Land tenure security and adoption of natural resource management technologies in Ethiopia

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Abstract

This paper examines the linkage between the degree of land tenure security and adoption of sustainable natural resource management practices among smallholder farmers in Ethiopia. A review of the available literature indicated that the land tenure system of the Imperial regime was characterised by a complex pattern of land ownership, namely communal, church ownership, private and state holdings. Since 1975, however, all rural land has become a public property. Essentially, the land tenure of current Ethiopia is similar to what prevailed during the socialist regime. Under both regimes, the land policy is based on the logic of providing access to land to all households who aspire to make a livelihood through working the land. The land policy, however, neither succeeded in providing access to all land claimants nor did it provide tenure security. Frequent land redistribution was mentioned, among others, as the major reason for tenure insecurity. Empirical results confirmed the main hypothesis that improved security of land tenure significantly increased the probability and intensity of soil conservation efforts as measured by stone/soil bund structures in the highlands of Ethiopia. Furthermore, public assistance with sharing initial costs of constructing soil conservation structures, and farmers' education and access to information on soil degradation and other soil related problems is found essential for farmers to make a long-term investment in conserving soil resources. Improved land tenure, therefore, is a necessary but not sufficient condition for a sustainable use of natural resources.

1. Introduction

Ethiopia with 67.2 million people is the second most populous country in Africa (CSA 2004). The total area of the country is 1.12 million km^2, of which about 66% of the land is considered to be suitable for agriculture. Although land and labor are the two most abundant resources vital for its economic development, the fast growing population, currently estimated to be increasing at 2.9%, and the current land-use appear to be in disharmony, threatening the sustainable use of its natural resources, particularly that of land, which forms the basis of livelihood for the majority of the population. The problem is more severe in the highlands, in areas higher than 1500m, which constitute 44% of the land area, 95% of the cultivated area and support 88% of the human and 75% of the livestock population. Available data indicate that out of the 60 million ha of agriculturally productive land, about 27 million ha are significantly eroded, 14 million ha are seriously eroded, and 7 million ha are considered no longer agriculturally productive (FAO 1999). Furthermore, the high natural forests that had once covered about 35-40% of the country's land have largely been converted into cultivated lands. Currently, the forest cover is estimated at about 2.4%.

In an effort to increase agricultural productivity, improve farm income and contain natural resource degradation, improved agricultural technologies (improved crop varieties, commercial fertilisers, better agronomic practices and pest control measures) have been promoted among smallholder farmers by government and non-government organisations (NGOs). Reforestation and soil conservation development programmes were also launched in various parts of the country. However, despite these efforts, adoption of both improved crop production and sustainable natural resource management practices by smallholder farmers across the country have remained below expectations (Yirga *et al*. 1996, Demeke *et al*. 1997, Shiferaw and Holden 1998, Gebremedhin and Swinton 2003, Bekele and Drake 2003, Croppenstedt *et al*. 2003). As a result, the productivity of Ethiopian agriculture has remained one of the lowest in the world. Yield per ha of cereals remained low at 1.2t ha^{-1} compared with the global average of 4.0t ha^{-1} (FAO, 1998). As a consequence, food availability per person has progressively declined (MEDaC 1999).

A review of a large body of literature revealed that efforts to increase agricultural productivity, improve farm income and contain natural resource degradation have been severely hampered by a combination of the biophysical environment, population pressure, the institutional setup and socio-economic conditions of farmers (Campbell 1991, Yirga *et al*. 1996, Demeke *et al*. 1997, FAO 1999, Adunga and Demeke 2000, Adal 2003). The land tenure policy of successive governments has been singled out as the major hindrance among others for a sustainable use of natural resources in Ethiopia (Campbell 1991, Adunga and Demeke 2000).

This paper has two objectives. First, based on literature it summarises the land tenure regimes that prevailed during successive governments of Ethiopia. Second, using a case study from the central highlands, it provides empirical evidence of the linkage between the degree of tenure security, socio-economic factors and adoption of soil conservation practices among smallholder farmers in the central highlands of Ethiopia. The paper provides evidence that land tenure security is a necessary but not sufficient condition for sustainable management of natural resources.

The paper is organised into six sections. Section two provides a theoretical background for the divergence between the private and social optimal rates of natural resource depletion. It also summarises the hypothesised relationship between improved tenure security and sustainable use of natural resources. Section three describes the land tenure regimes prevalent in the pre- and post-1975 land reform programme. While empirical evidence of the impact of land tenure insecurity on adoption of soil conservation is discussed in section five, section six concludes by providing implications for policy.

