CHAPTER 9

FARMERS INVESTING IN SUSTAINABLE LAND USE AT A TROPICAL FOREST FRINGE, THE PHILIPPINES

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Abstract. A transition from slash-and-burn farming to sustainable land use is essential for the prevention of poverty and the conservation of the rainforest in the Philippine uplands. The key of this transition is that farmers invest in the quality of their land, e.g., through terracing, contour bunding, irrigation facilities, agroforestry or tree plantation. In their turn, these investments depend on a variety of factors, such as the households' socioeconomic and agro-ecological conditions.

This chapter presents an econometric analysis of the determinants of households' investments in land quality in the Philippines. A logit model of investments is formulated using the information generated from an in-depth household survey of 104 households randomly selected in four upland villages located in Luzon, Philippines at varying distance to the major markets of metropolis Manila.

The findings show that older household heads have a higher probability of investing in land quality improvement. This is due to 'lifecycle effects' on the part of the farmers since they accumulate capital and knowledge as they grow older. Household heads with more knowledge of soil and water conservation techniques, and households with additional, non-farming income are also more likely to invest in land improvements. Significant influence is also observed of village-level characteristics. Contrary to (neo-) Boserupian theory, population density did not appear to have an influence.

Traditional upland policies tend to see farmers as destructive agents that must be forced towards sustainable agriculture – usually without much success. As suggested by the research results, many opportunities exist for policies that rather aim to reinforce and spread the positive actions that farmers are already carrying out spontaneously.
Keywords. agricultural transition; agricultural intensification; Malthus; Boserup; Von Thünen; soil and water conservation; sustainable land use; rainforest; slash-and-burn agriculture; uplands; the Philippines

INTRODUCTION

Tropical forest degradation is commonly blamed on the slash-and-burn practices of upland farmers who are often portrayed as resource-poor households, unable to undertake soil-conserving investments and driven only by short-term survival

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perspectives. Likewise, with low educational levels, these households are branded to be largely ignorant of soil and water conservation techniques, which exacerbates the risk of soil degradation. This long-standing view of Philippine upland farmers, popularly known as *kaingineros*, has led to flawed designs of projects addressing the degradation problems, e.g., confronting farmers with pre-formatted farming-system designs that they are unwilling to adopt, often for good reasons. For instance, farmers in upland development programs in the Philippines have a low adoption rate for contour hedgerows despite the technical and financial support being offered during project implementation – see the description of Balete, below, as an example.

An alternative way of looking that recently emerged recognizes that partially or fully, some farmers do already transform their cultivation practices to more intensive and sustainable land-use systems. For example, they may convert part of their agricultural lands to irrigated rice terracing, organic and contour farming, agroforestry or tree farming. Policies then should aim to reinforce and spread these practices. Such scenarios make use of the phenomenon often called *agricultural transition*, which is the process of agricultural change from one form of land-use system to another that is more environmentally sustainable. While some farmers may go through this process early and consistently, other farmers may not be motivated yet or too poor to carry out the necessary investments. A better understanding of agricultural transition in the uplands will give policy makers and development managers an information tool to bring more farmers and more land into the transition process, e.g., by way of economic carrots and sticks, or by strengthening the farmers' individual or collective capacities to implement the actions, or by reinforcing the cultural notions that farmers have of what it is to be a good farmer.

CONCEPTUAL FRAMEWORK

The question of what compels households to shift from extensive land-use systems (such as slash-and-burn) to intensive and more sustainable land-use systems is linked to a number of basic perspectives on land-use change. Some consider population as the force that drives the transition process while others point at the market as the force necessary to motivate and capacitate farmers to make investments in sustainable land use.

The population paradigm consists of a pessimistic neo-Malthusian variant and more optimistic (neo-)Boserupian variants. From the Malthusian perspective, natural-resource degradation is inevitable because of increasing population. A finite earth can only support a limited number of people. This proposition puts the blame for the environmental disaster that is currently happening on growing population, such that population must be controlled for a sustainable management of natural resources. This theory disregards technological advances which, if within reach of people, shift threshold levels and allow for an increase in food production. For the Philippine uplands, this perspective focuses the policy maker on the curtailing of in-migration and the removal of existing migrants back to the lowlands, combined with the notion that better technologies will have to be forced upon those who remain.

The optimistic view on the effect of population on land-use change is inspired by the seminal work of Esther Boserup (1965). She points out that facing land shortages, farmers will be inclined to invest in intensification even though on the long run, this will tend to result in lower returns to labour. This process may in extreme cases ('involution', see Geertz (1963) and also Netting (1993)) lead to very high (and often sustainable) returns to land combined with very low returns to labour, with farmers escaping from extreme poverty only through seasonal migration, remittances or other non-farm income.

Other population-centred authors whom we will call neo-Boserupians here, assert that in fortunate circumstances of soils and markets, the intensification may in fact lead to higher returns to labour. The description of Tiffen et al. (1994) of the 'miracle of Machakos' (Kenya) is a case in point, showing that an increase in population density, coupled as it was with reduced transaction cost, influx of new ideas and more available labour, motivated as well as enabled people to innovate and find a higher level of productivity in agriculture that is now terraced and irrigated. Conelly (1992) reports on a similar case in the Philippines, where irrigated rice and hillside fruit trees now provide higher incomes to more people than the original short-fallow swiddens. The neo-Boserupian vision posits population growth as the prime cause neither of Malthusian disaster nor of slow Boserupian income decline in spite of sustainable intensification, but of sustainability and prosperity.

As put forward by De Groot (1999), cognitive and economic factors will co-determine which pathway will be taken by farmers or regions. When extensive farming methods lose their economic attractiveness under conditions of rising population density, some farmers may be aware early enough and have enough capacity to invest in the land and follow a neo-Boserupian road towards a new and sustainable system. Other farmers, however, may postpone the transition and enter a period of 'soil mining', e.g., because investments in soil and water conservation are less attractive than other options on the short term (Pender et al. 2004). These farmers may become motivated only at a time when they have no more capacity left. They are then caught in a Malthusian poverty trap. Research of Murton (1999) has shown that even in the neo-Boserupian miracle region of Machakos, many farmers individually have gone the Malthusian way, ending up, for instance, as labourers making terraces on the very land that more successful, neo-Boserupian neighbours have bought from them. (Note that, with Platteau (2000), private land titles as prevalent in Machakos pave the way for this process of efficiency at the cost of equity.)

Writing on Uganda, Pender et al. (2004) show that many agricultural development pathways are market- rather than population-driven. Out of the group of more market-oriented and exogenous perspectives on agricultural transition we may take the neo-Thünian theory as explicated by De Groot (2006). In this perspective, large urban centres function as 'point markets' with areas around them of (going from the city outward) intensive agriculture, extensive agriculture and extraction of natural products. These zones are circular in a theoretically 'smooth' landscape and may be highly fragmented in practice. Growing 'point markets', however, always result in expansion of these zones and farmers residing in a zone where only extensive agriculture was economically feasible before, may one day find that the economic 'intensification frontier' has passed their area, along with the associated feeder roads, farm-gate prices, extension, credit facilities, tenure security and so on. Thus the farmer will be inclined to switch to the now more attractive intensive options. Note that in this mechanism, local population density does not play any role.

As stressed by Pender (1998), Lipton (1989) and Netting (1993), the population- and market-based perspectives should not be applied as if mutually exclusive. The three population-based views differ only gradually, and the results of external market expansion intermingle freely with the effects of endogenous population growth. Each region will display its own mixture of mechanisms, and explanations, rather than work from one point of view, should focus on how this intermingling goes about and which of the mechanisms dominates – see for instance Zaal and Oostendorp (2002) discussing the case of Machakos in the light of both the population- and the market-driven points of view. Answers to these questions may also shift over time; a neo-Boserupian 'up' may be followed by a steady Boserupian decline, for instance, when the innovation potential cannot outstrip population growth any more.

