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Land Tenure and Land Management in the Highlands of Northern Ethiopia

Berhanu Gebremedhin
International livestock Research Institute (ILRI), b.gebremedhin@cgiar.org

John Pender
International Food Policy Research Institute (IFPRI)

Simeon Ehui
International livestock Research Institute (ILRI)

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[1]Berhanu Gebremedhin is corresponding author, International livestock Research Institute, P.O.Box 5689, Addis Ababa, Tel. 251-1-463215, e-mail: b.gebremedhin@cgiar.org

ABSTRACT

Land tenure security is important to encourage investment in land improvements as well as the development of efficient land markets. In Ethiopia, empirical analysis is required to find out the effect of the current land tenure system on farmers' propensity to invest in land improvements, and the development and functioning of land markets. Data collected from 50 communities in the highlands of Tigray in 1998 was used to investigate the functioning of land markets, and determine the relationship between perceived land tenure security and land investments in the region. We found out that informal land markets (sharecropping and fixed rental) are emerging in the region, and while quality of land is an important determinant of rental price in fixed lease, quality appears to play limited role in determining the land holder's share in sharecropping. Landlessness is increasing in the region. Perceived tenure security is important for making land investments and use of improved farming practices. However, investments in land doest not appear to have significant effect on perceived tenure security of farmers. Our results imply that there is a need to improve tenure security of farmers in order to encourage land investment. The role of public policy in facilitating the development of the fledgling land markets needs to be explored. The wishes and preferences of farmers regarding land tenure arrangements and land administration should be considered as crucial inputs to future land tenure arrangements. Moreover, an open, concerted and inclusive debate on the relevance and feasibility of alternative land tenure arrangements for the country or for different parts of the country needs to be encouraged. Alternative tenure arrangements need to be evaluated based on the level of security they provide to farmers, since tenure security is more important than the mode of ownership.

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1. Introduction

Significant improvements in agricultural productivity are crucial to addressing the worsening conditions of poverty and food security in sub-Saharan Africa (Omiti et al., 2000). In Ethiopia, improvement in land productivity is vital to enhance and sustain the welfare of the largely agrarian population (World Bank, 1989). The traditional land use and land management practices that used to sustain the welfare of human population under low population pressure with little or no technical inputs is no longer able to support the growing population. Due to increasing population density and degradation of the natural resource base, declining per capita food production results in deteriorating human welfare conditions.

Improvements in agricultural productivity in Ethiopia will require a more efficient use of rural resources, especially land, labor and traction power, since these resources are the major inputs into agricultural production in the country. Improvements in the performance of agriculture will, therefore, depend considerably on how well the constraints of the functioning of markets for these key factors of production is addressed (Omiti, 2000).

Increasing population results in land scarcity and, when alternative employment opportunities outside agriculture are limited, may eventually lead to landlessness. Under this situation, well functioning land markets may result in welfare gain by allocating the land resource to more efficient users and by permitting land consolidation to achieve economies of size. For example, Holden et al. (2001) concluded that improvement in the labor and land rental markets in the Ethiopian highlands might reduce inefficiency in the agricultural sector. Similarly, in Coastal China, improvements in land markets and

associated institutions were found to be a major contributor to higher allocative efficiency (Yao, 1996).

However, for land markets to function efficiently, low transaction costs and tenure security are essential. Land tenure security is important not only for the development of efficient land markets, but also for investment in land improvements. For example, Gebremedhin and Swinton (2003) found that farmers' perceived land tenure security in Tigray, northern Ethiopia, was significantly and positively associated with long-term durable soil conservation investments such as stone terraces. Similarly, Feder and Onchan (1987) found in Thailand that ownership security was significant in explaining the incidence of land improvements. The findings of Pender and Kerr (1998) in India also suggest that improvements in land markets would increase conservation investments on farm land.

Efficient use of the land resource also requires access to agricultural inputs such as farm labor, traction power and farm implements. At peak periods of agricultural activities, traction constraint (eg. for land preparation) or labour constraint (eg. for weeding, harvesting) may result in low land productivity. Efficient labour and traction markets may, therefore, contribute to welfare gains by allocating these resources to their best use. However, in the absence of institutional support, markets for agricultural land, farm labor and traction are unlikely to develop and operate efficiently. The development of agricultural factor markets need broad and committed public intervention. For example, Bruce and Migot-Adholla (1994) posit that even in free market systems, further incentives in addition to security are required to encourage land sales and rental markets.