2. Reasons for the divergence between the optimal private and social rates of natural resource utilisation

Sustainable natural resource management from a practical point of view could be considered as any practice or action taken by the land user in an attempt to reduce the effect of natural resource degradation by means of biological, mechanical and chemical measures. This essentially implies that, like any other investment decisions, farmers intending to invest in natural resources are faced with inter-temporal resource allocation decisions and hence have to consider not only current costs and benefits, but also future costs and benefits associated with the investments. In developing countries including Ethiopia, the rate of natural resource use from a social point of view is believed to be excessive and is a cause for concern (Shiferaw and Holden 1999, Kidanu 2003). For instance, efforts of the federal and regional governments of Ethiopia to rehabilitate degraded lands, maintain and expand national parks, natural forest reserves and plantations are in sharp conflict with the interest of local people to clear up the areas for cultivation or grazing. Needs of individual households for immediate grazing and fuel wood collide with community interest for woodland (Shiferaw and Holden 1999, Kidanu 2003). The divergence between the optimal private rate of natural resource use and the social rate arises from:

a) Externalities: An externality occurs whenever the activities of one economic agent affect the activities of another agent in ways that are not reflected in market transactions. Externalities are thus costs and benefits arising in the process of production and consumption, which are not reflected in market prices. Examples of negative externalities arising from use of natural resources include the sedimentation of dams and irrigation channels. While society as a group is concerned with both on-site and off-site effects of depletion of natural resources, individual farmers are primarily concerned with on-site effects. Farm households as rational economic agents equating their private marginal costs and benefits of natural resource conservation, which do not include off-site externality costs, hence are likely to under-invest in natural resource conservation, due to the divergence between private and social objectives concerning the optimal level of natural resource conservation (Barbier 1995, Shiferaw and Holden 1999). Consequently, in a setting where significant off-site costs subsist, the optimal private and social rates of natural resource use diverge considerably.

b) Imperfect input and output markets: Under perfectly competitive conditions, prices reflect the marginal scarcity value of using resources. However, in most less developed countries, markets for agricultural inputs and outputs are far from competitive and even totally absent for some assets such as soil quality (Barbier 1995; Shiferaw and Holden 1999). For instance, in the highlands of Ethiopia, farmers have only usufruct rights to land, but land is neither traded nor used as collateral. Consequently, smallholder farmers may not take the full user costs of natural resource depletion into consideration when making decisions regarding natural resource conservation investments, resulting in too little conservation in relation to what society desires. The same applies to capital markets operating in such settings where farmers usually face major imperfections that often raise the opportunity cost of using available funds for making long-term investments in natural resource conservation. Hence, smallholder farmers who are facing imperfect capital markets and who often lack access to risk mitigation mechanisms if left on their own may under-invest in long term natural resource conservation technologies.

c) Time preferences: Time preference refers to the value people attaches to present against future income (Barbier 1995). Time preference is commonly considered to have two components, pure time preference and the marginal opportunity cost of capital. While pure time preference refers to the people's attitude to risk and uncertainty, as well as to household poverty, the marginal opportunity cost of capital represents the scarcity value of savings and returns to alternative investments. The discount rate, representing both pure time preference and the marginal opportunity cost of capital, is often used to compare present and future costs and benefits arising from alternative investments (Barbier 1995, Shiferaw and Holden 1999). The discount rate employed by private individual farmers in general and smallholder farmers in SSA in particular are considered to be very high compared to what society as a group deems appropriate, suggesting individual farmers attach less value to the future and hence degrade the environment much faster than society as a group wishes (Barbier 1995). For instance, Shiferaw and Holden (1999) in the Ethiopian highlands estimated the nominal discrete rates of time preference among smallholder farmers to be 71% on average. The high time preference displayed by smallholder farmers is believed to be associated with poverty, risk aversion behavior and insecure land tenure. In contrast, society as a whole having a wider asset base is less risk averse and thus displays lower time preferences. Hence, the optimal rate of natural resource depletion for society would be much lower than the level chosen by individual farmers (Barbier 1995, Shiferaw and Holden 1999).

d) Technological improvements: Obviously, technological innovations are geared either to devise substitutes or increase the productivity of scarce resources. In the short run, technological innovations by increasing the productivity of natural resources such as land (e.g. through the use of improved seeds) or providing substitutes for lost nutrients (e.g. commercial fertiliser) might reduce the economic significance of natural resource degradation both in the developed and developing countries. However, on the long run, the natural resource capital being an essential input in agriculture, particularly in developing countries where chances for a technological breakthrough are slim, natural resource degradation will continue to be a potential threat to a sustainable agricultural development.

e) Policy incentives: Government intervention in agricultural markets in SSA is widespread and believed to have significant effects on farm level incentives for conservation (Barbier 1995, Adugna and Demeke 2000, Shiferaw and Holden 1999). Policy distortions arising from interventions in input and output markets, exchange rate manipulations, insecure land tenure and imperfect competition often distort the true costs and benefits of natural resource conservation, thereby affecting farmers' perceptions about the optimal level of natural resource conservation.