Against this background, this chapter focuses on the key element of agricultural transition: investment in the quality of the land (IQL), specified as terracing, contour bunding, constructing irrigation facilities and agroforestry and tree planting. We take explanatory factors from both the market and population perspectives into account. The study sites are chosen from a basically Thünian perspective with varying distance from Manila, but local population densities are noted as well.

METHODOLOGY AND DESCRIPTION OF STUDY SITES

The data used in this chapter are mainly generated from a survey of 104 farmers living in four villages described below. The villages were selected on the basis of having a significant presence of investments in the land and being positioned along a long gradient of distance to the markets of the Manila metropolitan area. This distance varied between 1 and 13 hours drive. Care was taken, moreover, to avoid correlation of distance to Manila and local population density, so as to be able to distinguish between the market and population effects in the later analysis. Although each village is not saliently different from others in its region, regional representativeness has not been a criterion, and consequently we will not make any claims on the regional level.

Figure 1 shows the location of the research sites. There were 26 household respondents randomly selected for each village. Systematic random sampling was done using a list of households kept by the *barangay* (village) secretaries. Additional lists of households were also drawn, which served as possible replacements of the initial lists of sample households if, for any reason, they would be unable or would refuse to be interviewed.

Kapatalan (population density 235 people per km^2) is the most accessible among the *barangays* (villages), connected as it is to Manila by a two-hour drive. Almost 90 percent of the *barangay* area has slopes of 18 percent and above, located in the

Sierra Madre Mountains with elevations ranging from 300 to 450 m asl. From the time of settlement in the late 1950s, coconut and citrus have been the major agroforestry tree species grown in the village. Under the coconut trees are papaya and root crops, namely *gabi*, *taro* and ginger. An Integrated Social Forestry Project was carried out in the village from 1988 onwards.

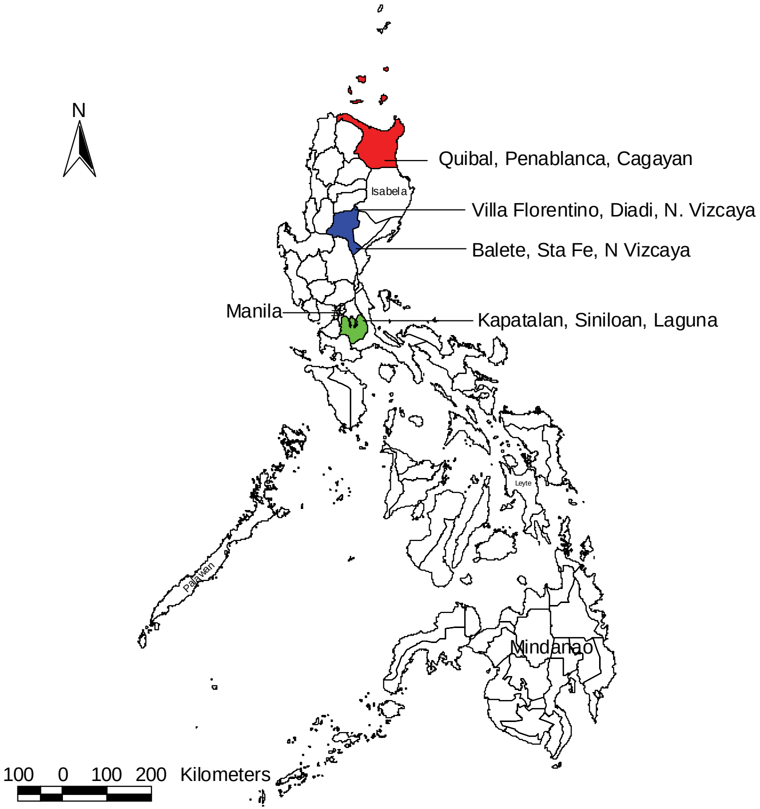

Figure 1. *Location of the study sites*

Balete (population density 13 people per km^2) is a recently settled village where most of the households produce various kinds of vegetables, such as tomato, *baguio* beans, celery, carrots and string beans. For growing these vegetable crops, contour bunds are constructed by the farmers (to be remade every year), deviating from the hedgerow technology promoted by the Integrated Social Forestry Project that entered the village and declared it a model site in 1988. Most of the households are located about one to three kilometres away from the national highway that reaches Manila in some 4 hours. The highway can only be reached over a footbridge during the rainy season and the roads crisscrossing the village become difficult to pass during that time.

At Villa Florentino (population density 235 people per km^2 and at 9 hours from Manila), the first wave of Ifugao migrants settled in 1973 followed by Igorot migrants the following year. It was claimed by key informants that Ifugaos occupied the valley areas where they easily tapped water in creeks and later constructed rice terraces. The Igorots occupied the higher-elevation parts of the village planting maize, upland rice and vegetable crops. During heavy rainfall, Villa Florentino is not accessible by any motor vehicle. Unlike in the other villages, there is only a minimal presence of the government in Villa Florentino; no project was ever carried out. Only the local government unit (LGU) of Diadi has constant interaction with the village officials.

Quibal (population density 93 people per km^2) is located about 15 km from the urban market centre of Tuguegarao City, Cagayan, and some 13 hours from Manila. Large portions of Quibal lie within a declared Protected Area Landscape of the DENR (Department of the Environment and Natural Resources). The Itawes are the major ethnic group of households in the village who came from neighbouring villages and other municipalities of Cagayan province. Maize is the major crop grown in the village. Yellow maize varieties are sold in the market while the native varieties are planted for local consumption. Stimulated by a Community Forestry project that started in 1992, boundary planting of forest (Gmelina) and fruit (mango) trees species is the most common type of agroforestry adopted by the households. Fuelwood gathering provides a significant source of income.

THE MAJOR INVESTMENTS IN THE QUALITY OF THE LAND (IQL)

Table 1 presents the main characteristics of the major investments in land quality: terracing, contour bunds, irrigation facilities and tree planting. They are briefly described here in preparation for the regression analysis.

Terraces are established through the transformation of sloping lands into productive areas where lowland rice and vegetables can grow. Considering the availability of abundant water supply, the decision to terrace rests solely on the household as a unit since it requires high capital and labour use, both family and non-family, to construct a productive unit. This may be the main reason why, in the villages studied, only 28 plots out of 235 were terraced. The average area terraced is also low at about 0.40 ha for all households that made terraces. Labour required per hectare for terracing is the highest among the major investments, standing at about 875 man-days on the average and ranging from about 64 man-days per hectare in Quibal to as high as 1300 man-days in Villa Florentino. These variations reflect the material used in terracing as well as the slopes of the land. This trend is similar in terms of cost (1998 prices, hired plus family labour) showing an average of Php 77,905 per hectare for all villages. Although costly, rice terraces allow two times harvesting of lowland rice ensuring food consumption of the households as well as cash if surplus production is realized.

There were 46 plots out of 235 in the villages studied that were developed with contour bunds. The average productive area was about 0.49 ha while the total labour required per hectare of productive area was about 86 man-days, to be repeated every season because the bunds were only temporary constructions. The total cost per hectare (1998 prices, hired plus family labour) was about Php 8,190 per year. Vegetables, considered to be high-valued crops, were grown in these areas, usually at two croppings per year. The revenue generated from vegetable production was usually high enough to support more than the basic needs of the household.

Table 1. *The major investments in land quality adopted by households in Philippine villages (barangays)*

INVESTMENTS IN LAND QUALITY	MEAN VALUES
1. Terracing	
Length, metres	404
Height, metres	0.90
Area, hectares	0.40
Labour required per hectare, man-days	668
Total cost per hectare, Php	77,905
No. of plots with terraces	28
2. Contour bunds	
Area, ha	0.49
Total labour required per hectare, man-days	78
Total cost per hectare, Php	8,190
No. of plots with contour bunds	46
3. Irrigation	
3.1. Channel irrigation	
Channel length, meter	368
Average labour required, man-day	32
Total cost of channel per metre, Php	28
No. of channels	26
3.2. Sprinkler irrigation	
Sprinkler length, metre	751
Average labour required, man-day	4
Total cost of sprinkler per meter, Php	11
No. of sprinklers	47
4. Major tree plantation (≥0.25 ha)	
Area, ha	1.26
Average labour required per hectare, man-days	27
Total cost per hectare, Php	2,300
No. of plots with trees	88

The sprinkler irrigation system was only practiced in Balete and Villa Florentino with an average length of 751 m of piping and an average total cost per metre of Php 11.