In Ethiopia, after almost two decades of socialist oriented economic policy under the military regime, the current Ethiopian Government has been taking measures to

liberalize the economy since 1991. In the agricultural sector, measures to liberalize the input and output markets and increase institutional support for agriculture, such as agricultural research and extension services, have been taken. In the regions of Tigray and Amhara, land titling aimed at improving farmers' land tenure security has also been implemented. The titling process provides certificates of holding but do not bestow ownership since, constitutionally, land belongs to the state.

The long-term impact of the measures taken by the government to improve agricultural production will depend on their effect on the structure and stability of economic incentives available to farmers. Whether or not government policies are conducive to investment in agriculture and whether the incentive structure translates into a more sustainable use of the natural resource base is an empirical question.

This paper is intended to assess the land use and land tenure situation in the northern Ethiopian region of Tigray since 1991 and investigate the effect of land tenure security on land management. Descriptive analysis and econometric analysis of data collected from 50 *tabias*[1] *(*communities) and 100 villages in 1998 are used. We find that an informal land market (leasing and sharecropping) is emerging in Tigray, and while the quality of land is an important determinant of rental price in fixed lease, quality appears to play limited role in determining land holder's share in share cropping. Landlessness is increasing in the region. Perceived tenure security is important for investments in land improvements, and use of improved farming practices. However, land investments do not appear to have significant effect on perceived tenure security of farmers.

The paper is organized as follows. Section two presents the data and results of analysis of descriptive information. Section three deals with the empirical approach,

[1] *Tabia* is the lowest administrative unit in Tigray usually comprising of four to five villages.

while section four presents results of the econometric analysis. The last section presents conclusions and implications of results.

2. Data

The analysis in this paper is based on community level data collected from 50 *tabias*[2] and 100 villages in the highlands of the Tigray region of northern Ethiopia during 1998/99. Sample *tabias* were selected following random sampling stratified by distance to the nearest town and presence of irrigation project. Two villages were randomly chosen from the selected *tabias.* A semi-structured questionnaire was administered with a group of representative individuals both at the *tabia* and village levels. Each interview group comprised of ten respondents chosen to represent different age groups, primary occupations, gender and villages. Information was collected on changes in agricultural and resource conditions between 1991 and 1998, and their causes and impacts.

Land use and land tenure

In Tigray, the dominant land tenure systems for rainfed cultivated and irrigated land are owner used and sharecropped, with limited use of fixed lease and borrowing. Homesteads are mostly owner used with limited use of fixed lease. However, homesteads are not sharecropped. Few *tabias* reported the existence of private pasture. Irrigated land appears to be more prevalent in more densely[3] populated areas. In 1998 35% of *tabias* with low population density and 86% of *tabias* with high population density reported owner used irrigated lands. The results for 1991 are also similar, with 35% of *tabias* of

[2] *Ttabia* is the lowest administrative unit in the region and usually consists of four to five villages.
[3] *Tabias* were classified as high population density if they had more than 100 people per km^2.

low population density and 79% of *tabias* with high population density reporting owner used irrigated lands.

The number of landless households in Tigray is increasing. According to respondents, the average number of landless households per *Tabia* in 1991 was 104. This figure grew to 264 in 1998, an increase of 140% (Table 1). The pattern of landlessness appears to show marked difference by population density and market access[4]. Landlessness is higher in low population density and low market access areas.

Several land acquisition methods are used in Tigray. These include distribution, sharecropping, fixed lease, borrowing, inheritance and "accommodation"[5]. However, there have been changes in the importance of these means of land acquisition in the region between 1991 and 1998 (Table 2). While the use of fixed lease appears to be increasing, the use of distribution, "accommodation", and inheritance are decreasing. Sharecropping arrangements also appear to be shifting towards equal share between the owner and the leaseholder. However, the use of borrowing showed no change. A household level analysis in south central Tigray showed that land transfer through leasing or sharecropping was higher in high altitude areas and with female headed households (Gebremedhin,1998).

