Discussion Paper No. 3/2008

Land titling policy and soil conservation in the Uplands of northern Vietnam

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Forschung zur Entwicklungsökonomie und -politik

Research in Development Economics and Policy

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Department of Agricultural Economics and Social Sciences in the Tropics and Subtropics (Ed.), Forschung zur Entwicklungsökonomie und -politik – Research in Development Economics and Policy, Discussion Paper No. 3/2008.

ISSN 1439-4952

Printed in Germany.
Druck: F. u. T. Müllerbader GmbH
Forststr. 18, 70794 Filderstadt, Germany

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Discussion papers in this series are intended to stimulate discussion among researchers, practitioners and policy makers. The papers mostly reflect work in progress. This paper has been reviewed by Holger Seebens (University of Göttingen, Gemany) and Daniel Müller (Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO)) whom we thank for their valuable and pertinent comments.

Table of Contents

List of Tables

List of Figures

Abstract

In Vietnam, a quasi private property regime has been established in 1993 with the issuance of exchangeable and mortgageable long term land use right certificates. Using primary qualitative and quantitative data collected in a mountainous district of Northern Vietnam, this paper investigates the role of the land policy in the adoption of soil conservation technologies by farmers. This issue is of crucial importance in the region where population growth and growing market demands have induced farmers to intensify agricultural production. While poverty has been reduced, environmental problems such as soil erosion, landslides, and declining soil fertility have become more severe over the past years. Among the abundant literature on the impact of property rights and formal land titles in developing countries, only a few studies have focused on the adoption of soil conservation technologies: an important element in sustainable development strategies of fragile agro-ecological areas confronted with increasing population densities.

Our findings suggest that soil conservation technologies are perceived as being economically unattractive; therefore, most upland farmers continue to practice the prevailing erosion-prone cultivation system. Focusing on agroforestry as one major soil conservation option, we estimate household and plot level econometric models to empirically assess the determinants of adoption. We find that the possession of a formal land title influences adoption, but that the threat of land re-allocations in villages discourages adoption by creating uncertainty and tenure insecurity.

We conclude that more efforts are needed from decision-makers to promote and support the adoption of conservation practices and to clarify objectives of the land policy in order to secure land tenure and foster sustainable development in fragile areas.

Key words: Land titling policy, technology adoption, upland agriculture.

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1 Introduction

Beginning with the *Doi Moi* policies in 1986, Vietnam has engaged in important institutional reforms in order to lead its economy from a centrally planned to a market oriented system. In rural areas, reforms were designed to empower farmer's decision-making capacity as a way to boost production and encourage the protection of natural resources. In this perspective, the land allocation policy, and the issuance of long-term land use right certificates to households have been among the most important measures taken by the state.

Our research focused on the Northern Mountain Region (NMR), an area inhabited predominantly by ethnic minorities[6]. Rapid population growth over the past 20 years has led to an increasing scarcity of arable land driving agricultural production up onto the steep slopes. Moreover, the increasing demand for food and feed from urban areas has induced farmers to further intensify the production of an erosion-prone crop, maize, on the hillsides. Soil erosion and landslides have become important issues as they lead to reduced soil fertility in the uplands, sedimentation of lowland water reservoirs, irrigation channels and paddy fields as well as severely damaging road infrastructure. Unchecked, these practices could affect the greater population as they threaten the sustainability of agricultural production in the mountainous area as well as local infrastructure and, at a larger scale, the quality of drinking water in the lowlands. Soil conservation technologies (SCT) are thus a major tool for sustaining livelihoods and agricultural production at the individual farm level and ensure food security for coming generations.

The determinants of soil degradation and the adoption of conservation practices have been widely investigated in the literature. While techniques to limit erosion on cropped fields are numerous and diverse, most of them share two common features: first, they incur opportunity costs in terms of land and labour that are not available for cropping activities any longer; these costs may be rather high, especially if SCT compete with profitable cash crops. And, second, SCT enhance soil fertility in the medium to long run only (1994). The adoption

[6] The Vietnamese ethnic, the Kinh, represent about 82 % of the country's population. The rest of the population is composed of 53 other ethnic groups located for most of them in mountainous regions.

decision of SCT involves intra- and intertemporal utility tradeoffs (Grepperud, 1997, McConnell, 1983). Poor farmers living in an environment of incomplete credit markets, insecure land tenure, and short planning horizons are unlikely to invest in such technologies, because of potential risks on consumption (Shively, 2001). State interventions that secure land tenure, provide safety nets to rural households, and relax constraints on liquidity via credits to farmers are thus expected to reduce poverty and encourage natural resource conservation and protection (Lutz, Pagiola and Reiche, 1994).

In particular, it is expected that, by securing land tenure, improving access to formal credit, and increasing land transactions, land titling policies increase investment incentives and foster rural development (Deininger and Feder, 2001). The formalization of property rights is, according de Soto (2000), a major step toward development and poverty alleviation as it enables poor households to transform their assets into productive capital. Notwithstanding this consensus, empirical studies conducted in different countries do not find that property rights have large and positive effects as investment incentives including formal land titles in particular (see Bromley (2009) for a review). Rather, it seems that the issuance of formal land titles has not necessarily led to increased tenure security and to higher investments on land. Legal pluralism and the co-existence of formal and informal land institutions may cause high enforcement costs, and lead to inefficiency of the land institutions (Meinzen-Dick and Pradhan, 2003, Platteau, 1996). The absence or imperfection of labour or credit markets may as well limit investment capacities, and the efficient allocation of land among farmers, making for inefficient land institutions. Recent empirical studies have found that land titles may benefit certain types of households more than others, for example the richest households in Paraguay (Carter and Olinto, 2003) or the powerful ones in Ghana (Goldstein and Udry, 2007).