Irrigation facilities are constructed in support of agricultural production in both rice terraces and contour bunds. Two types of irrigation facilities are used: the channel system and the sprinkler system. The channel system is mostly used for lowland rice cultivation while the sprinkler system is used in vegetable gardening. Households also used the sprinkler system for domestic or household purposes by detaching the sprinklers from the pipes. The average total length of channel constructed was about 368 m although values varied much from as low as 60 m in Quibal to as high as 461 m in Villa Florentino. The average total cost per metre of channel irrigation investment is about Php 28.

Major tree planting activities were undertaken on 88 out of the 235 plots for all the villages with an average total area of 1.26 ha per household. In this study, 'major tree planting' means that the area planted with trees is greater than or equal to 0.25 hectare per plot. Households usually termed these as their agroforestry and tree farms, which required an average total labour of 24 man-days per hectare. This value is much lower than the other major investments.

The average number of household members that were capable to work in the farm was about 3.52. This number was derived from the number of household members with ages ranging from 15 years up to 64 years. If working household members were going to school, then they were set to contribute only about 30 percent of the total labour of 312 days per year. From this calculus, the total number of working days per year in a household was 766 man-days. One hectare of terracing, requiring 668 man-days, then is equivalent to about 87 percent of the average household total working days. If labour for rice cultivation is added, the total labour required is more than the average household's total. Because of this, a household has an option of hiring outside labour or spreading out over several periods the establishment of the terraces. Making a one-hectare plot with contour bunds in two cropping seasons per year requires on average about 20 percent of the available household labour. The construction of an irrigation channel requires only 4 percent while sprinkler irrigation needs less than one. For tree plantation, the total labour requirement per hectare is only about 4 percent of the available total household labour. Labour requirement for terracing and contour bunding increases if labour for irrigation facilities is added. Obviously then, the availability of cash is important for many investments, either to hire outside labour or to buy the equipment such as piping. Only tree planting tends to be available to all, if seedlings are provided at low cost. For that reason, off-farm income has been included in the dataset.

A CONCEPTUAL MODEL OF INVESTMENT BEHAVIOUR

The problem of investment in improving the quality of the land is analysed from the perspective of the individual household which is confronted with multiple and relatively complex choices involving both production and consumption. In production, decisions have to be made on the allocation of resources, such as land, labour and capital, the techniques used in farming, and other accessible options readily accessible to them. The outcome of the household's decisions may be realized within one growing season or may extend into the future. Households also have to consider marketing strategies which influence choices on what crops to grow, the scale of the farm enterprise and where to sell the crop produced. Consumption decisions involve food consumption of the households, shelter or housing, domestic purchases, and savings for the education of their children, among others.

For farmers in developing countries, production and consumption decisions cannot be analysed separately. This is due to the existence of market imperfections in relation to labour, credit, leisure, land resources and some basic food products. In this case, the proper framework considers the household as one that maximizes a utility function over time with respect to consumption and production, including investments in land quality and other things (education of children and new farm technology). The utility function includes as arguments all the goods that are 'consumed' by the household, such as food commodities and leisure. (In principle, the utility function may also include 'social goods' such as the well-being of others and social status.) Households also make rational decisions that are influenced not only by their needs and aspirations but also by the resources available to them as well as the constraints put on by the environment. In developing countries like the Philippines, resources include not only physical resources and cash availability (due to imperfect capital markets) but also private social capital, such as socio-political linkages to facilitate the participation of the households in government programs or in the release of personal and legal documents, personal and economic security ties with government officials and rich families, and market and information ties as regards to product prices, technology and opportunities. The physical, socio-political and economic environments provide limits on the choice options available to households.

An analysis of the households' decisions to invest in the quality of the land (IQL) therefore needs to consider the general decision-making context of the households, and may be incorrectly analysed if standard micro-economic theory based on only profit maximization is used.

In the present study, the constraints on the household are labour and cash availability, agricultural production technology, slope and soil quality of the land. The process of optimization gives the household's investment as a function of the profitability of investment (influenced by slope and soil types, technology and other factors), labour availability (due to imperfect labour market), credit or cash availability (due to imperfect capital market), knowledge (including expectations), as well as time horizon (tenure and risks) and time discount. With these variables, we analysed the household's choice between IQL and non-IQL as a function of household, farm and village characteristics using a binary model, implying a focus on the adoption of soil and water conservation rather than their intensity. This falls in line with most other studies on IQL. A model with intensity as dependent variable has been estimated too but with poor results, probably due to a low number of observations.

The model utilizes a logistic distribution that subsequently allows for the calculation of marginal effects of the explanatory variables. The logit model for IQL is specified as (Greene 2000):

$$\Pr[\,inv\,] = \frac{e^{\beta x}}{(1 + e^{\beta x})} \tag{1}$$

where $\Pr[inv]$ is the probability of a household to invest in IQL, x is a vector of explanatory variables and β is a vector of coefficients. The marginal effect of an explanatory variable x on the probability of that the household invests in IQL is a nonlinear function of x and β and is given by:

$$\frac{\partial \Pr[inv]}{\partial x} = \Lambda(\beta x)[1 - \Lambda(\beta x)]\beta \tag{2}$$

where β is the coefficient corresponding to x and

$$\Lambda(\beta' x) = \frac{e^{\beta' x}}{1 + e^{\beta' x}} \tag{3}$$

Obviously, the marginal effect will vary with x and therefore with households. An alternative is to measure the effect of the explanatory variable x by the odds ratio, which is given by:

$$odds(x) = e^{\beta} \tag{4}$$

The odds ratio can be interpreted as the odds of investing in land quality after a one-unit change in the explanatory variable as a ratio of the base odds while controlling for other factors. The odds refer to the probability of IQL over the probability of not investing in land quality. For example, if the odds ratio $e^{\beta} = 2$ on the dummy variable "with irrigation", this indicates that households using irrigation technology are twice as likely to invest in land quality as compared to households "without irrigation", the reference group. An odds ratio equal to 1 indicates that there is an equal probability that the two groups of households will invest in the quality of the land.

EXPLANATORY VARIABLES OF INVESTMENTS IN LAND QUALITY AND HYPOTHESES

The mean values of explanatory variables in this study are shown in Table 2. These are data at the household level and they are presented here to provide clear understanding of the factors that have been found in the literature to affect investment decisions of households.

The dependent variables are major investments in land quality. They are aggregated into two categories; one category combines terracing, contour bunds and irrigation facilities while the other category includes tree planting. These categories are selected considering the capital requirements (see above) and the time span of yields. Terraces, contour bunds and irrigation facilities generate immediate benefits, while trees have a much longer gestation period, running up to 5 to 7 years for fruit trees and 7 to 10 years for forest trees.

The explanatory variables are grouped into two categories: (1) household characteristics and (2) farm characteristics. The variables in each category are defined below including our hypotheses explaining their effects on the investments in the quality of the land (IQLs), the dependent variable. The regression analysis is undertaken at the household level, which takes into account the household variations of the explanatory variables. The analysis is at the household level because the investments, and especially large investments, on separate plots within household are correlated through budget and time constraints. The plot characteristics, therefore, are transformed into their arithmetic mean values within households.

The top horizontal part of Table 2 gives the distribution of the two categorized dependent variables. It shows that those households that invested in terracing, contour bunds or irrigation also invested in agroforestry or tree planting with a proportion of households of about 42 percent. The proportion of households that invested in agroforestry or tree planting and also invested in the other category is about 36 percent. This implies that many households in the four villages studied undertake both forms of IQL.