The quality of land appears to determine the rental price of land. In 1998, the average rental price per ha for land with fixed lease was Birr[6] 450, 550, and 845 for poor, medium and good quality land, respectively (Table 3). The rental price also appears to show marked difference by population density and market access. Rental prices tend to be higher in high population density areas. However, rental prices surprisingly seem to be higher in low market access areas.

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[4] *Tabias* were classified as high market access if they are within 1o km distance from the nearest town.
[5] "Accommodation", locally called "Mishigishag" is an institution where a landless household is allotted land from communal land or from households who are believed to have larger land, without making a major land distribution in the community.
[6] In 1998, 7.02 Birr= 1 US $.

Under share tenancy, the land holder receives on average about a half of the grain, and about 15% of the straw or crop residue in 1998 (Table 4). Land holders' share of grain and straw does not appear to be influenced by differences in land quality, nor by population density or market access, consistent with the standard theory about sharecropping being a balance between incentive problems in wage contracts and risk pooling advantage of sharecropping. Under share cropping arrangements, land holders contribute to labor, seed and fertilizer costs, although traction and equipment costs are entirely covered by the leaseholder. On average, land owners contributed about 10% of labor cost, 16% of seed cost and 5% of fertilizer cost in 1998 (Table 5). The proportion of labor cost covered by the land owner seems to be higher in low market access areas (than high market access areas).

The average duration of contract for both sharecropping and fixed lease arrangements appears to be two years, and seems to be independent of the type of crop planted by the leaseholder, population density and market access (Table 6). The likelihood of renewal of lease or sharecropping contracts is not affected by the type of crop planted, or investment in soil and water conservation and tree planting (Table 7). This suggests that lease and sharecropping contracts in the region do not provide incentive to leaseholders to invest in land improvement measures.

Farmers in Tigray do not perceive that their land tenure security can be enhanced by their investments in the land, such as investing in soil and water conservation practices, planting trees, clearing the land or building fences (Table 8). These perceptions appear to be unaffected by differences in population density or market access. However, land tenure security has a significant perceived impact on the incentive of farmers to invest in land improvements (Table 9). Land tenure security affects significantly farmers' incentives to invest in constructing soil and water conservation practices, building

fences, and planting trees. Tenure security also appears to affect likelihood of fallowing land for more than a year. The effect of tenure security on farmer incentives to invest in land improvements appears to be consistent across population density or market access conditions.

3. Empirical Approach

Our primary focus in this paper is to determine if farmers' perceived land tenure affects investments in land improvement and use of improved farming practices that maintain soil fertility, after controlling for other factors that could affect land investment and improved land use. The analysis aims to test the general hypothesis that perceived tenure security will enhance investments on land and use of improved farming practices.

We use proportion of households in *Tabia who* made private investments in stone terraces, tree planting and soil bunds between 1991 and 1998 as indicators of investment in land. We use changes in proportion of households who use fallowing for more than a year and composting between 1991 and 1998 as indicators of improved farming practices that maintain or enhance soil fertility. Stone terraces and tree planting are durable long-term investments, the returns of which may take several years in the future. Hence, farmers' incentives to invest in these practices is expected to be dependent on perceived land tenure security. Soil bunds are low cost, medium-term investments, but tenure security is still important for investment decisions since returns accrue in the future. Fallowing and composting are expected to improve soil fertility. However, farmers with low tenure security may not opt to fallow their land or use compost as they may not be certain of cultivating the same land the next cropping seasons.

We use seven indicators of tenure security. These include number of land distributions in *tabia* since 1974, number of years since last land distribution in *tabia*,

number of landless households in *tabia* in 1991 and change in number of landless households between 1991 and 1998, if community members felt very or moderately secure in their land tenure in 1991 (as opposed to very or moderately insecure), if tenure security perception of community members improved moderately between 1991 and 1998 (as opposed to no change), and if tenure security perception of community members improved significantly between 1991 and 1998 (as opposed to no change).