Regarding soil conservation practices, Soule et al. (2000) find that land owners in the United States have a higher propensity to adopt such technologies than cash or share-renters. Shively (2001) also concludes that land tenure is an important determinant of SCT adoption in the Philippines. In Vietnam, using national living standard survey data, Do et al. (2008) find that the 1993 land law has significantly increased the allocation of land to perennial crops, although the effect is only of small magnitude. In contrast with most of the existing literature on Vietnam’s land titling policy, this paper proposes a small scale and detailed study which allows to control for local factors potentially relevant in explaining the impact of land titles on investment incentives.

The objectives of the paper are (1) to describe how the land titling policy has been implemented in the NMR, (2) to assess upland farmers' knowledge and adoption of soil conservation technologies, and (3) to identify the influencing factors of the adoption of such measures household and plot level econometric models and controlling for knowledge. We focus in particular on the role of the land titling policy in fostering such investments.

After outlining the land reform and its implementation in Vietnam in Section 2, we describe the research area in Section 3 and present our data and sampling procedure in Section 4. The estimation strategy for our regression models is described in Section 5, results are presented in Section 6. In Section 7 we discuss the results and draw conclusions.

2 Reform of land institutions and implementation in the NMR

Prior to 1981, agricultural land, means of production, and production output were fully managed by the collectives, namely the village cooperatives. The first reform of tenurial contracts was implemented by Directive 100 in 1981, which allowed farmers to keep the surplus produced in excess of the contracted output for home consumption. The series of directives that followed were designed to increase the flexibility of the land management and taxation systems in order to raise investment incentives, increase production levels, and overcome food insecurity (Que, 2005). The collective farming system officially ended with the 1988 land law (Resolution 10) and the allocation of collective land to private households according to family size. The land is still owned by the Vietnamese people (and managed by the state); farmers initially received land use rights for a period of fifteen years.

The 1993 land law granted five rights to land users: the right to exchange, transfer, mortgage, inherit, and lease out the land. Land use certificates (known as Red Books) were issued to users for a period of 20 years for annual crops and for 50 years for perennial crops. The law confirms that the land is publicly owned, it is therefore a quasi-private land management system. Through local authorities the state maintains control over transactions, rental contracts, and more importantly on the general land use plans.

This policy represents one of the largest land titling programs ever implemented throughout the developing world with around 11 million titles issued in 2000 (Do and Iyer, 2008) and was assessed by observers and researchers as egalitarian (Ravallion and van de Walle, 2001). Its implementation however has been a costly process, and has not been evenly achieved in the regions. In 1998 less than half of the total area in NMR had been allocated with a certificate (Do and Iyer, 2003). The considerable administrative costs involved for measuring land, issuing and registering the certificates and the lack of qualified personnel were the main explanation of this slowness Haque, et al. (1996). Secondly, in mountainous regions, the enforcement of the land law has been contested by some ethnic groups who returned instead to traditional land management systems when collective farming ended (see Corlin (1997) on H'mong villages; Mellac (2006) and Sikor (2004) on Thai communities). Sikor (2004) reports cases of conflicts in Thai communities in Yen Chau district where village heads refused at first to allocate paddy fields as directed by the Red Book, preferring instead the traditional allocation system in which the village head regularly reallocates paddy fields to villagers. Corlin (1997) reports the same types of conflicts over rights allocation and the conflict with ancestral rights in H'mong communities. In some regions these conflicts have been solved by re-allocations along with strong enforcement by the provincial government (cf. section 6). Uncertainty still persists on whether these rights will be reallocated at the end of the use right term (20 years). Despite repeated interventions of the ministry of agriculture stipulating that no reallocation will occur, an important share of farmers still expect the contrary and are reluctant to operate land transactions[7].

3 The research area

The study region is Yen Chau district, a mountainous area inhabited primarily by ethnic minorities (85%). The largest ethnic groups are the Thai (Black Thai) with about 55% of the district's population, followed by the H'mong who account for 20%, and the Kinh, "ethnic Vietnamese" who represent 13% of the district's population. The Thai and the Kinh were the first settlers in the area and occupied the lowlands, while later arrivals, such as the H'mong, settled mainly in the highlands (Neef, Friederichsen, Sangkapitux and Thac, 2002). Lowland villages along the highway benefit from greater access to infrastructure (i.e. markets, paved roads, and irrigation systems) and are relatively better off than villages located in higher altitudes. Between 1988 and 2006 the districts' population rose by 50% at a growth rate of 2.4% annually.

[7] cf. Interview of Mr. Dang Hung Vo, Vice Minister of Natural Resources and Environment (28/08/2007) [ONLINE in Vietnamese http://www.agro.gov.vn/news/newsDetail.asp?targetID=2128, (last accessed, 27/11/2008).

Farmers nowadays cultivate two main crops: rice as a subsistence crop grown in irrigated paddy fields of the lowlands and maize as a cash crop in the uplands. The rapid development of the livestock sector accompanied by rising maize prices and the shortage of rainfall have pushed farmers to intensify maize production and abandon rice cultivation in the uplands. Thus, the area allocated to maize cultivation has more than tripled over the last twenty years while the area allocated to upland rice has decreased by 27%, according to the district statistical office. Nowadays, farmers plant on average 71% of arable land are cropped with maize from April to September, and left uncovered the rest of the year, exposed to wind and rainfall. As a consequence, the area is susceptible to erosion leading to an increasing incidence of sedimentation and landslides during the rainy seasons over the past years.