Table 2. *Means of explanatory variables of major investments in land quality for the four selected Philippine barangays (N=104)*

Explanatory variables	*Terracing, contour bunds and/or irrigation*		*Agroforestry and/or tree plantation*	
	No	Yes	No	Yes
IQL Interaction				
Investments in T, CB and IF[a]	0	1	0	0.42
Investments in TP[a]	0	0.36	0	1
Household Characteristics				
Age (Hh head)	47.10	46.85	43.47*	51.48*
Educ (Hh head), %				
Up to primary level	0.41	0.52	0.51	0.38
Intermediate level	0.36	0.25	0.27	0.38
Secondary/college level	0.23	0.23	0.22	0.24
Household (Hh) size, No.	5.50	6.18	5.86	5.62
No. of working Hh members	3.35	3.82	3.50	3.55
Proportion of Hh with off-/non-farm, self-employment income	0.66*	0.83*	0.82*	0.60*
Equiv. weekly per cap. expend., Php	191.22	154.49	169.75	187.55
Material assets	0.40	0.33	0.26	0.51
Knowledge on SWC, No.	3.19*	4.55*	3.23*	4.33*
Man-land ratio	2.83	2.80	3.12	2.42
Dependency ratio	81.31	98.47	92.15	78.08
Farm/Plot Characteristics				
Prop. of plots with secure tenure	0.61*	0.75*	0.63	0.71
Farm size, ha	4.10	4.47	3.41	5.32
Plot size, ha	1.99	2.19	0.90*	3.58*
No. of years of plot cultivation	13.77*	6.93*	13.56*	5.40*
Slope categories: Flat slopes (0-3%)	0.22*	0.04*	0.19	0.10
.Rolling/moderate (4-18%)	0.55*	0.30*	0.46	0.55
.Steep/mountainous (>18%)	0.23*	0.66*	0.35	0.35
Soil types: Clay loam	0.58	0.60	0.64	0.51
.Sandy loam	0.42	0.40	0.36	0.49
Dist. of plots from residence, m	1314*	606*	380*	1909*
Dist. of plots fr. village centre, m	2106*	1104*	1324	2240
Number of observations, N	64	40	59	45

Note: * Indicates that differences between means are significant at least at 5% level using t-test.
[a] T = terracing, CB = contour bunds, IF = irrigation facilities, AF = agroforestry, TP = tree plantation

HOUSEHOLD CHARACTERISTICS

Age and education

The variables age and education in this study consider the age and education of the household heads, who, in the Philippine paternalistic culture, make major decisions with regard to farming.

Many researchers agree that the age of the household head may have an ambiguous influence on investments in IQL. Younger generations, as compared to the older ones, may be more inclined to adopt new techniques as they learned these in school and they might have a longer time horizon. However, older people may have saved money to invest (lifecycle effect) and gained more knowledge through their actual experiences in farming; thus they become more knowledgeable in dealing with soil fertility maintenance and IQL. Furthermore, older farmers may be motivated to leave something of lasting value for their children, hence invest in long-term assets such as terraces and trees.

There are four levels of education existing in the research area that are to be taken in succession: primary level, which corresponds to the initial four years in school; intermediate level, another two years; secondary level, additional four years after intermediate level; and the college level, four or more years after secondary.

For education, Pender and Kerr (1996) observed that in their study of villages in India's semi-arid tropics, investments in soil and water conservation increased by about 25 % of the average investment level for every additional year of education.

In Table 2, household heads who invested in tree planting were significantly older (about 51 years old) compared to those who did not. The highest proportion of household heads of about 52 percent who invested in terracing, contour bunds and irrigation had low education (up to primary level). The proportion of household heads of about 38 percent who invested in agroforestry and/or tree planting had finished intermediate level of education. This inclination follows that of the households that did not invest in any of the different categories of IQL.

Household size

A measure of the household size is the number of children plus the husband and wife. We used the equivalence scale of 1.0 for household head, 0.7 for other adults and 0.5 for household members with ages less than 18 years. The Table shows that the household sizes of those who terraced, made contour bunds and irrigation facilities were larger than those who did not. Of those who invested in tree planting, the household size was lower than of those who did not. The differences are statistically insignificant, however.

Number of working household members

This variable reflects the amount of labour that households have at their own disposal, which is measured as the number of household members whose ages range from 15 to 64 years including husband and wife. This households' own labour capacity is expected to have a positive effects on IQL, especially the labour-intensive types such as terracing. *Ceteris paribus*, we hypothesize that larger households are more capable of undertaking this type of IQL (Clay et al. 1998). In Table 2, the numbers of working household members are indeed slightly higher for this category of IQL, but the difference is not significant.

Income from off-farm agricultural and non-farm employment and self-employment

This variable, measured as a dummy (equal to 1 if at least one member of the household is significantly engaged in off-farm, non-farm and self-employment, and 0 if otherwise), may have an ambiguous role in IQL. On the one hand, greater alternative income opportunities provide more cash available to households for IQL (Reardon and Vosti 1995). On the other hand, a negative correlation may also show up, reflecting competition of labour between farm cultivation and off-farm activities or a better income in off-farm opportunities, which may provide a signal to shift household interests away from farming activities. In some ways, labour and financial capital utilized for off-farm activities may also reduce pressure on the land since this provides money to buy food. By this manner, it may encourage households to undertake less erosive cultivation practices, such as planting trees and allowing lands to fallow. In a previous Philippine research by Delos Angeles (1986), she observed a negative relationship between conservation adoption among upland farmers and their level of non-farm income. She concluded that farmers without off-farm income had more incentives to maintain land resources.

As shown in Table 2, a higher proportion of those households that had off-farm agricultural and non-farm income and self-employment invested in terraces, contour bunds and irrigation. A different scenario is visible in tree planting because the proportion of households with off-farm, non-farm and self-employment is lower than the proportion of those that did not.

Equivalent per-capita cash expenditure (weekly) and material assets

This variable is determined by initially summing up the cash expenses incurred per household in clothing, school fees and food (rice, maize, salt, coffee, sugar etc.). Expenses in clothing and school fees are usually made annually but were calculated on a weekly basis, consistent with the reported weekly food expenses. The values of equivalent per-capita expenditure are then estimated using the FAO standard weight equivalents of equal to 1 for household head, 0.7 for household members with ages equal to or greater than 18 years, and equal to 0.5 for other members of the household with ages less than 18 years. Material assets are those acquired by the households, such as a car, motorcycle, tricycle and refrigerator, but it was treated as a dummy variable: 1 for those who have at least one of these items and 0 otherwise. There is no clear hypothesis about the effect of per-capita cash expenditure and material wealth on IQL. Households with high per-capita cash expenditure may have higher cash availability which is favourable to farm investments because they can hire labour and buy inputs for land improvements. But the availability of cash may shift the interests of households towards non-farm activities (such as establishing small business or *sari-sari* store, tricycling and peddling) thus lowering IQL. Hence, households with more wealth have greater capacity to do IQL but possibly less motivation. This relationship may also hold true for material assets. In the regression analysis, the material-assets variable is the only variable that is considered. A problem of causality exists in the per-capita expenditure and material-asset variables. While more wealth enhances the capacity of households to invest, maybe IQL also leads to higher income and material assets.

Table 2 shows that the average weekly equivalent per-capita expenditure of households that invested in terracing, contour bunds and irrigation facilities were lower than of those households that did not. This was the opposite in agroforestry or tree planting; the households that did invest had a higher equivalent per-capita expenditure than those that did not. The differences are, however, insignificant. Table 2 also shows that the proportion of wealthy households investing in terraces, contour bunds and irrigation is lower than the proportion of those that did not. The opposite situation is observed in agroforestry and tree planting with a higher proportion of wealthy households investing in this category. The differences between those that did invest and those that did not are insignificant in all categories of investments.