We expect that the frequency of land distributions in the community will be associated with less tenure security, and thus less investment on the land or use of improved land management practices. Number of years since last land distribution is expected to enhance tenure security and thus investment, since it is an indicator of stability of tenure in the region, after controlling for other indicators of tenure security. The number of landless households in 1991 and the change in the number of landless households are expected to be associated with less tenure security, since the higher the number of landless households, the higher will be community expectations for land redistribution to take place. The survey also solicited directly community perceptions of tenure security in 1991 and 1998. Community perceptions of tenure security in 1991 was solicited in ordinal terms (very insecure, moderately insecure, moderately secure, and very secure). A dummy variable was constructed from the ordinal responses (1=very or moderately secure, 0=very or moderately insecure). Community perceptions of change in their tenure security in 1998 (cf. 1991) was solicited in ordinal terms (deteriorated significantly, deteriorated moderately, no change, improved moderately, and improved significantly). Since perceived tenure security either remained the same or improved in the sample communities, two dummy variables were constructed from the ordinal responses (1= improved moderately, 0=no change; and 1=improved significantly, 0=no change).

In order to isolate the effect of these tenure security variables on land investment and improved farming practices, we controlled for indicators of agricultural potential (annual precipitation and average elevation), and market access. We also controlled for changes in literacy in village between 1991 and 1998. We included zonal dummies to control for zone specific factors that may have bearing on land tenure, such as differences in land administration and community involvement in land related issues.

The econometric model is given by:

$$Y_{v2} - y_{v1} = \mathbf{a}_2 - \mathbf{a}_1 + \mathbf{b}(\mathbf{x}_{v2} - \mathbf{x}_{v1}) + (\mathbf{c}_2 - \mathbf{c}_1)\mathbf{z}_v + \mathbf{e}_{v2} - \mathbf{e}_{v1}$$

Where y_{vt} is the proportion of households in village v who invested in land or used improved farming practices in year t, $\mathbf{x}_{vt}$ is a vector of time varying factors affecting land investment or use of improved practices, $\mathbf{z}_v$ is a vector of observed fixed factors affecting land investment or use of farm practices, and $\mathbf{e}_{vt}$ are unobserved time varying factors. This first difference model eliminates unobservable fixed factors as a source of omitted variable bias. The observable fixed factors ($\mathbf{z}_v$) will have effect only if their marginal impact has changed over time.

Perceived tenure security variables may also be endogenous to land investment, since farmers may feel that their tenure security can be influenced by their land management decisions, especially long-term investments. Analysis of descriptive information showed that farmers in the study area do not believe that their land investment decisions do influence their tenure security. This result was also confirmed by an exogeneity test using Hausman's test (Hausman, 1978).

We use maximum likelihood two-limit Tobit to estimate the equations for the changes in the proportion of households who invested in stone terraces, tree planting, and soil bunds, since these variables are censored from both sides. We use ordinary least squares

(OLS) to estimate the equations for the changes in proportion of households using fallowing and composting since theses variables were continuous.

5. Results

Results of the determinants of land investments are given in Table 10. Three of the seven tenure security variables in the case of investment in stone terraces, and two of them in the case of tree planting are significant with the expected signs, supporting the general hypotheses that tenure security is important for land investment. In the case of investment in soil bunds, two of the tenure security variables are significant with one having the expected sign.

The duration since last land distribution in *tabia* is associated with higher investments in stone terraces, as expected, but failed to influence investments in tree planting or soil bunds. Number of landless households in 1991 and change (increase) in number of landless households between 1998 and 1991 are associated with less investment in stone terraces. When the number of landless households increases, the expectation of communities for a redistribution of land to occur increases thus reducing the tenure security perception of landed households. However, number of landless households in 1991 is associated with investment in soil bunds. It could be that farmers with less tenure security resort more to investing in soil bunds, practices that are low cost and medium-term soil and water conservation investments. Gebremedhin and Swinton (2003) found that tenure security is more important for investment in durable long-term investments such as stone terraces, than for short-term low cost investments such as soil bunds.

Communities which felt secure about their land tenure in 1991 and communities whose tenure security perception improved significantly between 1991 and 1998 invest more

in tree planting than those who felt insecure in 1991 and those whose tenure security perception remained the same between 1991 and 1998. Moreover, moderate improvement in tenure security is also associated with increased investment in soil bunds.