The above discussion suggests that improved land tenure is a necessary but not sufficient condition for a sustainable use of natural resources. Therefore, attempts to redress policy distortions to bring about the private rate of natural resource depletion, in line with the optimal social rate of natural resource depletion, need improved understanding of not only the land tenure policy, but also the biophysical and economic processes and the decision-making behavior of farmers shaping that relationship.

Land tenure (land policy) represents the social relations and institutions governing access to and ownership of land and natural resources (Maxwell and Wiebe 1998). Land tenure, therefore, through the rights and obligations it bestows on farm households determines both short and long-term investment decisions and the benefits landholders derive thereof. Land tenure rights often derive from both statutory and customary laws. Research in land tenure has shown that land tenure regimes are rarely static and hence evolve in response to political, economic and demographic changes. Although the importance of appropriate land tenure policy to agricultural development was recognised long ago, there has not been any agreement as to what constitutes an appropriate land policy (Maxwell and Wiebe 1998, EEA\EEPRI 2002). Land reform (agrarian reform) programmes are usually justified on the basis of efficiency and equity goals. In reality, however, political motives often outweigh economic considerations. As a result, land tenure reforms often focus in times of political uncertainty.

Tenure status affects investments in sustainable NRM by altering the planning horizon. A number of studies have shown that land ownership increases incentives of adopting NRM technologies by lengthening planning horizons and the share of benefits accruing to adopters, while lowering the rates of time preference. Others argue that the effect of tenure on adoption depends on the type of technology under consideration. A technology with a high potential to conserve input use, reduce cost, and provide economic benefits such as conservation tillage could create incentives for adoption even among renters, part-time renters and part-time operators (Norris and Batie1987, Soule *et al*. 2000). Nonetheless, it is generally held that renters of farmland are less likely to invest in conservation practices because short-term leases reduce incentives to maintain the productivity of rented land (Norris and Batie 1987, Soule *et al*. 2000). Increased security of tenure defined in terms of private freehold ownership recognised and protected by the state (Maxwell and Wiebe 1998) is therefore presumed to be necessary to internalise costs and benefits and to capture the future income streams resulting from investments.

3. Evolution of the land tenure systems in Ethiopia

As in most parts of Africa, land tenure in Ethiopia has been the subject of debate among farmers, policy makers, researchers and the public at large. Historically, in Ethiopia, land was viewed not only as a source of livelihood to the majority of the population, but also as a source of political and economic power to all groups who aspire to hold political power (Adal 2000, Adal 2003, EEA/EEPRI 2002, Rahmato 2004). The following section describes the evolution of land tenure policy in Ethiopia.

3.1. Land tenure prior to 1975

Prior to the 1975 land reform, land tenure in Ethiopia was characterised by a complex system of ownership, namely communal, church ownership, private and state holdings (Rahmato 1984, Campbell 1991, Adal 2003). State or government holdings were most prevalent in the less densely populated and pastoral areas of the lowlands, irrespective of the geographical location, whereas communal ownership locally referred to as “Rist”, and church holdings characterised the northern highlands including Gojam, Gonder, Tigray and parts of Wollo. Private holdings were a feature of the South.

The communal system (Rist) was based on the principle that land is the collective property of the community that bestows access and transfer rights to its individual members who can trace their kinship ties back to the founding ancestors. However, land could not be sold or mortgaged. The presence of a descent system that allows an individual to be a member of different kinship groups at the same time, often arising from intermarriages, entitles the individual to claim land from several kinship groups, irrespective of the residence of the individual or the geographical locations of the contested land. As a result, the number of people with “rist” rights is generally very high. Consequently, farmers used to end up in endless land related litigations, which claimed valuable time and resources, led to land fragmentation and in certain cases to absentee landlordism (Rahmato 1984, Campbell 1991, EEA/EEPRI 2002).

In the south, private ownership of land was developed as a result of land grants by the government to loyalists of the imperial regime. This has resulted in land concentration in the hands of a few individuals subjecting the cultivators of the land to treats of arbitrary eviction and an exploitative landlord-tenant relationship. The land tenure system during the imperial regime, therefore, did not provide enough incentives for the cultivators to manage land in a more sustainable manner.

3.2. Land tenure from 1975 to 1990

Following the overthrow of the imperial government and establishment of the military regime in 1974, the military regime issued the land reform Proclamation of February 1975, formally known as the “Public Ownership of Rural Lands Proclamation”. This proclamation nationalised all rural land and ended all forms of tenancy (Rahmato 1984, Campbell 1991, Adal 2000, Teklu and Lemi 2004). Peasant associations (PAs) were established, which were bestowed with administering land. Consequently, the PA distributed land to farm households based on family size with little regard to other factors such as resource endowment (e.g. oxen ownership, adult labor and working capital). The new land tenure system provided farmers with restricted usufruct rights, prohibiting the transfer of holdings in any form (inheritance, renting, share-cropping or gift). Land was frequently re-distributed in order to reduce landlessness, as well as to address land quality differences until 1990, which had the effect of leveling down differences in land holdings and reducing land allotted to community forests and grazing (Rahmato 1984, Campbell 1991, Adal 2000). Smallholder farmers were also evicted from their holdings to give way for state farms and producer cooperatives.