Knowledge of conservation techniques

This was measured as the number of conservation techniques reported to be known by the household heads, such as contour ploughing, cover crops, hedgerows, agroforestry, reforestation, green and animal manuring, sprinkler and channel irrigation and contour bunds. Our hypothesis is that more knowledge on soil and water conservation techniques may have a positive influence on farmers' investment decisions. In their study of Ethiopian villages, Shiferaw and Holden (1996) found a positive correlation between adoption of level bunds and the number of conservation techniques known.

Table 2 shows that the number of SWC technologies known to the household heads was significantly higher in households with terracing, contour bunds and irrigation investments. The differences between those households that did invest in agroforestry and tree planting and those that did not were insignificant although the number of SWC technologies known to the households that invested was higher.

Man–land ratio

This variable is derived by dividing the household size by the total farm size owned for each household. It is considered to be a measure of the number of people per cultivable area and therefore land scarcity. According to (neo-)Boserupian theory, the man–land ratio will be positively correlated with IQL. As shown in Table 2, however, households investing in land quality (all categories) had a lower man–land ratio, indicating an opposite relationship. The difference was statistically insignificant.

Dependency ratio

The dependency ratio is the number of economically inactive members of the household, i.e., the number of children with ages 0 to 14 years and elderly with ages 65 and above, relative to the total number of working household members. This variable was expected to have a negative relationship with investments since a significant number of children and elderly within a household can siphon off labour and money that may be intended for IQL.

As shown in Table 2, the values of the dependency ratio for all IQL categories and chemical inputs had insignificant differences. The trend of the values, however, shows that the dependency ratio was higher in households that invested in terracing, contour bunds and/or irrigation but lower values in those that invested in agroforestry and/or tree planting compared to those that did not.

FARM CHARACTERISTICS

Security of tenure

This variable is the proportion of plots owned by the farmers with secure tenure such as private title documents or the tenure instrument called “Certificate of Stewardship Contract’ (CSC). It is often expected that farmers make longer-term land improvements on landholdings that are owned (Clay and Reardon 1997; Shively 1996). The hypothesis then is that IQL correlates positively with the proportion of plots with secure tenure. In other instances, however, farmers’ investments on their plots serve as proofs of good behaviour, helping to obtain *de facto* if not *de jure* land rights on these plots. In these cases, the direction of causality between IQL and tenure is reversed. Moreover as stressed by Platteau (2000, p. 139), informal tenure arrangements may in fact be felt by farmers as just as secure as formal titles or certificates. In such cases, correlations are expected to be insignificant (except, as Platteau notes, if credit is conditional for investments, if farmers are wiling to take loans, and if formal tenure gives access to credit).

Table 2 shows a higher proportion of plots with secure tenure in both categories of the major investments. However, a significant difference was observed only for investments in terracing, contour bunds and irrigation.

Plot and total farm sizes

These variables reflect the amount of households’ landholdings that could serve as collaterals in market transactions as well as an input to agricultural production. We hypothesized that farmers with larger plot and farm sizes are more capable of undertaking investments because they can spare land areas for terraces and irrigation channels, for fallow, and for trees while putting larger portions of their lands under cultivation. A household study of Semgalawe (1998) in rural Tanzania revealed a positive effect of farm size on the probability of adoption of improved soil conservation techniques. This relationship is further confirmed by studies in the Philippines by Shively (1996) on the probability of hedgerows adoption and in other countries by Feder and O'Mara (1981), Just and Zilberman (1983), Pender and Kerr (1996) and Shiferaw and Holden (1996).

As Table 2 shows, the values of the plot size and farm size exhibited similar trends in relation to the dependent variables. Both had higher values in all categories of investments. This means that households with large areas had a stronger tendency to invest in land quality. Insignificant differences for the variable farm size, however, was observed in any of the major investments while a significant difference was observed on the plot size variable for the investments in agroforestry and tree planting.

Number of years of plot under cultivation

This variable is the number of years the plots had been continuously cultivated by the farmers until the time of investments in land quality. Our hypothesis regarding this variable was ambiguous. Long cultivation results in declining yields so that an investment in the quality of the land would sustain its productivity, thereby increasing the benefits from the investment, which might encourage farmers to invest. On the other hand, a declining yield due to low soil fertility resulting from long-term cultivation will cause a declining capability of the households to invest thereby leading them into the Malthusian 'poverty cycle'. In conditions of low fertility, plots require increasing labour from the households, which may not be compensating because production output from the plot is not proportionately increasing or even to attain, at least, the current level of production. In Rwanda, Clay et al. (1998) observed that farmers have more investments in land conservation and soil fertility in plots cultivated only a short period.

In terms of the number of years of continuous cultivation, higher values are observed for those households that did not invest in any category of land quality. The differences are also significant.

Plot slopes, soil types and distances

Plot slopes were defined in three categories, namely flat slopes (0-3 %), rolling/moderately sloping (4-17 %) and steep slopes (≥18 %) while the soil types were defined in two categories, namely clay loam and sandy loam. These variables were transformed into household-level data by getting the average of the plots within a household. We hypothesized that steeper slopes increase the incentive to invest in land protection particularly in areas where rainfall is relatively high. In the Philippines, cultivation on lands with slopes higher than 18% is prohibited and instead farmers are encouraged to reserve these areas for trees.

In Table 2, a higher proportion of plots with steep slopes appear to have been selected for terracing, contour bunds and irrigation while investments in agroforestry and tree planting had a higher proportion of plots in the rolling to moderately sloping plots. However, significant differences were observed only for the investments in terracing, contour bunds and irrigation. In terms of soil types, the proportion of plots with clay loam soil types was higher in both categories of IQL.

Households perceived that these soil types have lower fertility caused by continuous cultivation. Table 2 shows, however, that soil types do not differ significantly in any category of IQL.

As plot distances from home increase, farmers have less incentive to make land improvements due to higher transaction costs. An opposite relationship, however, is expected for agroforestry or tree farming because of their low maintenance requirements.

Distances of plots from residence and from barangay centre have similar trends in terms of their relationships to investments. Investments in terracing, contour bunds and/or irrigation facilities have shorter distances to home than investments in agroforestry and/or tree plantation. Significant differences in distances to plots from residence in any categories of IQL are observed. For plot distances from the village centre, significant difference is only observed in terracing, contour bunds and tree planting.

The pairwise correlation for the explanatory variables, however, showed that the dependency ratio was strongly correlated with age (correlation coefficient –0.59), size of plots was strongly correlated with total size of plots (correlation 0.73), distance to home was strongly correlated with distance to village centre (correlation 0.57), number of working household members was strongly correlated with household equivalent size (correlation 0.72) and the village dummy for Kapatalan was strongly correlated with the wealth dummy and distance to home (correlation 0.62). Multicollinearity of the variables suggests that the value of the coefficient of one variable in the regression analysis will affect the value of the coefficient of the other variable for which it is found to be collinear.

Thus, dependency ratio, size of plots, distance to village centre and number of working household members were dropped in the regression analysis. The village dummy of Kapatalan and wealth dummy variables were retained, however, because of their relevance to determining village and wealth effects, respectively. The man–land ratio and total landholdings were also retained because of their pervasiveness in literatures concerning soil and water conservation adoption and the fact that the multicollinearity coefficient was only just below 0.5. All other variables had correlations below 0.5 in absolute value with others.

DEFINITION OF THE REGRESSION VARIABLE

Table 3 presents the summary statistics of the variables selected for the regression model. For reasons explained earlier, regression analyses were done separately for the combined investments (IQL) in terraces, contour bunds and irrigation facilities and the combined investments (IQL) in agroforestry and tree planting.