We also find that investment in stone terraces is higher in higher altitude areas, and in areas where literacy is higher. Literacy, as a means of access to written information, may raise the awareness of households regarding the availability and importance of land investments, and improve efficiency of farm operations. Investment in soil bunds is less in areas of higher rainfall, perhaps because of water logging problems, but higher in higher elevation. Area of *tabia* decreased investment in soil bunds. However, investment in soil bunds is higher in higher altitude areas.

The results of the regression estimates for fallowing and composting also support the general hypotheses that tenure security is important for improved farming practices that would have a carry-over effect in soil fertility (Table 11). Secure land tenure perception of communities in 1991 is associated with higher fallowing, as expected. Increases in number of landless households in *tabia* is also associated with reduced fallowing. Moderate or significant improvements in perceived tenure security is associated with higher use of composting. However, contrary to expectations, we find that moderate improvement in land tenure security is associated with reduced fallowing. Fallowing is higher in higher altitude areas, and in areas closer to market places. There is more use of fallowing in the eastern zone compared to the southern zone, and more use of composting in the central zone compared to the southern zone.

One of the reasons that the explanatory variables may be insignificant is if there is a high colinearity among the variables. We tested for multicillearity and found that it is not a problem in the data set. The maximum variance inflation factor we found is 8, and most variables have variance inflation factors of less than 5.

6. Conclusions and Implications

According to survey respondents, landlessness is increasing in the Tigray region. Between 1991 and 1998, the number of landless households per *tabia* grew by more than 140%. Informal land transaction are operating in the region, including sharecropping, fixed lease paid in cash or in kind, and borrowing. The use of fixed lease as a means of land acquisition, although very low, appears to be increasing, and sharecropping arrangements seem to be shifting towards equal share between the landholder and the leaseholder. While the rental price of land seems to depend on the quality of land, sharecropping ratios appear to be independent of the quality of land.

While land owners cover part of labour, seed and fertilizer costs in sharecropping arrangements, traction and equipment costs are entirely covered by the shareholders. The average terms of sharecropping and fixed lease is about two years, and is not influenced by the type of crop planted. Likelihood of renewal of sharecropping or lease contracts is not affected by the type of crop planted or land investment by the tenant. Farmers reported that while tenure security is highly likely to affect farmer incentives to invest in land, farmers own land investment is unlikely to affect tenure security. Irrigated land appears to be concentrated in high population density areas.

Econometric analysis of the effect of tenure security on land investments and use of improved farming practices show that tenure security is an important determinant of farmers incentives to invest in land and use improved farming practices. Stability of tenure encourages investment in stone terraces, while tenure insecurity due to higher number of landless households detracts from it. Moderate improvements in perceived tenure security results in higher investment in soil bunds. Significant improvements in tenure security is important for investment in tree plantation.

Our results imply that improving tenure security is important for improved land management in the region. The land titling that took place in Tigray, coupled with the regional legislation that prohibits further land redistribution, is an important step in this direction. However, legal support of farmers' use rights in perpetuity, their right for compensation of land investment in case of special-circumstance land redistributions, and the right to bequeath land to children could strengthen tenure security.

Our results also imply that the potential roles of public policy to facilitate the development of the fledgling land market needs to be explored. Moreover, restrictions on land exchange, such as those which limit land transactions to two years, may need to be revisited. The wishes and preferences of farmers regarding land tenure arrangements and land administration should be considered as an important and crucial input in to the design of future tenure arrangements in the region.

An open, concerted and inclusive debate on the relevance and feasibility of alternative land tenure systems for the country or different parts of the country needs to be encouraged. The debate on land tenure should broader than being fixated on the state/public versus private ownership dichotomy, since these are only two polar end points of a continuum of several possible tenure arrangements. Each potential land tenure system needs to be evaluated in terms of its effect on the tenure security it provides to farmers, since security is more important than the mode of ownership.

References

Bruce, J.W. and S. Migot-Adholla (eds). 1994. *Searching for land tenure security in Africa.* Iowa: Kendall-Hunt Publishing Company.

Feder, G. and T. Onchan. 1987. "Land ownership security and farm investment in Thailand." *American Journal of Agricultural Economics,* 26(2): 311-320.