In addition to frequent land redistribution, the socialist government promoted economic polices such as controlled agricultural input and output markets, forced food grain deliveries at fixed prices and involuntary villagization of farm households. Thus the land policy of the military regime, which was characterised by state ownership of land coupled with its economic policy of nationalization of industries, collectivizing commercial private farms, government control of agricultural input and output markets, forced food grain deliveries at fixed prices and involuntary villagization of farm households by denying favorable economic environment and the private incentives required for sustainable use of natural resources, contributed to the degradation of natural resources (Rahmato 1984, Campbell 1991, EEA/EEPRI 2002). Furthermore, the land tenure policy of the military governments resulted in a diminution of the size of land holdings and tenure insecurity with all its adverse effects of unsustainable utilisation of natural resources (Campbell 1991, Rahmato 1994, Adal 2000, EEA/EEPRI 2002).

In 1990, the military regime introduced mixed economic policy, which in effect stopped land redistribution and brought along some tenure security and informal land markets resulting from the need to equalise factor proportions. Nonetheless, the land reform of 1975 managed to destroy the landlord-tenant relationship characterizing much of the south and benefited landless households, particularly social groups that did not traditionally own land in the communally “Rist”-dominated north. For instance, in areas where the communal “Rist” system was prevalent, Muslims and Flashas (black Jews), who in most instances did not have “Rist” rights, benefited from the reform.

3.3. Land tenure since 1991 to date

The Transitional Government of Ethiopia (TGE) replaced the socialist regime in 1991. The TGE, subsequently renamed as the Federal Democratic Republic of Ethiopia (FDRE), adopted an Economic Reform Programme in 1992 (ERP). The programme, aimed at stabilization and trade liberalization to revive the economy that had suffered from many years of civil war, food security crises and heavy control, took several measures: devaluation of the local currency, disbanding of producer cooperatives, drastic reduction of subsidies to state farms, elimination of compulsory food grain quotas and liberalizing input markets (Demeke *et al*. 1997, MEDaC 1999, EEA/EEPRI 2002). These policy reforms have been further strengthened through the adoption of a new development strategy popularly known as “Agricultural Development Led Industrialization (ADLI)”.

ADLI, primarily focusing on the agricultural sector, aimed at bringing about productivity improvements to the smallholder agriculture and expansion of private commercial farming. Improvements in the agricultural sector were hoped to provide commodities for exports, satisfy domestic food requirements and supply industrial inputs. Improvements in the agricultural sector in turn were expected to help expand the market for domestic manufacturing as a result of an increased income of smallholders. Establishing an effective input delivery and marketing system which can ensure adequate and sustained agricultural inputs such as fertilisers, improved seeds and crop protection chemicals to smallholder farmers in the required quantity, product mix, at the right time and at a reasonable price, is considered the key to the success of the development programme (Demeke *et al*. 1997, MEDaC 1999, EEA/EEPRI 2002).

Nonetheless, while the current government introduced a series of economic reforms in line with a free market philosophy, it has effected little substantive change to farmers’ land rights (EEA/EEPRI 2002, USAID 2004, Gebremedhin and Nega 2005). Article 40 (3) of the 1994 Ethiopian Constitution clearly asserts land to be the collective property of all nations, nationalities and peoples of Ethiopia under the custody of the government. Proclamation No. 89/1997, “Rural Land Adminstration”, further clarifies Ethiopia’s national land policy. The Rural Land Administration Proclamation of 1997 entrusted regional governments with the responsibility of land administration, including the assignment of holding rights and the distribution of landholdings. This law allowed land leasing and inheritance, though subject to some restrictions.

Land distribution in the Tigray region and some parts of the Amhara region that were liberated before 1991 was implemented in 1990. In much of the Amhara region, however, land was distributed following the Rural Land Administration Proclamation of 1997, whereas other regions have not yet implemented any land distribution since the fall of the socialist government (Adal 2000, Adal 2003, Rahmato 2004, Teklu and Lemi 2004).

The recent land redistribution in the Amhara region such as Debere Birehane benefited newly formed households and households headed by women who did not own land for various reasons. However, most of the women-headed and newly established young households unable to cultivate by their own, due to lack of access to key resources (oxen, labor and seed), leased out their newly acquired land to households who have oxen and capital (mainly households who lost land during the redistribution) (Teklu and Lemi 2004, USAID 2004, Yirga 2006).