The variable *age* refers to the age of the household heads, who are either males or (sometimes) widowed females, at the time of the survey. The average age of household heads for this study was about 47 years with the youngest of 24 years while the oldest was 81 years old. *Education* indicates the level of education completed by the household heads. The omitted education category is the category variable, *up to primary*. The *household size* variable is transformed into the equivalent household size. The average equivalent household size was about 4. *Man–land ratio* is the ratio of the (real) household size over the total landholdings of the households. This ratio had a mean value of about 3 and a maximum of about 12 people per hectare. The dummy variable *off-farm and non-farm employment and self-employment* equals one if at least one household member brings in some income from a non-farming source. About 76 percent of the households enjoyed this extra income. *Knowledge of SWC techniques* is a measure of the number of soil and water conservation techniques known by the household heads. The average was about 4 while the maximum is 10. Some household heads have no knowledge of SWC technologies at all. The variable *security of tenure* equals 1 if a household has at least one plot with secure tenure, and is zero otherwise. About 65 percent of the households in this study had at least one plot with secure tenure. *Material asset* is a dummy variable equal to 1 if the household owns at least one of such items as cars, motorcycles and household facilities, and zero otherwise. Due to measurement problems and endogeneity, this variable is not considered in the initial analysis but it is used later to test its effect on the other variables. On average, about 41 percent of the households owned at least one item.

Table 3. *Descriptive statistics of model variables*

Variable	No. of observants	Mean	Standard deviation	Mini-mum	Maxi-mum
Investment in land quality					
Investment in T, CB and/or IF[a]	95	0.36	0.48	0	1
Investment in AF and/or TP[a]	95	0.42	0.50	0	1
Household characteristics					
Age	95	47.01	12.05	24	81
Education: Up to primary level	95	0.45	0.50	0	1
.Intermediate level	95	0.33	0.48	0	1
.Secondary level	95	0.22	0.42	0	1
Equivalent household size	95	3.90	1.49	1	8
Man-land ratio	95	2.91	3.97	0.31	12
Prop. of Hh[a] with off-/non-farm, self-employment income	95	0.76	0.43	0	1
Knowledge of SWC tech.	95	3.68	2.41	0	10
Security of tenure	95	0.65	0.49	0	1
With material asset	95	0.41	0.49	0	1
Farm characteristics	95				
Total landholdings, ha	95	4.28	3.54	0.06	16.5
No. of years of cont. cult.	95	6.12	11.66	0	43
Distance to home, m	95	1064	2188	1	10000
Slope types: Flat (0-3%)	95	0.19	0.39	0	1
.Rolling/sloping (4-17%)	95	0.49	0.50	0	1
.Steep/mountain. (≥18%)	95	0.32	0.47	0	1
Soil types: Clay loam	95	0.57	0.50	0	1
.Sandy loam	95	0.43	0.50	0	1
Village dummies: Balete	95	0.20	0.39	0	1
.Kapatalan	95	0.27	0.45	0	1
.Quibal	95	0.27	0.45	0	1
.Villa Florentino	95	0.26	0.44	0	1

[a] T = terracing, CB = contour bunds, IF = irrigation facilities, AF = agroforestry, TP = tree plantation; Hh = households

For farm characteristics, *total landholding* is, in hectares, the total area of lands occupied by each household. On average, households owned 4.28 hectares. *Years of continuous cultivation* variable is the number of years the plots were continuously cultivated by the households before investments were made (if any). The average number was about 6 years, with some households making the investments immediately after settling. The *distance to home* (m) is the distance of plots to the household farmstead. The slope and soil types are presented as dummy variables. The slope variables *Flat slopes*, *Rolling slopes* and *Steep slopes* are defined above. The steep-slopes variable is the omitted variable for the slope dummies. For soil types, *Clay loam* and *sandy loam* indicate the share of plots within households that have clay loam or sandy loam soil types. Sandy loam is the omitted variable. Table 3 shows that the proportion of plots with rolling to moderate slopes was about 49 percent, with steep slopes about 32 percent. The average proportion of plots with clay loam soil types was about 57 percent and about 43 percent had sandy loam. *Village dummies* are also included in the regression analysis to control for other village differences, such as: cultural differences, distance to major urban markets, and climate. Villa Florentino is the omitted village dummy in the model.

REGRESSION RESULTS AND DISCUSSION

Table 4 presents the results of two logit regressions for the four Philippine villages. The first regression considers the combined investment in the quality of the land (IQL) through terracing (T), contour bunds (CB) and irrigation facilities (IF). The second regression considers the combined IQL of agroforestry (AF) and tree plantation (TP).

Generally, there were more parameters on the household variables than on the farm characteristics that were significantly different from zero at a 90- or 95-percent level of confidence. Likewise, the village dummies with Villa Florentino, as the omitted variable or the basis for comparison between the villages covered in the study, show significant differences from each other with regard to IQL.

Household characteristics

The regression results show that the age of the households was positively correlated in both categories of IQL with significant relationships. This indicates that the older the household heads, the higher the probability that they invested in the various IQL. The odds ratios (i.e., the ratio of the probability of investing to the probability of non-investing) of 1.06 on the age variable for the combined IQL in terraces, contour bunds and irrigation facilities implies that the odds of investing in IQL is 1.06 times with each additional year of age of the household head. Since the regression analyses considered age of the household heads at the time of the survey, this indicated positive ‘life-cycle effects’ on IQL. This relationship did not change if the age variables were redefined as age of the household head at the time of investment.

Household heads who finished the intermediate levels invested significantly more likely in agroforestry and/or tree planting than those with lower or no education or those with secondary and/or college education. The weak and negative effects of higher levels of education on IQL may be due to the loss of interest in sustainable farming by those household heads that attained high education. With high education, these household heads may have engaged in wage labour or in other livelihood enterprises apart from farming. Household heads with low or no education, on the other hand, invested more likely in terracing, contour bunds and/or irrigation facilities and less likely in agroforestry and/or tree plantation. This may reflect the preference of these households to make investments in land quality that generates short-term benefits.

The household size variable had a positive relationship in the regression for both IQL categories. This relationship was, however, insignificant, indicating that labour availability in the households has no effect on investment. This may be due to the existence of a good labour market in the study villages, so that working household members can easily find jobs apart from their own farm.

Households with off-farm, non-farm and self-employment incomes were much more likely to invest in IQL. This relationship was particularly strong for combined IQL in terracing, contour bunds and/or irrigation facilities. The significant regression results show that the odds ratio of IQL for households with incomes other than farming their own land was about 7 times higher than for those households without other income for terracing, contour bunds and/or irrigation. Reardon and Vosti (1995) and Clay et al. (1998) had similar results in their studies of African farmers concluding that off-farm income or non-cropping income provides the necessary capital for investments in land improvements. This result also shows the imperfection of credit markets in the villages because credit for IQL would lift the cash constraint on IQL.

The numbers of SWC techniques known to household heads were positively correlated with IQL in all categories. This means that households who had more knowledge of SWC techniques were more inclined to do IQL, which confirms the hypothesis. This result may indicate the positive role of extension programs on IQL that increase the level of information of households concerning sustainable farming systems that addresses their household needs while maintaining land quality. But the possibility of reversed causality may occur in the households; i.e., households that started investing may also learn while doing or want to learn more SWC technologies afterwards.

Households invested more likely in IQL when they had secure tenure as shown by the positive regression results. The regression coefficient though, is insignificant. As said, the possible explanation for the insignificant results may be the fact that investments facilitate the households for the acquisition of land rights. Conelly (1992) similarly observed that investments help farmers acquire rights to the lands they occupied as *de facto* land rights. Farmers in a Palawan village in the Philippines were given full ownership of the lands they occupied because of their ‘good behaviour’, which implied the practice of agroforestry or establishment of tree farms on their lands.

For the man–land ratio variable, households were likely to invest slightly more in terracing, contour bunds and irrigation and slightly less in tree planting. These relations are insignificant, however. This represents a contradiction with population-based perspectives on investments in land quality.

The material assets variable is a proxy for wealth. The regression results for IQL since settlement show that wealthy households were less likely to invest in terracing, contour bunds and irrigation facilities and more likely to invest in tree planting. This relationship is, however, weak. Although various researches in some areas (Clay et al. 1998; Shively 1996) found that wealthy households are capable of having their lands under fallow, and also that they are not compelled to undertake investments to meet their daily needs for food and cash. The insignificant effect plus the endogeneity problem of the material-assets variable with IQL makes the result difficult to interpret.