Gebremedhin, B. and S. Swinton. 2003. "Investment in soil conservation in northern Ethiopia: the role of tenure security and public programs." Forthcoming in *Agricultural Economics.*

Gebremedhin, B. 1998. "The economics of soil conservation investments in the Tigray region of Ethiopia." PhD dissertation, Department of Agricultural Economics, Michigan State University, East Lansing.

Hausman, J. 1978. "Specification tests in econometrics." *Econometrica*, 46:1251-1271.

Holden, S., B. Shiferaw and J. Pender. 2001. "Market imperfections and land productivity in the Ethiopian highlands." Environment and Production Technology division Discussion Paper No. 76. International Food Policy Research Institute (IFPRI): Washington D.C..

Omiti, J., K. Parton, S. ehui and J. Sinden. 2000. "Some policy implications of the resurfacing of rural factor markets following agrarian de-collectivisation in Ethiopia." *Human Ecology*, 28(4):585-603.

Pender, J. and M. Fafchamps. 2001. "Land lease markets and agricultural efficiency: theory and evidence from Ethiopia." Environment and Production Technology Division Discussion Paper No. 81. International Food Policy Research Institute (IFPRI): Washington D.C.

Pender, J. and J. Kerr. 1998. "Determinants of farmers' indigenous soil and water conservation investments in semi-arid India." *Agricultural Economics*, 19(1998): 113-125.

Yao, Y. 1996. Three essays on the implications of imperfect markets in China. Ph.D. Dissertation, Department of Agricultural Economics, University of Wisconsin, Madison.

World Bank. 1989. "Sub-Saharan Africa: from crisis to sustainable growth: a long-term perspective study." The World Bank: Washington D.C.

Table 1: Number of Land Less Households in *Tabia* by Population Density and Market Access

Year	Average	Population Density		Market Access	
		Low	High	Low	High
1991	104	196	64	115	63
1998	267	318	251	277	232

Table 2: Change in Methods of Land Acquisition (1991 – 1998) by Population Density and Market Access*

Means of acquisition	Average	Population Density		Market Access	
		Low	High	Low	High
Inheritance	2	1.59	2.32	2	2
Distribution	2.12	1.86	2.28	2.01	2.55
"Accommodation"	1.61	1.61	1.61	1.66	1.39
Fixed Lease	3.86	3.88	3.84	3.94	3.63
Sharecropping(1/2)	3.3	3.58	3.25	3.34	3.17
Sharecropping(1/3)	3.2	3.67	2.76	3.16	3.54
Sharecropping(1/4)	2.58	2.64	1.75	2.62	2
Borrowing	3	3	3	3	No obs

***** 1 = major decrease, 2 = minor decrease , 3 = no change, 4 = minor increase
5 = major increase

Table3: Average Rental Price in 1998 for Fixed Rental by Soil Quality, Population Density and Market Access (Birr/ha)

Soil Type	Average	Population Density		Market Access	
		Low	High	Low	High
Poor Soil	450	---	450	577	320
Medium Soil	550	315	709	604	452
Good Soil	845	400	972	906	746

Table 4: Land Holders Share under Share Tenancy by Population Density and Market Access (1998)

Out put	Soil Type	Average	Population Density		Market Access	
			Low	High	Low	High
Grain	Poor Soil	0.43	0.33	0.47	0.42	0.45
	Medium Soil	0.44	0.32	0.50	0.43	0.48
	Good Soil	0.45	0.35	0.50	0.44	0.49
Straw/Crop Residue	Poor Soil	0.14	0.09	0.13	0.12	0.18
	Medium Soil	0.13	0.11	0.14	0.11	0.19
	Good Soil	0.14	0.14	0.14	0.12	0.18

Table 5: Land Holder's Share of Cost Under Share Tenancy by Population Density and Market Access (1998)

Cost	Average	Population Density		Market Access	
		Low	High	Low	High
Labor	0.1	0.11	0.1	0.11	0.04
Seed	0.16	0.06	0.22	0.08	0.11
Fertilizer	0.05	0.09	0.03	0.06	0.03
Oxen	0	0	0	0	0
Equipment	0	0	0	0	0

Table 6: Average Duration (years) of Contract by Population Density and Market Access (1998)