Of recent, efforts are underway to improve land administration and tenure security through land certification (cultivated lands) and the distribution of marginal lands (waste lands) to individual households and communities for tree (USAID, 2004). The success of this recent move in improving tenure security and adoption of sustainable natural resource management is yet to be seen.

4. Empirical evidence of the linkage between the degree of tenure security and adoption of soil conservation practices

4.1. Data and study area

The primary concern of this section is to estimate the consequences of tenure insecurity and other socio-economic factors on the soil conservation adoption behavior of smallholder farmers in the central highlands of Ethiopia. Cross-section data were collected from 229 randomly selected households managing some 1411 plots in the Dendi and Debre Birehan districts in the central highlands of Ethiopia during 2003. The collected data include plot characteristics (size, distance from residence, severity of soil degradation, fertility level, perceived plot productivity, and slope), soil fertility and soil conservation practices used, and production. Major socio-economic variables measured include demographic structure of households, farm size, livestock owned, access to credit, extension, and improved inputs.

4.2. The empirical model and choice of variables

The dependent variable, intensity of use of stone/soil bunds, measured in mt ha^{-1}, is a censored continuous variable. This censoring arises due to the fact that not all sample households use stone/soil bunds. The appropriate model suggested and often used in the literature is the Tobit model (Green, 2000). The Tobit model, a more general case of probit, besides the probability of adoption as in the probit model, estimates the value of the continuous response for the case when

$$y_i^* = b' x_i + e_i$$

(1)

Where X_i is an N * 1 vector of explanatory factors, β is a vector of coefficients, and e_i are independently and normally distributed error terms with mean zero and variance, s^2. If y_i^* is negative, the variable that is actually observed, the length of stone/soil bund y_i is zero. When y_i^* is positive, $y_i = y_i^*$. The Tobit model is preferable to OLS for it allows the inclusion of observations with zero values. The Tobit model requires maximum likelihood methods (MLE) to estimate the coefficients of the adoption equation (Green 2000).

The study seeks to investigate the linkages between tenure insecurity and adoption of soil conservation measures. Based on previous studies and analyses of the agriculture sector of Ethiopia (Ervin and Ervin 1982, Feder *et al*. 1985, Norris and Batie 1987, Shiferaw and Holden 1998, Gebremedhin and Swinton 2003, Bekele and Drake 2003), a range of household, farm and plot characteristics, institutional factors, and agro-ecology variations are hypothesised to influence the adoption of soil conservation technologies by smallholder farmers in the highlands of Ethiopia (Table 1).

4.3. Empirical results

4.3.1. Adoption rate and pattern of soil conservation technologies

Soil conservation practices promoted by the various projects on cultivated lands in the highlands include cut-off drains (*golenta*), stone and soil bunds, grass-strips and *Fanya juu*. While the first three practices are not completely new, grass-strips and *Fanya juu* represent soil conservation practices introduced by various SWC projects.

Cut-off drains are semi-permanent drainage ditches constructed around a plot or parcel to protect draining water from upslope fields to inundate a parcel. While cut-off drains are used in both districts, the use of stone/soil bunds is restricted to the Debre Birehan district, constructed on 42% (2.5% in reasonable condition and 39.4% in excellent shape) of the cultivated plots, compared to 1.4% (0.24% in reasonable condition and 1.2 in good shape) in the Dendi district (Table 2). The Debre Birehan district, identified as one of the heavily degraded areas in the central highlands and one with a tradition of using soil conservation practices, received government assistance for constructing stone and soil bunds on individual and communal holdings in the 1980's and 1990's. Interestingly, despite the widely held view that smallholder farmers remove much of the soil conservation practices constructed by public assistance, only 7.7% and 16.3% of the plots that had some type of soil conservation structures (3.9% and 3.7% of the total plots) in Debre Birehan and Dendi, respectively, were removed. Adoptions of grass strips were dismal due to their incompatibility with the land tenure system, where stubble fields after harvest are considered as communal (open to all community members for grazing livestock). *Fanya juu* was also rejected for its alleged problem of aggravating water logging.

4.3.2. Empirical results of the Tobit soil conservation adoption model

In empirical adoption studies involving cross-section data, multicollinearity often poses a major econometric challenge. Hence, as a first step, prior to estimating the Tobit model, the independent variables were scrutinised for possible strong correlations among them. Among the variables hypothesised to influence adoption behaviour, the age of the head of the farm household was found to be correlated with the education level of the household head (ρ=0.29), farm size (ρ=0.26) and the number of livestock owned (ρ=0.22). Farm size was also found to be correlated with plot area (ρ=0.39), number of plots (ρ=0.17) and number of livestock owned (ρ=0.31). Hence, age and farm size were dropped from further consideration.

Table 3 presents the parameter estimates of the Tobit model. The likelihood ratio statistics of the Tobit model is significant ($P<0.001$), suggesting a strong determining power of the independent factors taken together on the intensity of the use of stone/soil bunds among the surveyed farmers.