Farm characteristics

The farm-characteristic variable that is statistically significant at the 99-percent level was the number of years of continuous plot cultivation in the regression for investments in agroforestry and/or tree plantation. The number of years of continuous plot cultivation had a negative relationship with IQL, which indicates that households are less likely to undertake investments after longer periods of cultivation. It was only insignificant (but negative) for investment at settlement in terracing, contour bunds and irrigation. Baland and Platteau (1996) theoretically described a scenario of farmers' rationality in which it is optimal for a farmer to extract soil nutrients till a certain level because they are concerned in meeting their subsistence requirement in each period.

This holds intuitive appeal: that households postpone or withhold investments on plots with remaining productive potential. The results of the regression suggest, however, that the longer the plot is cultivated, the less households are likely to invest. Because we did not have a given exogenous measure of fertility at the time of investment, we used the period of cultivation till investment as a proxy; this proxy might be too primitive. This proxy, however might be endogenous as it is defined in terms of the investment made leading to a negative correlation between investment and the variable period of cultivation till investment.

The contradictory and insignificant regression coefficients for the variable total landholdings[1] indicate the ambiguous effects of this variable on investments. De la Brière (1999) and Clay et al. (1998), in their studies of farmers in Dominican Republic and Rwanda, respectively, found out that farmers with large landholdings invested less in soil conservation. They attributed this to labour constraints to undertake conservation investments. Large farmers could allow plots to lie fallow such that they were less pressured to undertake conservation investments, while households with smaller landholdings were more likely to undertake IQL because they might have recognized that IQL was vital to their livelihoods. In contrast, Feder

Table 4. *The β-coefficients, odds ratios and probability values for the various investments in land quality*[a]

	Investments in T, CB, and/or IF			Investments in AF and/or TP		
	β	*Odds ratio*	*Prob. value*	*β*	*Odds ratio*	*Prob. value*
Household (Hh) characteristics:						
Age	**0.06***	**1.06**	*0.07*	**0.09***	**1.10**	*0.04*
Education: (with up to primary level as basis for comparison)						
Intermediate level	-0.52	0.60	*0.53*	**2.92***	**18.59**	*0.02*
Secondary/College level	-0.88	0.41	*0.31*	0.59	1.80	*0.63*
Household size	0.15	1.16	*0.51*	0.03	1.03	*0.95*
Off/non-farm and self-employment	**1.95***	**6.99**	*0.02*	-1.51	0.22	*0.12*
Knowledge of SWC techniques	**0.36***	**1.43**	*0.07*	0.20	1.23	*0.37*
Security of tenure	0.39	1.48	*0.61*	0.08	1.08	*0.93*
Man–land ratio	0.05	1.05	*0.72*	-0.32	0.73	*0.17*
With material asset	-1.34	0.26	*0.30*	2.55	12.83	*0.15*
Farm characteristics:						
Total landholdings	0.10	1.11	*0.43*	-0.12	0.89	*0.46*
Ave. dist. to home	0.0001	1.00	*0.64*	0.005	1.00	*0.38*
Years of cont. cultivation	-0.01	1.00	*0.30*	**-0.18****	**0.83**	*0.01*
Slope:(with steep slopes as basis for comparison)						
Flat (0-3%)	-1.93	0.14	*0.18*	0.61	1.84	*0.73*
Rolling (4-8%)	-1.52	0.22	*0.11*	1.15	3.15	*0.27*
Soil types: (with sandy loam as basis for comparison)						
Clay loam	0.25	1.28	*0.73*	-0.06	0.94	*0.94*
Village characteristics						
Village effect: (with Villa Florentino as basis for comparison)						
Balete	**2.15***	8.57	*0.07*	0.68	1.98	*0.54*
Kapatalan	-1.31	0.27	*0.44*	**3.80***	**44.87**	*0.09*
Quibal[b]	-2.06	0.13	*0.24*	**-3.19***	**0.04**	*0.07*
Pseudo R^2	*46.94*			*60.48*		
Number of observations	*95*			*95*		

Note: [a]T, CB, IF means that households invest in either terraces (T), contour bunds (CB) or irrigation facilities (IF); AF, TG means that households invest in either agroforestry (AF) or tree growing (TG).
[b]Missing value of the regression coefficient of this variable indicate non-variation of variable values at the household level.
* Indicates that the estimated coefficient is significantly different from zero at the 90-percent level; ** indicates significantly different from zero at the 95-percent level.

and O'Mara (1981), Fujisaka and Wollenberg (1991) and Delos Angeles (1986) found out that farmers with large landholdings were more likely to adopt soil conservation.

The insignificant positive relationship between investments and distance of plots to the farmstead as shown in the regressions indicates that other local spatial factors may have influenced the investment decisions of households, such as planting of trees on land boundaries.

Although not statistically significant, investments in land quality seem somewhat more likely in plots with steep slopes for terracing, contour bunds and/or irrigation facilities which may be due to greater relative returns to conservation investments (Adégbidi et al. 2004; Pender and Kerr 1996). Although not significant as well, investments in terracing, contour bunds and/or irrigation facilities appear slightly more likely in clay loam soil types but investments in agroforestry and/or tree plantation are less likely invest for this type of soil. This may reflect the farmers' preference of clay loam for terraces and contour bunds which they expressed during informal conversations. The relationship with slope steepness may reflect that households have knowledge of the severity of soil erosion and its effects on their livelihoods. This then would be consistent with findings of Clay et al. (1998) from Rwanda, concluding that farmers tend to make more conservation investments in lands of medium steepness.

The village level

With respect to the village dummies, the regression analysis shows clear trends for major IQLs, indicating that each village has its specific characteristics separate from the variables included in the dataset. The results show that farmers in Balete were more likely to invest than those in Vila Florentino in all the major IQL, which is particularly significant in terracing, contour bunds and/or irrigation facilities. This especially concerns contour bunds.

The results further indicate that the probability that these investments are undertaken in Balete ranges from about 2 to 9 times higher than Villa Florentino. Farmers in Kapatalan were more likely than those in Villa Florentino to invest in agroforestry and/or tree planting, which is significant, but less likely on terracing, contour bunds and/or irrigation facilities. Compared to Villa Florentino, farmers in Quibal are less likely to undertake IQL, which shows a strong negative correlation particularly in agroforestry and tree planting. As said, this holds quite apart from all other variables such as off-farm and non-farm income, knowledge of SWC, slopes etc.; the communities have their own unique character. Households in Kapatalan, for instance, are quite in favour of agroforestry or forest-related investments irrespective of other factors. Cultural aspects such as ethnicity (e.g., the Ifugao traditions of rice terracing), risk-avoidance and learning effects (e.g., doing what the neighbours do) as well as economies of scale (e.g., helping each other or a market position towards traders) may be in the background here.

INVESTMENT DECISION FACTORS: REFLECTIONS ON THE HYPOTHESIS AND CONCLUSION

The econometric analysis provides empirical evidence that households' specific variables, farm characteristics and village conditions influence households' decisions on investments in land quality. The evidence presents a set of findings that characterize the trends of investments in the quality of the land (IQL) in the study villages. These findings may conform or contrast the hypotheses which were developed from previous studies.

Older people invest more

Age of household heads significantly influenced investments in the quality of the land, with older household heads more likely to practice sustainable land-use systems than younger ones. One underlying factor may be the farmer's capacity, older household heads having accumulated more capital and more knowledge and skills during their lifetime. Concurrently, motivational factors appear to play a role, with older household heads expressing in informal conversations that they want to leave a valuable farm to the next generation.

More people, not more investment

An increase in household size and the man–land ratio did not appear to lead to more investments in the land. This is opposed to the population-based (Boserupian and neo-Boserupian) perspectives on land-use change. Also the overall population density in the village areas does not show such a relationship. This discrepancy could possibly be explained by the labour market. Chayanov (1966), for example, concluded that farm labour input depends on household composition only in cases of missing or imperfect labour markets. In such situations, an increase in the household size would stimulate investments in the quality of the land. In our study areas, however, households could easily find farm labour that could be tapped for these investments. Reversely, large households could participate in wage labour on other farms or in urban areas.