4 Sampling and data collection

A household survey was conducted in 2007/2008 in Yen Chau district. In selecting the households, a cluster sampling procedure was followed where a village-level sampling frame was constructed encompassing all villages of the district[8], including information on the number of resident households. First, 20 villages were randomly selected using the Probability Proportionate to Size (PPS) method (Carletto, 1999). Next, 15 households were randomly selected in each of these villages using updated village-level household lists. Since the PPS method accounts for differences in the number of resident households between villages in the first stage, this sampling procedure results in a self-weighing sample (Carletto, 1999). In total the database consists of 300 households and 2279 agricultural plots, among which 2059 are operated by farmers and 1190 are upland plots, i.e., rain-fed plots dedicated to crop production other than paddy rice. Both the household and plot samples are representative at the district and village levels. The survey covered a wide range of topics, including quantitative and qualitative questions on the effect and perceptions of soil conservation technologies.

In addition, we conducted focus group discussions using semi-structured interview guidelines to collect information on village history and composition, and to reconstruct the land allocation process chronologically. A visual timeline was elaborated with respondents in order

[8] Except for the villages in four sub-districts bordering Laos, for which research permits are very difficult to obtain.

to facilitate these recall questions, and a standardized questionnaire gathered the necessary background data. The respondents were part of the current and former village boards.

5 Estimation strategy

We estimate the determinants of farmers' decision to invest in agroforesty[9], and in particular the effect of the land titling policy on adoption incentives. Since aggregating different technologies that imply different costs and benefits over time may be misleading (cf. Section 6), we focus on agroforestry which is one of the most widely known measures against soil erosion in the study area and is also perceived to be one of the most effective (cf. Table 1).

The investigation of adoption determinants in a population where the diffusion of innovation is incomplete may lead to biased estimates (Diagne and Demont, 2007). Selection bias arises when exposed and unexposed farmers differ in their propensity to adopt the technology[10]. This may be the case for at least two reasons. First, knowledge acquisition is part of the farmers' adoption decision and therefore endogenous, and second, for efficiency reasons agricultural extension may especially target farmers or communities with a high innovative capacity. Table 3 shows that knowledge diffusion for agroforestry is incomplete in the study area, suggesting the use of a selection bias correction model.

Our problem can be written as follows:

$$y_{1i} = 1[\beta X_{1i} + u_i > 0] \qquad \text{if } y_{2i} = 1 \qquad \forall i \in [1, N^k], N^k < N$$

$$= 0 \qquad \text{otherwise} \qquad (1)$$

$$y_{2i} = 1[\delta X_{2i} + v_i > 0] \qquad \forall i \in [1, N] \qquad (2)$$

where: N is the total population, and N^k, the subpopulation of households knowing agroforestry as a SCT; y_{1i} and y_{2i} are binary dependent variables indicating the adoption and knowledge status of the i^{th} household respectively; X_{1i} and X_{2i} are vectors of regressors;

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[9] "Agroforestry is a collective name for land-use systems in which woody perennials are *deliberately* grown on the same piece of land as agricultural crops and/or animals" Lundgren (1982). By agroforestry, we refer to a cultivation technique consisting in planting trees and/or shrubs on a cultivated land as a way to limit soil erosion and improve soil fertility. The plants mostly used in the study area are wild tamarind (*leucaena leucocephola*), teak trees and pine trees.

[10] In this context selection bias is also termed exposure bias in the literature, e.g. by Diagne and Demont (2007).

(u_i, v_i) are the error terms, we assume that they are jointly bivariate normally distributed. The covariance matrix is: $\text{cov}(u_i, v_i) = \begin{pmatrix} \sigma_u^2 & \rho \\ \rho & \sigma_v^2 \end{pmatrix}$.

We use a Heckman full maximum likelihood procedure to jointly estimate the probability of knowing and adopting the technology and control for selection bias (Heckman, 1979). The model predicts household's probability to adopt and maintain agroforestry on at least one of its plots conditional on variables X_{1i} and on knowing agroforestry[11] (Table 2).

Table 1 summarizes the explanatory variables (X_{1i} and X_{2i}). Following literature on knowledge acquisition and learning (Conley and Udry, 2001, Feder and Slade, 1984, Foster and Rosenzweig, 1995), we expect that those farmers who are well connected socially, have good communication assets, higher education levels, and good access to extension services also have greater access to information. We use two measures of social capital in order to differentiate the effect of "horizontal" social capital, i.e., connections of individuals with their peers, and "vertical" social capital, i.e., connections with individuals who have better access to information. The former is measured by the participation of adults in any organizations, while the latter measures how well the household is connected with the mass organizations[12] in its village by assessing how easily help is obtained in case of problems. As indicators of wealth, we use size of the farm and the share of off farm income in cash income. The other variables control for access to agricultural extension, human capital and possession of communication assets.

Among regressors of adoption, control variables account for household (human and social capital), soil, and farm characteristics, as well as geographic location. In addition, we include a regressor indicating whether material support was received by the household to implement agroforestry[13]. Material support includes labour, in-kind inputs (seeds, seedlings or fertilizer, for instance) or cash support. Such support is either provided by governmental or non-governmental organizations in the research area to encourage certain farmers to adopt

[11] The probability $P(y_{1i} = 1 | y_{2i} = 1, X_{1i})$ is derived in Wooldridge (2002): pp.477-78 and 570-71.

[12] In Vietnam, the mass organizations play a crucial role and are present at all administrative levels (from the village to the state). They are composed of six unions representing women, farmers, veteran, elderly, youth and the fatherland front union. In addition to participating in major village decisions, these organizations carry out multiple tasks: from extension agents to rural bank staffs.