As expected, the type of land ownership (PA allotted land as opposed to plots acquired through informal transactions) significantly influenced both the adoption decision and intensity of the use of stone/soil bunds by smallholder farmers. Stone/soil bunds are long-term investments, the benefits of which are realised after several years of initial investment. It is therefore rational for a household to restrict soil conservation investments on their own land (land allotted directly by a PA to a household) as opposed to land acquired through informal land markets. While a household has legally defensible rights on land allotted by PA officials, thus enjoying the benefits of soil conservation investments until a time of land redistribution, plots acquired through informal mechanisms have to be surrendered to the legal owner at the end of each cropping season. In a similar study of the impact of socio-economic factors on adoption of soil fertility management practices, Yirga (2006), found that the likelihood of using animal manure and integrated soil fertility management was higher on land that carries higher security (land directly allotted to the farmer) than on share-cropped and rented plots. On the other hand, the chances of using inorganic fertilisers on less secure lands (leased-in plots through the informal land markets) were found to be higher compared to PA allotted plots. A possible explanation, other things being equal, could be that farmers who lack legally defensible use rights prefer to use inorganic fertilisers on leased-in land in an attempt to maximise short-term benefits and save available manure to be used on relatively secure PA allotted plots. Studies by Teklu (1997), Alemu (1999) and Gebremedhin and Swinton (2003) also provide evidence of a significant and positive relationship between increased tenure security and the use of long-term soil fertility and soil conservation practices.

Education is positively and significantly correlated with the adoption and intensity of stone/soil bund use. Household heads with relatively better formal education are likely to foresee the productivity consequences of soil degradation and soil conservation. Providing access to formal education would therefore play a crucial role in the fight against soil degradation and its consequences on food insecurity and poverty in the highlands of Ethiopia.

Among the farm and plot characteristics, plot size and plot slope positively and significantly affect both the likelihood of adoption and intensity of use. Similarly, other things being equal, the chances of constructing soil conservation structures would be higher by 12% for plots having a medium slope compared to plots on bottom lands. In their soil conservation adoption studies, Shiferaw and Holden (1998) for the central highlands and Bekele and Drake (2003) for the eastern highlands of Ethiopia reported a positive correlation between slope and likelihood of using soil conservation structures.

The number of livestock owned, a proxy for the wealth position of a household, positively and significantly conditioned the likelihood and intensity of stone/soil bunds. In Ethiopia, livestock are sources of cash and security against climatic uncertainties. Households with livestock, therefore, are in a better position to invest on soil conservation, for they have the financial resources to pay for the extra labour required for initial investments, as well as to afford the short-term yield declines resulting from reduced plot size (due to area taken by stone/soil bunds).
Access to extension, measured by the number of contacts a household head had with extension personnel was positively and significantly (10.3%) related with the likelihood of using stone/soil bunds. In Ethiopia, agricultural extension services provided by the MOA are the major source of information on agriculture and natural resource conservation. The results therefore confirm the hypothesised positive role extension would play in natural resource conservation in general and soil conservation in particular.

Surprisingly, access to institutional credit for the purchase of inorganic fertilisers had a negative and significant influence both on the likelihood of adoption and intensity of use. The results suggest that the chances of investing in permanent soil conservation structures drop by 11.5% for a new household having access to short-term institutional credit. Similarly, among those who are currently using soil conservation structures, the intensity of use would be lower by 12.7% for an average farmer having access to institutional credit compared to a household who did not have access. A possible explanation is that households who have access to short-term credit for the purchase of inorganic fertilisers are likely to use inorganic fertilisers to compensate for lost soil nutrients and hence postpone the adoption of soil conservation practices. Several other studies have shown the importance of improving smallholder farmers' access to credit in enhancing the adoption of inorganic fertilisers (Yirga *et al*. 1996, Croppenstedt *et al*. 2003). The current short-term credit schemes, targeted at raising the number of households using inorganic fertilisers and the intensity of inorganic fertiliser use per unit of cropped area, would only help solve the short-term treats of soil degradation (soil nutrient mining), but could have a detrimental effect on the sustainable use of soil resources, as inorganic fertiliser use does not compensate for soil lost due to water erosion.

As expected, perception of the severity of soil degradation and government assistance for initial construction of soil conservation practices positively and significantly influence the use of stone/soil bunds. The chances of investing in soil conservation structures would be higher by 23.1% for a household receiving assistance compared to a household who did not receive such assistance. This result contradicts the widely held view that assistance programmes for construction of soil conservation structures in Ethiopia were largely unsuccessful and that soil conservation structures constructed under assistance programmes were partially or wholly removed (Shiferaw and Holden 1998). The result, however, is consistent with the findings of Bekele and Drake (2003), who focused on the soil conservation research project (SCRP) site, whereas our study areas are located outside the SCRP sites, and hence are broadly representative. Similarly, the chances of investing in soil conservation structures on plots displayed some degree of degradation would be higher by at least 14% compared to plots perceived to be free from any symptom of physical degradation.

