(0.00452)	(0.00108)
dev public investment	4.667	-1.409
	(15.92)	(8.698)
m public investment	-10.33	-2.119
	(28.06)	(7.917)
Dev distance	-0.424***	-0.0563
	(0.102)	(0.0559)
m distance	-0.0626	-0.0132
	(0.231)	(0.0632)
Dev plot size	-1.24e-07	9.56e-08
	(2.34e-06)	(1.32e-06)
m plot size	1.42e-08	1.51e-07
	(7.10e-06)	(1.89e-06)
Dev shallow soil	-17.52**	-9.311*
	(8.926)	(4.945)
m shallow soil	9.657	2.188
	(17.26)	(4.530)
m Oxen	-10.40	-0.755
	(9.707)	(2.935)
m household head sex	9.431	0.839
	(12.94)	(3.514)
m household head age	-0.591*	-0.0252
	(0.356)	(0.0950)
m total labor	0.151	0.534
	(4.643)	(1.189)
m male labor	8.448	1.893
	(5.975)	(1.534)
m household head education	-1.788	-0.161
	(3.235)	(0.815)
m livestock	1.330	-0.626
	(2.198)	(0.646)
Dev medium deep soil	-0.982	2.086
	(4.220)	(2.342)
m medium deep soil	-7.286	-1.181
	(8.602)	(2.273)
Dev low hill	13.87	1.587
	(9.610)	(4.942)

m low hill	-9.712	14.88***
	(17.64)	(5.355)
Dev flat slope	17.38	1.925
	(17.75)	(8.853)
m flat slope	-24.54	7.511
	(29.28)	(9.256)
Dev medium hill	9.613	2.373
	(8.095)	(4.265)
m medium hill	-15.30	0.366
	(16.21)	(4.717)
Dev soil type cambisol	11.47	-8.580*
	(9.117)	(5.075)
m soil type cambisol	-17.46	-8.131
	(20.19)	(5.375)
Dev soil type vertisol	2.296	-2.591
	(7.358)	(4.087)
m soil type vertisol	-19.18	-6.050
	(19.36)	(5.076)
Dev soil type regosol	6.665	-2.413
	(10.44)	(5.819)
m soil type regosol	25.94	-8.200
	(22.71)	(5.928)
Constant	43.57	-7.442
	(36.89)	(11.15)
Observations	1,696	1,696
Number of hhid	534	534
Number of lower censored obs	0	67

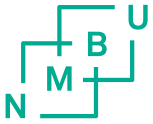
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 4: The impact of certification on Stock of trees

VARIABLES	Stock of Eucalyptus trees	Stock of other trees
Dev certificate	12.35	2.276
	(10.79)	(3.049)
m certificate	-5.933	0.386
	(5.158)	(1.459)
m farm size	5.64e-05	4.30e-05
	(0.00193)	(0.000538)
Dev public investment	-9.382	-2.530
	(15.43)	(4.422)
m public investment	3.548	-1.407
	(14.03)	(4.046)
Dev distance	-0.380***	-0.0190
	(0.0993)	(0.0285)
m distance	-0.161	-0.0405
	(0.112)	(0.0322)
Dev plot size	2.25e-08	4.03e-08
	(2.37e-06)	(6.61e-07)
m plot size	-9.62e-07	4.92e-08
	(3.40e-06)	(9.46e-07)
Dev shallow soil	-16.09*	-1.204
	(8.795)	(2.502)
m shallow soil	-3.328	-1.908
	(8.059)	(2.292)
m oxen	1.536	-0.817
	(5.217)	(1.470)
m household head sex	-3.460	-0.902
	(6.241)	(1.767)
m household head age	0.164	0.0263
	(0.169)	(0.0479)
m total labor	-2.068	0.234
	(2.121)	(0.600)
m male labor	9.799***	1.242
	(2.733)	(0.777)
m household education	0.671	0.0492
	(1.455)	(0.411)
m livestock	-0.122	0.438
	(1.135)	(0.323)
Dev medium deep soil	-4.483	1.364
	(4.167)	(1.181)
m medium deep soil	2.908	-0.125
	(4.046)	(1.146)
Dev low hill	19.62**	3.011
	(8.765)	(2.489)

m low hill	-4.158	0.663
	(9.466)	(2.721)
Dev flat slope	20.25	0.0800
	(15.69)	(4.450)
m flat slope	-12.94	-1.041
	(16.33)	(4.687)
Dev medium hill	8.034	1.561
	(7.561)	(2.143)
m medium hill	-3.025	1.052
	(8.342)	(2.376)
Dev soil type cambisol	0.646	-1.997
	(9.007)	(2.569)
m soil type cambisol	-5.488	-2.375
	(9.530)	(2.714)
Dev soil type vertisol	-3.771	-0.00412
	(7.283)	(2.063)
m soil type vertisol	6.859	3.278
	(9.038)	(2.563)
Dev soil type regosol	-13.65	-1.559
	(10.33)	(2.937)
m soil type regosol	3.330	-0.545
	(10.58)	(2.993)
Constant	11.21	-2.308
	(19.76)	(5.615)
Observations	1,696	1,696
Number of hhid	534	534
Left censored observations	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1



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