[13] The comparison of means show that there are no systematic differences in characteristics that may influence adoption (human, social, and financial capital) between those that have been supported, and the rest. We conclude that attribution of support was random regarding characteristics that also influence adoption, and that there is consequently no endogeneity.

agroforestry. Hereby, several goals are pursued: firstly, to target farmers with a low investment capacity; secondly, extension organizations may target influential or exemplary farmers as a way to disseminate a technology (using a demonstration plot); finally, it may be intended to enforce adoption in areas of strategic importance, such as easily visible locations close to the main road[14].

We hypothesize that improved access to credit is conducive to the adoption of agroforestry based SCT because it relaxes liquidity and/or consumption constraints, and reduce farmers discount rates. This will lead to a higher value being attached to benefits from reduced soil erosion that accrue in the future. We use a binary variable indicating whether a household is credit constrained. Following Zeller (1994), we consider farmers to be credit constrained if they did not apply for credit for fear of rejection or if they applied for a loan but were partially or fully rejected by the lenders[15].

A positive and significant sign of the land title variable would indicate that land title is perceived as a guarantee of tenure security thus encouraging farmers to engage in soil conservation. Apart from being registered and operated under a title, the land can be leased from a private households with a defined time period and/or a fixed payment; lent or given by private households with no payment and for an undefined time period; leased or borrowed from the village fund land; or cultivated without agreement or informally purchased (Table 3). With this variable on land title, we test our main hypothesis - that tenure is perceived to be more secure when land is operated under title than under any of the other tenurial arrangements. Place et al. (2000) recommend to treat tenure security as endogenous in long term investment estimations, as it was observed that farmers in some countries may undertake some investments to secure tenure, and obtain land titles. In our case, the fact that land titles have been distributed to all households on all land at a certain point in time (cf. section 6 and Table 3) excludes risk of endogeneity.

As outlined in section 6, the implementation of the land policy in the study area has resulted in successive reallocations and a majority of farmers expect further reallocations to take place before the end of the use right term. While the issuance of a land title was supposed to

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[14] It was mentioned that some farmers having their plot located close to the National road had been strongly encouraged to implement hedgerows on their field so as to create positive impressions on officials and visitors passing by the area.

[15] The literature on credit and technology adoption suggests that this variable is endogenous (i.e. correlated with unobserved factors of adoption such as entrepreneurial capacity). The test of endogeneity conducted on this variable does not reject exogeneity, with various specifications and various measures of credit access. We therefore treat this variable as exogenous in the model.

empower farmers as decision makers over the use of their land, the successive reallocations send a contradictory signal, showing users that the state remains the primary decision maker over land issues. We test the hypothesis that this threat of land reallocations is perceived as a source of insecurity and therefore acts as a disincentive for long-term agricultural investments, such as SCT. The variable testing this effect measures the share of villagers who believe that a reallocation is likely to occur before the end of the use right term.

Using the household-level model we are able to test whether our estimates would be affected by exposure bias if we did not account for farmers' knowledge of the technology. Since we do not find evidence of exposure bias (cf. Section 6), it is safe to estimate a plot-level model in which we do not account for prior exposure to the technology. A plot-level model can more accurately control the effect of soil characteristics (X_{3ij} j, summarized in Table 2), slope, or plot size; factors expected to strongly influence farmers' adoption decision.

More importantly, the household-level model may not bring satisfactory results regarding the effect of tenure on adoption. Farmers in northern Vietnam cultivate a relatively large number of scattered plots (10 on average in our sample – among which 4 are upland plots). Almost half of farmers (48%) in our sample operate both titled and untitled plots. Given the variation of conditions within a same household, the aggregation of plot-level variables to the household-level induces a loss of information on whether agroforestry is adopted on (non-) titled plots. Following previous literature on property rights (see Besley (1995) and Hayes et al. (1997) for example) we develop a plot-level model of adoption in order to identify the effect of tenure on adoption. After all, it matters whether the long-term benefits of agroforestry can be reaped by the farmer on a given plot.

The plot level model can be written as:

$$y_{3ij} = 1\left[\alpha X_{3ij} + \beta X_{1i} + \varepsilon_{ij} > 0\right]$$

$$j \in \left[1, T_i\right],\ i \in \left[1, N^k\right],\quad N^k < N$$

where y_{3ij} indicates the adoption status of agroforestry by farmer *i* on plot *j*, and T_i is the number of upland plots operated by household *i*. We cluster the standard error at the household level in order to account for heteroskedasticity as well the non-independence of observations within a household, as suggested by Wooldridge (2006).

Table 1: Description and summary statistics of household-level variables

Variable	Description	Mean	St. Dev
Know agroforestry	HH[a/] knows agroforestry as SCT (yes=1, no=0)	0.42	0.50
Human and social capital			
Education +	Highest educated member has a high school certificate (yes=1, no=0)	0.05	0.23
Age +	Age of the household head	43.16	12.66
Peer connections	Average participation in organisation per adult	1.49	0.67
Vertical connections	Number of problems for which it is easy to get help from Union[b/]	2.01	2.00
Communication and extension			
Television	HH possesses a TV (yes=1, no=0)	0.82	0.38
Telephone	HH possesses a telephone connection (yes=1, no=0)	0.07	0.25
Radio	HH possesses a radio (yes=1, no=0)	0.18	0.38
Extension service	Subjective score on access to extension service (1= lowest, 5= highest)	3.10	1.06
Farmer union	HH participates in the farmer union (yes=1, no=0)	0.79	0.41
Wealth			
Farm size	Total area operated by household in square meter [c/]	15,999	11,664
Off farm income	Share of off-farm income in total cash income (2006) (in %)	15.28	22.75
Geographic characteristics			
Elevation +	Elevation of the house in meter above the sea level (m.a.s.l.)	520.33	241.87
Distance to city +	Distance to Yen Chau city in minutes by motorbike	43.60	36.44
Adoption	HH has adopted and uses agroforestry on at least one plot (yes=1, no=	0.12	0.32
Soil and farm characteristics			
Poor soil	Share of area with poor soil (in %)	30.91	33.59
Medium soil	Share of area with medium soil (in %)	56.09	36.54
Land availability	Total area operated by household in hectare per capita	0.35	0.22
Upland allocation	Area of titled upland per capita > village average (yes=1, no=0)	0.41	0.49
Relation to village head	Number of problems for which it is easy to get help from the village head[b/]	3.74	2.20
Support and access to credit			
Support	HH received support to implement agroforestry (yes=1, no=0)	0.07	0.26
Credit constraint	HH is credit constrained in the formal market (yes=1, no=0)	0.27	0.45
Land policy			
Titled land	Share of titled upland area on total area operated (in %)	70.56	39.13
Villagers expecti reallocation	Share of household in village expecting a reallocation (in %)	79.28	13.14
			292 Obs.