Another important and noteworthy result is that district (proxy for unobservable factors such as traditional values, attitudes and aspirations of the community) positively and significantly influenced the likelihood and intensity of investment in soil conservation structures. The chances of investing in soil conservation structures would be higher by 14.7% for a household in the Debre Birehan district compared to a similar household in Dendi. This could be explained by the relative extension efforts exerted in the two districts and by local tradition. A number of soil conservation projects were also implemented by government and NGOs, which helped improve awareness and contributed to the actual construction of soil conservation structures. In the Dendi district, however, extension efforts concentrated on extending improved crop packages consisting of improved crop varieties, agronomic practices and the recommended type and rate of inorganic fertilisers.

5. Conclusions and policy implications

As in most parts of Africa, land tenure in Ethiopia has been the subject of debate among farmers, policy makers, researchers and the public at large. In Ethiopia, land is viewed not only as a source of livelihood to the majority of the population but also as a source of political and economic power to all groups who aspire to hold political power. Consequently, the land tenure reforms that Ethiopia has witnessed had been designed and implemented in the light of the political advantages they were presumed to yield to successive governments, with very little economic rationale. A review of available literature revealed that the land tenure of the Imperial regime was characterised by a complex system of ownership, namely communal, church ownership, private and state holdings, whereas all rural land became a public property under the military regime and the current government. The current government, although it introduced a number of policy reforms in line with the philosophy of open market, has not implemented significant changes in land policy. The logic of the land policy since 1975 to date has been based on providing access to land to as many rural households as possible who want to make a living out of farming. However, the policy neither succeeded in providing access to all land claimants, nor did it provide tenure security and with it the much needed productivity improvement and sustainable natural resource management.

The results of the case study confirmed the main hypothesis that improved security of land tenure significantly increases the probability and intensity of soil conservation efforts as measured by stone/soil bund structures in the highlands of Ethiopia. Furthermore, public assistance with sharing initial costs for constructing soil conservation structures, farmers' education, and access to information on soil degradation and other soil related problems were found essential for farmers to make long-term investment in conserving soil resources. On the other hand, improved small farmers' access to short-term credit for the purchase of inorganic fertilisers presents a disincentive for long-term conservation practices, an important trade-off with serious policy implications to be carefully evaluated.

In Ethiopia, efforts are underway to improve land administration and the security of tenure through land certification. Yet the existing land policy does not take into consideration the economic and demographic dynamics taking place in Ethiopia. A natural question, then, would be whether there are alternative forms of land ownership patterns to the current land policy. Current debate on land policy issues in Ethiopia dwells on public/state ownership versus a radical measure of complete privatization. Others suggest that partial measures would be as effective as the radical measure of complete privatization (EEA/EEPRI 2002, Gebremedhin and Nega 2005). Alternative land tenure systems suggested for Ethiopia include:

a) Associative ownership. Rahmato (1994) suggested associative ownership of rural land could provide the desired level of tenure security and incentives for sustainable management of natural resources. In associative ownership, land belongs to the community with freehold rights vested on individuals. Individuals have the right to rent and mortgage, but can only sell to members of the community. Although associative ownership provides security of tenure and prevents the much feared land concentration in the hands of the urban elites, it has several drawbacks. Firstly, it does not allow the development of land markets or at best creates a highly fragmented market.

Secondly, it limits the value of land as collateral. Thirdly, the mere fact that associative ownership prohibits transfer of land outside community members is likely to create inefficiency by restricting the movement of land to those who can make the best out of it.

b) Long-term leases. Some believe that long term leases, which vest strong secondary rights in landholders, would help to address some of the weaknesses of the existing land tenure system (EEA/EEPRI 2002, USAID 2004).

c) Individual ownership. Many believe that individualization of land tenure by increasing tenure security and the reduction of transaction costs provide incentives for increased investment and adoption of sustainable natural resource management practices. In a recent empirical investigation of the land policy of Ethiopia, Gebremedhin and Nega (2005) found the expected probability of preference for private ownership to be 32% well below the 53% for public ownership with improved security.

The debate on alternative forms of land ownership and hence improved tenure security, therefore, needs to be based on empirical evidence including ownership patterns other than the two polarised ones of public/state ownership and complete privatization.

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Table 1: Definition of variables hypothesised to condition the adoption of soil fertility management practices by smallholder farmers in the central highlands of Ethiopia, 2003.