Land Tenure	Crop Type	Average	Population Density		Market Access	
			Low	High	Low	High
Fixed Rental	Teff	1.73	1.69	1.77	1.68	1.81
	Legumes	1.69	1.62	1.77	1.68	1.70
	Other Crops	1.61	1.60	1.63	1.59	1.66
Share Tenancy	Teff	1.98	2.10	1.93	2	1.92
	Legumes	1.90	1.95	1.87	1.90	1.89
	Other Crops	1.94	2.06	1.88	1.94	1.91

Table 7: Factors Affecting Likelihood of Renewal or Extension of Land Lease or Share Cropping Arrangement by Population Density and Market Access*

			Population Density		Market Access	
	Factors	Average	Low	High	Low	High
	Plant Teff	3.06	3	3.09	3.08	3
	Plant Legumes	3.12	3	3.19	3.16	3
Tenant	Use Manure	3.14	3.1	3.16	3.16	3.05
	Invest in SWC	3.15	3.1	3.19	3.20	3
	Plant Trees	3	3	3	3	3
Owner	Invest in SWC	3	3	3	3	3
	Plant Trees	3	3	3	3	3

* 1=reduces significantly, 2= reduces slightly, 3=no effect, 4= increases slightly, 5= increases significantly

Table 8: Factors Affecting Land Tenure Security by Population Density and Market Access*

			Population Density		Market Access	
Factors	Year	Average	Low	High	Low	High
	1991	3.06	3.04	3.08	3.06	3.06
Building Fences	1998	3.36	3.54	3.29	3.41	3.17
	1991	3.07	3.05	3.09	3.08	3.05
Planting Trees	1998	3.35	3.61	3.24	3.38	3.23
	1991	3.10	3.25	3.04	3.11	3.06
Cutting Trees	1998	2.95	2.73	3.05	2.93	3.06
	1991	3.06	3.09	3.05	3.07	3.05
Clearing Land	1998	3.08	3.08	3.09	3.04	3.23
Constructing or	1991	3.14	3.24	3.11	3.14	3.16
Maintaining SWC	1998	3.16	3.12	3.18	3.12	3.27
	1991	2.94	3	2.90	2.92	3
Leaving Land Fallow	1998	3.12	3	3.18	3.11	3.16
	1991	3.15	3.24	3.12	3.14	3.21
Constructing a House	1998	3.08	3.31	2.97	3.10	3

*1 = decrease substantially, 2 = decrease slightly, 3 = no effect, 4 = increase slightly 5 = increase substantially

Table9: Factors Affected by Tenure Security by Population Density and Market Access* (1998)

Factors	Average	Population Density		Market Access	
		Low	High	Low	High
Building Fence	4.96	4.9	4.98	4.96	4.94
Planting Trees	4.83	4.9	4.79	4.80	4.94
Cutting Trees	3.13	2.46	3.40	3.16	2.98
Clearing Land	4.49	4.62	4.46	4.45	4.69
Constructing or Maintaining SWC	4.70	4.70	4.7	4.64	4.94
Leaving Land Fallow	4.46	4.46	4.42	4.5	4.30
Constructing a House	3.73	3.66	3.75	3.72	3.76
Reside outside of Tabia	3.77	3.90	3.71	3.88	3.34

*1 = decrease substantially, 2 = decrease slightly, 3 = no effect, 4 = increase slightly 5 = increase substantially

Table 10: Determinants of land investments in the highlands of Tigray[1]