+ these variables are present in both models

[a/] HH=Household

[b/] Respondents were asked to assess the easiness in receiving help from village mass organization and village head to (i) borrow money for education; (ii) borrow money for health expenses; (iii) borrow money for any positive event; (iv) borrow money for any negative event; (v) borrow a water buffaloe; (vi) ask for labour

[c/] Variable logged in the regression

Table 2: Description and summary statistics of Plot-level variables

Variable		Full sample (N)		Restricted sample (N^k)	
		Mean	Std. Dev.	Mean	Std. Dev.
Adopt	Agroforestry is adopted on this plot (yes=1, no=0)	0.04	0.19	0.08	0.27
Poor soil	Soil on this plot is of medium quality (yes=1, no=0)	0.30	0.46	0.30	0.46
Medium soil	Soil on this plot is of poor quality (yes=1, no=0)	0.55	0.50	0.54	0.50
Area share	Area of this plot divided by household farm size	0.23	0.20	0.21	0.19
Steepness	The slope of this plot is very steep[a/] (yes=1, no=0)	0.37	0.48	0.38	0.48
Land title	The plot is operated under land title (yes=1, no=0)	0.75	0.43	0.80	0.40
			1190 Obs.		567 Obs.

[a/] The slope was assessed by respondents on a scale from one (=level) to five, using a graph for illustration.

Table 3: Tenurial arrangement and year of land acquisition

	% Plots [a/]	% Household [b/]	Year of acquisition (mean)
Operated under title	74.9	81.5	1989
Operated without title	25.1	50.5	2002
Leased in from private household	6.8	19.5	2006
Borrowed to private household	10.1	19.9	2002
Village land fund	4.8	13.0	2000
No agreement	2.3	8.2	1997
Non registered purchase	1.0	2.1	2002

[a/] Upland plots operated in 2007 (T=1190)
[b/] Households using at least one plot under such arrangement (N=292)

6 Results

Land allocation in Yen Chau district

Due to the region's formerly low population density and ethnic diversity, land management in the NMR has proceeded differently from the rest of the country. During the period of cooperative farming informal permission was given to individuals to cultivate the uplands bordering the common land as long as collective goals were met. With the passing of the first land law in 1988 farmers were encouraged to clear forest and upland areas as only the common land was distributed following official criteria.

The application of the 1993 law and the issuance of LURC followed a long process: some of the households received a title in 1991 while others, few kilometres away and usually on higher altitudes, received a first title only in 1999. We summarize the issuance of process in the study area in three phases:

- *From 1991 to 1996*: a first allocation was achieved in part of the lowland villages. The allocation was carried out by commune and village officials, with some supervision by provincial-level staff. Respondents reported that despite the official criteria established (family size, soil quality), land was generally allocated to the actual users, without being properly measured. In some Thai villages only upland areas were registered on the certificate and the allocation of paddy land remained under the authority of the village heads.
- *After 1998*, the provincial administration implemented a second wave of land allocation. Upland villages, where allocation had not yet taken place, were issued the first certificates. In other villages land was reallocated and land titles reissued. During this second wave, provincial officials were actively involved in order to enforce the law's implementation. Agricultural and residential plots, including paddy fields, were allocated following the official criteria, formally measured, and the lands were titled and recorded in cadastral maps. A share of non-allocated land (paddy and upland) was kept as a village fund and controlled by the village board for allocation to newly established households.
- *Since 2003* a third allocation wave has been taking place. In villages where reallocation occurred (five out of our twenty sample villages), land titles had yet to be reissued in 2007. The official rationale for this reallocation was firstly to provide land to newly established and landless households and secondly to combine scattered small plots as a way to increase farm productivity, following the land use plan established by the Province[16].

Despite the existence of long-term use right certificates originally issued for twenty to fifty years, some households have seen their land reallocated two times at five year intervals. Whereas only a minority of farmers have been directly affected by reallocations (35% of our sample), most live in villages or close to villages where a reallocation has or is going to occur. As a consequence, 80% of interviewed farmers believe that a reallocation will take place in their village before the end of their 20 year use right, an expression of the very low trust households currently have in land institutions.

[16] However, in light with the current situation, it appears that this reallocation is linked to a larger scale plan to introduce rubber plantations in the district.

Knowledge and adoption of soil conservation technologies

We report in Table 4 descriptive qualitative and quantitative results on farmers' knowledge on soil conservation technologies and adoption behaviour. Farmers were asked to enumerate the methods they know to limit erosion. Most farmers - three quarters - know at least one SCT and are therefore aware of problems related to erosion. When looking separately at different technologies, the diffusion rates[17] vary widely. Knowledge on terraces, contour ploughing, or ditch[18] techniques has been spread mostly through social networks, whereas other technologies have been diffused by more formal communication channels such as media and external organizations. With the exception of the hedgerow technique, the governmental agricultural extension service and non-governmental organizations (NGOs) appear as secondary sources of information on SCT.