Variable	Description	Values
HH characteristics		
Age	Age of the head of the farm HH	Years
Education	Level of formal schooling attained by the head of the HH	Highest grade attend
Livestock	Number of livestock owned by a HH	Number in TLU
House type	Whether a HH owned corrugated iron roofed house or not	1= yes, 0=no
Family size	Number of family members of a HH	Number
Farm and plot characteristics		
Farm size	Total area (crop, fallow, grazing) managed by a HH	Area in hectares
Plot area	The physical size of a plot	Area in hectares
No. of plots	Plots owned and managed by a HH	Number
Plot distance	The distance of a plot from the homestead	Minutes walked
Slope	Slope of a plot	1=flat, 2=medium, 3=high
Soil fertility	Farmers' perception of the level of soil fertility of a plot	1=poor, 2=medium, 3=fertile, 4=manured (kossi)
Degradation	Farmers' perception of the severity of soil loss on a plot	1=none, 2=light, 3=severe, 4=very severe
Institutional factors		
Tenure	Whether plot is owned (allotted to HH by PA) or rented/share cropped	1=owned, 0=otherwise
Extension	Whether HH has access to extension services	1= yes, 0=no
Assistance	Whether HH has received assistance from government/NGO for constructing conservation structures	1= yes, 0=no
Credit	Whether a HH has access to institutional credit for inorganic fertiliser	Amount of money borrowed (Birr)
Off-farm	Income from off-farm activities during the survey year	Estimated average income (Birr/year)
Agro-ecology	Upper highlands or mid highlands	1=upper highlands, 0=mid highlands
District	Dendi and Debre Birehan	1= Debre Birehan 0=Dendi

HH=household; Local currency, 1USD=8.6 Ethiopian Birr

Table 2: Use of soil conservation practices by smallholder farmers on cultivated lands (% of plots treated), central highlands of Ethiopia, 2003.

Soil and water conservation practices	Debre Birehan (N=724)	Dendi (417)	Both districts combined (1141)
Not ever constructed	50.00	79.38	60.74
Cut off drains (golenta) only			
Removed	1.66	2.88	2.10
Reasonable condition	0.14	1.68	0.70
Excellent condition	4.14	14.15	7.80
Stone and soil bunds			
Removed	2.21	0.48	1.58
Reasonable condition	2.49	0.24	1.67
Excellent condition	39.36	1.20	25.42

Source: Farmer's survey

Table 3: Parameter estimates of the Tobit adoption model for the intensity of stone/soil bund-use, central highlands of Ethiopia, 2003.

Variable	Coefficient	P-level	Adoption (index)		Expected use	
			Elasticity	Marginal effects	Elasticity	Marginal effects (m/ha)
Constant	-320.4803***	0.000				
Tenure[1]	37.1450**	0.012	0.2769**	0.0763***	0.0869**	8.4359**
Education[2]	6.0547*	0.068	0.0637*	0.0133**	0.0200**	1.4458**
Off-farm income[3]	-26.7276*	0.083	-0.0652*	-0.0567*	-0.0205*	-6.2248*
Livestock[4]	3.1450*	0.077	0.1650*	0.0069*	0.0518*	0.7510*
Plot area[5]	82.1367**	0.010	0.3153***	0.1798***	0.0989***	19.6137***
No. of plots	-3.5717	0.169	-0.1931	-0.0078	-0.0606	-0.8529
Plot distance[6]	0.0148	0.966	0.0022	0.0000	0.0007	0.0035
Soil degradation[7]						
Severe	127.4936***	0.000	0.1415***	0.3237***	0.0444***	37.7390***
Medium	158.7275***	0.000	0.2886***	0.3962***	0.0905***	47.1408***
Light	159.2407***	0.000	0.4400***	0.3802***	0.1380***	44.1137***
Credit[8]	-54.8909*	0.061	-0.1767*	-0.1153*	-0.0554*	-12.7187*
Extension[9]	43.1145	0.250	0.0231	0.1023	0.0072	11.1684
Plot slope[10]	54.7832***	0.000	0.2406***	0.1199***	0.0755***	13.1464***
Assistance[11]	91.7587***	0.001	0.0607***	0.2307***	0.0190***	26.0110***
District[12]	70.7553**	0.029	0.4032**	0.1470**	0.1265**	16.3012**
Diagnostics						
No. Observations	1141					
Wald Chi-Square	80.29***					

***, **, *= Significant at 1%, 5% and 10% probability levels, respectively;

[1] dummy variable, 1 denoting PA allotted plots;
[2] number of years;
[3] dummy variable, 1 denoting participation in off-farm activities;
[4] Tropical Livestock Unit (TLU);
[5] hectares;
[6] minutes walked from residence;
[7] the comparison category is plots perceived as not having shown any form of soil degradation;
[8] dummy variable, 1 denoting access to institutional credit;
[9] dummy variable, 1 representing access to government extension;
[10] dummy variable, 1 representing plots on a higher slope (upland);
[11] dummy variable, 1 denoting access to project assistance;
[12] dummy variable, 1 referring to the Debre Birehane district.