Variable	Stone Terrace (Tobit[2])	Tree Planting (Tobit[2])	Soil Bund (Tobit[2])
Number of land distribution since 1974	0.01540	0.04374	-0.03698
Number of years since last land distribution in *Tabia*	0.02663**	0.01294	-0.02486
Number of landless households in *Tabia* in 1991	-0.00053**	0.00048	0.00211***
Change in number of landless households (1991 – 1998)	-0.00073***	0.00004	-0.00081
If community felt very or moderately secure in 1991	0.15732	0.68895**	0.14717
If land tenure security improved significantly (1998 – 1991)	-0.06490	0.74333***	0.081103
If land tenure security improved moderately (1998 – 1991)	-0.06330	-0.24963	0.35504**
Average elevation (meters)	0.00042*	-0.00169	0.00003
Average annual precipitation (mm)	0.00062	0.00169	-0.00275**
Change in proportion of households who are literate (1998 – 1991)	0.47635**	-0.76777	0.27268
Distance to market (walking minutes)	0.00018	0.00047	-0.00057
Central Zone *(cf. South Zone)*	0.18188	0.31770	0.19013
East Zone *(cf. South Zone)*	0.05512	0.41756	0.05169
West Zone *(cf. South Zone)*	0.21141	0.32152	0.27355
Area of *tabia*	0.00164	0.00197	-0.00454**
Constant	-1.3333	-2.5143	1.79430
Number of observations	91	88	91
F	3.55	2.25	3.38
Prob > F	0.0001	0.0008	0.0002

*** Significant at 1%, ** significant at 5%, * significant at 10%

[1] All regression results are corrected for sampling stratification and weights, and standard errors are robust to hetroskedasticity and non-independence within the primary sampling units.

[2] Survey Interval Regression was used to estimate the two-limit maximum likelihood Tobit models.

Table 11: Determinants of use of improved farming practices in the highlands of Tigray[1]

Variable	Fallowing (OLS)	Composting (OLS)
Number of land distribution since 1974	-0.00201	0.03516
Number of years since last land distribution in Tabia	0.00766	0.00315
Number of landless households in Tabia in 1991	0.00001	0.00012
Change in number of landless households 1991 - 1998	-0.00025**	-0.00002
If community felt very or moderately secure in 1991	0.11073*	0.08529
If land tenure security improved significantly (1998 – 1991)	0.00382	0.21856*
If land tenure security improved moderately (1998 – 1991)	-0.09674**	0.20113***
Average elevation	0.00017***	0.00008
Average annual precipitation	0.00022	-0.00004
Change in proportion of households literate (1998 – 1991)	0.00023	0.05844
Distance to market	-0.00023**	-0.00016
Central Zone *(cf. South Zone)*	0.01583	0.13834**
East Zone *(cf. South Zone)*	0.08742*	0.08030
West Zone *(cf. South Zone)*	0.00189	0.07078
Tabia area *(cf. South Zone)*	0.00199***	-0.00145
Constant	-0.74437	-0.19051
Number of observations	91	91
R-squared	0.28	0.32

*** Significant at 1%, ** significant at 5%, * significant at 10%.

[1] All regression results are corrected for sampling stratification and weights, and standard errors are robust to hetroskedasticity and non-independence within the primary sampling units.

Annex : Summary statistics of variables used in regression

Variable	No of observations	Mean	Std. Dev.	Min	Max
Proportion of households who invested in soil bunds (1991-1998)	100	0.23	0.30	0	1
Proportion of households who privately invested in SWC (1991-1998)	100	0.52	0.30	0	1
Proportion of households investing in tree plantation (1991-1998)	100	0.58	0.36	0	1
Change in proportion of households using compost between 1998 and 1991	100	0.17	0.25	-0.80	0.90
Change in proportion of households fallowing between 1991 and 1998	100	-0.07	0.13	-0.50	0.10
Number of land distribution in *Tabia* since 1974	100	3.58	1.12	1	6
No of years since last land distribution in *Tabia*	100	8.84	2.53	1	19
Number of landless households in *Tabia* in 1991	100	89.26	157.65	0	750
Change in number of landless households (1991-1998)	100	160.60	168.65	-210	800
If community felt very or moderately secure in 1991	100	0.80	0.40	0	1
If land tenure security improved significantly (1998-1991)	100	0.16	0.37	0	1
If land tenure security improved moderately (1998-1991)	100	0.66	0.48	0	1
Average elevation (meters)	92	2003.04	297.21	1278.73	2725.14
Average annual precipitation (mm)	92	641.10	85.57	501.37	870.5
Change in proportion in households who are literate (1988-1991)	88	0.34	0.12	-0.19	0.62
Distance in market (walking minutes)	100	167.20	124.76	10	720
Central Zone	100	0.34	0.47	0	1
East Zone	100	0.24	0.43	0	1
West Zone	100	0.14	0.35	0	1
Area of *tabia*	98	57.24	35.24	12.30	179