Table 4 reports adoption rates, defined as the share of household knowing a technology and currently using the technology on at least one of their plot. An effectiveness score based on adopters' perception is also reported. It appears clearly that the methods requiring a relatively high input of labor or take up a considerable portion of land (terraces, vegetative contour strips, agroforestry and cover crops) are adopted the least although they are found to be effective. Short-term and low extra-input technologies (contour ploughing or ditches) are more attractive to farmers but are deemed to be less effective. Among adoption constraints (i.e. the main reason given by respondents for not adopting a known technique), the lack of land is frequently cited in the case of vegetative strips, cover crop, or agroforestry. Lack of labour was identified by farmers as an important constraint for building terraces and planting cover crops. Respondents emphasized lacking access to seedlings as a major reason for not adopting agroforestry, and, with regard to ditches, their ineffectiveness against erosion. The differentiated answers given by respondents show that farmers' perception of costs and benefits over time differ significantly between SCT, so does their adoption decision.

The dynamics of the adoption of selected SCT over time (at the plot level) are shown in Figure 1. In 1990, agroforestry was practiced on 1.8% of all the plots operated at that period and ditches were used on 2%. Note that the graph does not account for a cohort effect due to the under-representation of older generations. Nonetheless, one can observe that changes in

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[17] The term diffusion is used in the adoption literature for either adoption diffusion, or knowledge diffusion. In this paper, diffusion refers to knowledge.

[18] The ditch technique consists of channels oriented diagonally to the slope of the land so that rain water is captured and channeled off the field. This technique is used for soil conservation rather than water conservation as the channels are rarely connected to the paddy fields.

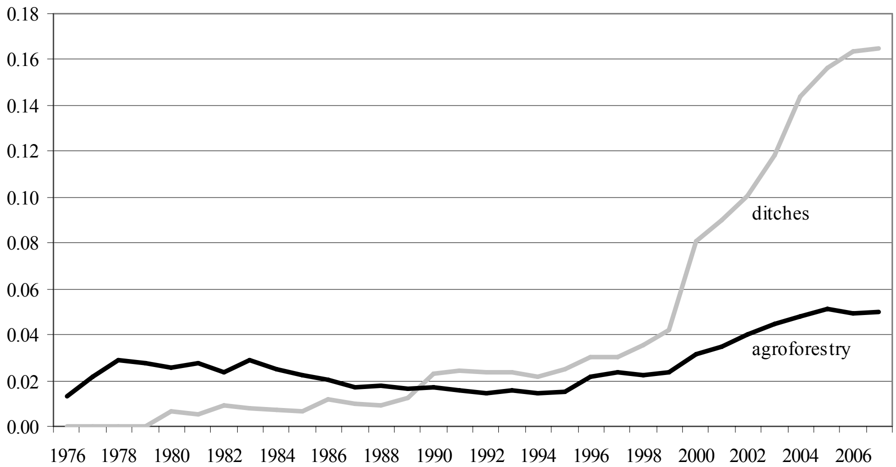
adoption rates follow institutional changes. The adoption of ditches has clearly accelerated following the first land law in 1988 (decollectivization), while agroforestry has slowed down. The issuance of Red Books in the study area has been clearly followed by a considerable acceleration of adoption of the two technologies, although the increase of agroforestry is less pronounced.

Table 4: Knowledge about and adoption of SCT

	Knowing SCT (N^k) (% of N [a])	**Knowledge source**	**Currently using SCT** (% of N^k)	**Effectiveness score** (0: no effect; 10: very effective)	**Adoption constraints** (1)	(2)
Ditches or channel	56.2	Rel/Neighb[b]	61.0	5.7	Not effective	Lack of labor
Agroforestry	42.5	Extension	27.4	6.7	No access to seedlings	Lack of land
Terrace	20.9	Rel/Neighb	9.8	7.0	Lack of labor	Expensive
Contour ploughing	20.2	Rel/Neighb	88.1	6.1	No erosion	Lack of Equipment
Cover crop	12.7	Media	10.8	7.3	Lack of land	Lack of labor
Vegetative strips	5.8	Media	11.8	6.0	Lack of land	
Mulching	3.4	Media	20.0	5.7	Lack of labor	
Other SCT	5.1	Own initiative	66.7	5.8		
TOTAL (at least one)	**74.7**		**53.4**[c]			

[a] N=292: non farmers and farmers growing paddy rice only are excluded
[b] Relative or Neighbor
[c] Share of total households using at least one SCT

Figure 1: Adoption of ditches and agroforestry (in share of plots cultivated, per year)



Source: own data

Determinants of knowledge and adoption of soil conservation – the household-level model

Table 4 presents results of the household-level probit model with sample selection. In the last column we report the marginal effects on the probability to adopt agroforestry conditionally on knowing it. The model has a good predictive quality, with over 90% of households correctly predicted.

The first part of Table 4 shows that vertical connections, the possession of a radio, the participation in the farmer union, and the size of the operated farm are positive and significant determinants of farmers' knowledge of agroforestry. Access to extension service and education however are not significant. However, these variables are found to have no impact on the adoption decision of agroforestry.

We find that the this decision is positively influenced by farmers' soil characteristics. The model predicts that, *ceteris paribus* and conditionally on knowledge, receiving material support increases the probability of practicing agroforestry by 70 percentage points. The share of titled land does not appear as a significant determinant of households' adoption decision. As expected, the threat of a future reallocation in the village results in a negative effect but is only significant at the 15% level of error probability.

The likelihood ratio test of selection bias on the parameter ρ does not reject the null-hypothesis ($\rho = 0$), an indication that the estimated parameters of adoption determinants on the exposed subpopulation are not affected by exposure bias. As mentioned earlier the aggregation of plot-level variables to the household level induces a loss of information with respect to plot-level tenure and natural characteristics because of variable plot conditions within a same household. We thus estimate a plot-level model of adoption.

Table 5: Household-level model, Probit with sample selection estimates

	Coefficient estimates: $\Pr(y_{2i}=1)$ **and** $\Pr(y_{1i}=1 \mid y_{2i}=1)$		Conditional probability: $\Pr(y_{1i}=1 \mid y_{2i}=1)$	
	Coefficient	z-stat [a/]	Marginal effect (x100)	z-stat [a/]
y_{2i} **: Household knows agroforestry as a SCT (yes=1)**				
Age household head	-0.022	(0.51)	-	
Age household head²	0.000	(0.22)	-	
Education (dummy)	0.466	(1.27)	-	
Peer connections	0.032	(0.25)	0.186	(0.25)
Vertical connections	0.081*	(1.91)	0.473	(0.62)
Television	0.290	(1.06)	1.648	(0.59)
Telephone	0.176	(0.49)	1.041	(0.39)
Radio	0.571***	(2.79)	3.435	(0.63)
Extension service	0.125	(1.59)	0.730	(0.72)
Farmer union	0.393*	(1.83)	2.215	(0.72)
Off farm income	0.006	(1.34)	0.038	(0.55)
Farm size (log)	0.412***	(3.20)	2.403	(0.69)
Elevation x 10^{-3}	-0.869	(1.51)	-	
Distance to city	0.001	(0.40)	-	
Constant	-4.362***	(3.37)		
y_{1i} **: Household uses agroforestry on at least one plot (yes=1)**				
Age household head	0.032	(0.35)	0.432	(0.27)
Age household head²	0.000	(0.50)	-0.007	(0.47)
Education (dummy)	0.980	(1.62)	33.999	(1.63)
Adults	0.035	(0.25)	0.603	(0.25)
Relation to village head	0.143*	(1.72)	2.477*	(1.82)
Poor soil (share)	0.025**	(2.28)	0.436***	(2.64)
Medium soil (share)	0.020**	(2.06)	0.343**	(2.43)
Land availability	-0.593	(0.62)	-10.292	(0.59)
Upland allocation (dummy)	0.369	(1.13)	6.766	(1.07)
Support (dummy)	2.075***	(3.58)	70.200***	(5.70)
Credit constraint (dummy)	0.436	(1.37)	8.744	(1.18)
Titled land (share)	0.002	(0.34)	4.426	(0.52)
Villagers expecting reallocation (share)	-0.019*	(1.71)	-0.332	(1.56)
Elevation x 10^{-3}	-0.268	(0.19)	-9.721	(0.41)
Distance to Yen Chau city	-0.010	(1.02)	-0.169	(1.14)
Constant	-2.083	(0.80)		
Observation				292
Censored				168
Log likelihood				-221.67
Estimated ρ (P-value of Wald-test independence equation(ρ=0))				-0.47 (0.487)
Correctly predicted(%) cut-off: p>0.50				91.4
Adopters correctly predicted(%) cut-off: p>0.50				61.8
Adopters correctly predicted(%) cut-off: p>0.25				85.3

[a/] Robust z-statistics in parentheses: *,(**),[***] significant at 10%, (5%) and [1%] level of error probability

Determinants of adoption of soil conservation – the plot-level model

Table 6 presents the probit estimates of the plot-level model. The low predictive quality of the model is explaind by the presence of numerous household-level regressors, as well as the low plot-level adoption rate.

Table 6: Plot level model, Probit estimates

	$\Pr\left(y_{3ij}=1\right)$	
	Marginal effects (x 100)	z-stat [a/]
y_{3ij} **: agroforestry has been adopted on this plot (yes=1)**		
Age household head	0.477*	(1.94)
Age household head²	-0.005**	(2.29)
Education (dummy)	0.058*	(1.75)
Adults	0.260	(0.73)
Relation to village head	0.430**	(2.22)
Poor soil (dummy)	17.185***	(4.78)
Medium soil (dummy)	6.142***	(3.69)
Area share (%)	7.388***	(4.57)
Steepness (dummy)	0.802	(1.07)
Land availability	-3.212	(1.19)
Upland allocation (dummy)	1.349	(1.55)
Support (dummy)	14.009***	(4.27)
Credit constraint (dummy)	1.370	(1.25)
Land title (dummy)	1.406*	(1.74)
Villagers expecting reallocation (share)	-0.108***	(3.29)
Elevation x 10^{-3}	-3.871	(0.78)
Distance to Yen Chau city	0.007	(0.25)
Observations		567
Log likelihood		-99.46
Pseudo R-squared		0.37
Correctly predicted (%) - cut-off: p>0.50		92.6
Adopters correctly predicted (%) - cut-off: p>0.50		22.2
Adopters correctly predicted (%) - cut-off: p>0.25		62.2

[a/] z-statistics in parentheses are based on robust standard errors clustered by household.
*,(**),[***] significant at 10%, (5%) and [1%] level of error probability

Farmers' endowment in human capital is found to significantly influence adoption in the plot-level model. The probability of adoption increases with age of the household head but decreases beyond 50 years old. The education level has a significantly positive effect, as does the household's social capital measured by its relation to the village head. However, these effects remain small in magnitude.

As in the household-level model, we find soil characteristics to be important determinants of farmers' choice. Agroforestry is rather used on poor and medium soils than on fertile ones.

The relative size of the plots also matters in the adoption decision. We find that 62% of adopters chose the first or the second largest of their plots to implement the technology. In agroforestry especially, space is a constraint as both trees and hedgerows require some space to grow, lead to shading of the crop, and compete for nutrients. However, the overall households' land availability is not found to be significant, which is surprising since farmers mentioned this constraint repeatedly during interviews. Household endowment in upland relative to their village is significant at the 15% level only, and the size of the estimated effect is of small magnitude.

As already observed in the household-level model, support is found to be an important determinant of adoption decision, although the measured effect is of smaller magnitude. A plot belonging to a household that has been supported by an external organization has a higher probability by 3 to 24 percentage points of being covered by agroforestry than other plots. We find that access to formal credit has a negative but not significant effect on adoption probability. Although counter-intuitive at a first glance, this result is less surprising considering the low initial cash costs requirement of agroforestry beside the purchase of seeds and fertilizer. Pagiola (1995)[19] argues that poor farmers, who are generally also risk adverse, may have higher incentives than their richer cohort to invest in inexpensive sustainable practices. Furthermore, the fact that access to formal credit is not a significant constraint and that outside material support is a major adoption determinant indicates that many farmers lack motivation to undertake such an investment on their own[20].

Finally, variables capturing the land policy effect are both significant. We find that plots operated under land title have a greater probability of being covered by agroforestry than

[19] Cited by Shively (2001), who finds however that in the Philippines, a greater access to credit smoothes the effect of adoption of soil conservation technology on consumption loss, and therefore encourages adoption.

[20] An illustrative example is given by a qualitative case study conducted in one of the H'mong sample villages by social scientists: there, farmers were given seeds and a lump sum of 300,000 VND (around 20 US$) to test hedgerows on their upland fields. In spite of this initial support, only a small fraction of these farmers still maintain these hedgerows nowadays; and if they do so this mostly happens out of fear to be punished otherwise by the administrative office which supported them. Farmers mentioned the lack of profitability of this technique and the competition with their primary cash crop, maize, for land, sunlight, and nutrients as major disadvantages. The findings of this case study are however not fully representative of the situation in the whole of Yen Chau district as indicated by statistical tests: a Hausman specification test concludes that the full sample and the restricted sample (excluding this village) estimates differ systematically. A likelihood ratio test concludes that the restricted sample model fits the data better.

other plots. The marginal effect, significantly different from zero at the 10% level, is of small magnitude: it ranges between 0 to 2.8 percentage points[21].

The marginal effect of the share of villagers expecting land reallocation before the end of the use term is highly significant and negative. An increase by one percentage point of this share leads to a decrease in the probability of adoption by 0.1 percentage points. As such information is being picked up through the village gossip, individual farmers may use this information to decide on whether the formal land titles for their plots are safe enough to invest in agroforestry.

7 Discussion and conclusions

The reforms of land institutions by the state in the 1990s were intended to increase tenure security, establish a real estate market, and thereby increase investment incentives and boost agricultural production while fostering natural resource conservation. However, the implementation of the reforms has been a long and complicated process, especially in the mountainous regions where enforcement has been opposed by ethnic minority communities. Moreover, we find that in Yen Chau the state maintains a substantial control over land resources by carrying out land reallocations, which sends contradictory signals to farmers and results in tenure insecurity.

Although the majority of farmers are aware of soil erosion and know methods to mitigate the problem, adoption rates of these methods remain very low. Farmers perceive these techniques to be economically unattractive, as they compete with the main cropping activities for scarce land and labour resources. In the case of agroforestry, we find that adoption is influenced by human and social capital, but more strongly by attributes of farmers' land, such as plot size and soil characteristics. While credit access is not a significant determinant of adoption, material support by external agents strongly influences farmers' decision, indicating a low initial motivation by land users to undertake such investments.

[21] To test whether this effect of land title is due to the effect of the length of use (much longer for titled plot, cf. Table 3) we interact the title with a variable on the number of year used, but none of the three variables become significant. In other words, the length of use is neither an adoption factor when the plot is titled nor when it is not.

In line with previous empirical studies on land titling we find little evidence that the tenure of land operated and registered under a formal title is perceived to be more secure, which should result in a higher propensity of farmers to make long-term investments in soil conservation, such as agroforestry-based practices. Rather, we find that the threat of future land reallocations discourages the adoption of such technologies, although the magnitude of this effect is relatively small. We conclude that local governments should better clarify the objectives of land use plans, especially when these entail land reallocations, in order to promote sustainable land use over the environmentally damaging practices that currently prevail.

We further conclude that the economic attractiveness of SCT that have been promoted so far need to be addressed by interdisciplinary research to identify land use options that are economically competitive with the prevailing cropping activities and also serve a soil conservation purpose.

Soil conservation is a public good as long as its benefits extend not only to the land users but to the society as a whole. Our findings show that farmers face knowledge, economic, and institutional constraints that reduce their capacity and incentive to invest in long-term soil conservation technologies. These findings may encourage decision-makers and development organizations in fragile areas not only to promote SCT, but also to actively support their adoption by farmers in order to address societal issues of water safety, food security, and sustainable rural development.

Acknowledgements

We acknowledge the willingness and patience of the respondent farmers to participate in our survey. Furthermore, we are thankful to Le Thi Ai Van and Dinh Thi Tuyet Van for their contribution in the data collection and to Thai Thi Minh and Andreas Neef for sharing case study findings. We acknowledge the DFG (Deutsche Forschungsgemeinschaft) for funding this research through the special research program SFB 564.

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