Additional income of households induces investment

Income generated from off-farm, non-farm and self-employment is utilized by the households to finance investments in the quality of the land. This is in conformity with the hypothesis that off-farm income provides the necessary capital for investments in sustainable land-use systems. Clay et al. (1998), from a study of Rwandan farmers, supports our findings, concluding that non-farm income is "an important source of own liquidity". In an economy of underdeveloped or imperfect credit markets, non-farm income is used to buy material and labour inputs needed for sustainable farming. A purely rational choice explanation is that, compared to other investment options, farming appeared to be perceived as generating the most benefits. Additionally, the image of being a well-embedded farmer rather than some footloose opportunist may have held appeal for many.

In contrast to our result, Delos Angeles (1986) and Shively (1996), who conducted separate studies of upland Filipino farmers, concluded that farmers with off-farm income had less motivation to maintain on-farm resources. Some of them started businesses that competed for capital investments and labour. No conclusion can be reached on which pattern will prevail over the Philippines as a whole but we surmise that markets and local culture play a role.

Knowledge and investments go hand in hand

Knowledge of soil conservation techniques correlates strongly with investments in the quality of the land such that households that have more knowledge gained from whatever sources have more tendencies to invest in sustainable farming. Since it is unlikely that the only causal direction is that farmers learn about the techniques by simply doing them, it appears that the diffusion of knowledge of sustainable farming practices, such as agroforestry and tree-farm establishments, building of terraces and contour bunding, that are promoted in extension programs, have contributed to farmers' adoption of investments in the quality of the land. Clay et al. (1998) observed that, in Rwanda, farmers who had more exposure to soil conservation technologies were more capable of establishing hedgerows than other farmers.

Does tenure really matter?

Households' control of land through the various forms of security of tenure existing in the Philippines did not appear to influence investments in the quality of the land significantly. In other words, neither the mechanism that tenure security invites these investments (due to the certainty to reap the future benefits) nor the reverse mechanism that tenure *in*security invites investments (because government will be less likely to evict farmers from improved land) appeared to prevail. The informal impression from the field is that tenure for all farmers is felt as secure enough to not really make a difference in decisions to invest in land quality. Although this finding falls in line with many cases discussed in Platteau (2000), the relation between tenure security and investments depends much on the institutional context of formal and informal securities and access (Platteau 2000; Lipton 1989), which may very much across locations.

The importance of physical farm characteristics

Farm and plot variables appeared to be additional but weak considerations for investments in the quality of the land. With respect to tree-based investments, households appeared to be less likely to make investments if their plots had a longer cultivation period. In other words, trees tended to appear on newly settled farms relatively fast but with a slower rate of adoption afterwards. Other relationships between investments and farm characteristics showed a certain logic but were statistically insignificant.

The village-level effects on investments in land quality: ethnicity and government

Each village could be characterized by a concentration on one major type of investments in the quality of the land. Households in Balete were mostly investing in contour bunds and irrigation facilities with little investments in tree planting and terracing. Tree planting could be observed mostly in Kapatalan but they tended to plant more fruit trees rather than the traditional coconut-based agroforestry. Although households in Quibal invested least as compared with the other barangays, they tended to plant both forest and fruit trees. Households in Villa Florentino were investing in all major investment types but more on terracing and irrigation facilities. Since trees were perceived to be an integral part of terraces, they tended to plant more trees especially in upstream watersheds to maintain continuous water supply.

Thus, investments in the quality of the land might have been influenced not only by household and farm variables but also by ethnicity, public-policy variables and other things captured in the village dummies. In terms of ethnic traditions, for instance, Ifugaos are known for their ingenuity in making rice terraces notwithstanding their knowledge of growing vegetables gained through their interactions with other people. Igorots, who migrated from the vegetable-growing province of Benguet in the Cordillera mountains, brought these knowledge and skills to their new settlements in Balete and Villa Florentino. Coconut-based agroforestry, as practiced by the Tagalogs of Kapatalan, is widely practiced throughout the Southern Tagalog region.

Even though the four villages had been selected for their relatively high level of adoption of land investment methods, it is striking that active environmental government projects were present in three of them, as described above. The other (Vila Florentino) had rejected to host an environmental project out of distrust of government intentions but both the villagers and the local government unit (LGU) were quite active to show the outside world that they were capable to invest in sustainability even without external control and support.

At the same time, it may be noted that in Balete, Vila Florentino and Kapatalan, farmers were already practising their particular forms of investment in the quality of the land before government projects arrived, and these forms of investments in the quality of the land did not change during or after project implementation, even if, as in Balete, government prescriptions were opposed to the local method of investment in land quality. It could be, therefore, that government efforts did work to sustain and enhance farmer capacities and motivations to invest even though farmers rejected that particular method.

As a policy-oriented conclusion, we may say that first of all, the image of slash-and-burn farmers as intrinsically opposed to or incapable of transition to sustainable land use is ripe to be buried forever. Even without government control and support, markets and local traditions can stimulate farmers to invest in their land.

Government interventions in the upland remain important, however. First of all for the sake of an issue not covered in the present paper, namely biodiversity conservation and protection of the forest against illegal small-scale logging. Secondly, with a view to sustainable land use, government presence (preferably in close collaboration between the line ministry DENR and the local government units) appears to be important in order to reinforce the capacity and motivation of farmers. Based on the present analysis, essential elements in such support projects appear to be the provision of knowledge and possibly of credit for households lacking off-farm income sources. This should go alongside with putting a soft but persistent pressure on farmers that focuses on the general need of transition but leaves the choices of how to arrive there to local markets and traditions.

NOTES

[1] The variable total landholding has a correlation coefficient with the man-land ratio variable of – 0.47, indicating a problem of collinearity.

REFERENCES

Adégbidi, A., Gandonou, E. and Oostendorp, R., 2004. Measuring the productivity from indigenous soil and water conservation technologies with household fixed effects: a case study of hilly mountainous areas of Benin. *Economic Development and Cultural Change,* 52 (2), 313-346.

Baland, J.M. and Platteau, J.-P., 1996. *Halting degradation of natural resources: is there a role for rural communities?* Oxford University Press, Oxford.

Boserup, E., 1965. *The conditions of agricultural growth: the economics of agrarian change under population pressure*. Aldine Publishing Company, Chicago.

Chayanov, A.V., 1966. *The theory of peasant economy*. (editors: Thorner, D., Kerblay, B.and Smith, R.E.F.), Homewood, Illinois.

Clay, D., Reardon, T. and Kangasniemi, J., 1998. Sustainable intensification in the highland tropics: Rwandan farmers' investments in land conservation and soil fertility. *Economic Development and Cultural Change,* 46 (2), 351-377.

Clay, D.C. and Reardon, T., 1997. Determinants of farm-level conservation investments in Rwanda. *In:* Rose, R., Tanner, C. and Bellamy, M.A. eds. *Issues in agricultural competitiveness: markets and policies: conference proceedings of the 22nd congress of International Association of Agricultural Economists (IAAE), August 1994, in Harare*. Dartmouth, London, 210-221. IAAE Occasional Paper no. 7.

Conelly, W.T., 1992. Agricultural intensification in a Philippine frontier community: impact on labor efficiency and farm diversity. *Human Ecology,* 20 (2), 203-223.

De Groot, W.T., 1999. *Van vriend naar vijand naar verslagene en verder: een evolutionair perspectief op de verhouding tussen mens en natuur*. Nijmegen University Press, Nijmegen.

De Groot, W.T., 2006. From fiend to enemy and onwards: visions of nature in an evolutionary perspective. *In:* Van den Born, R.J.G., Lenders, R.H.J. and De Groot, W.T. eds. *Visions of nature: a scientific exploration of people's implicit philosophies regarding nature in Germany, the Netherlands and the United Kingdom*. Lit Verlag, Berlin, 19-40.

De la Brière, B., 1999. *Determinants of sustainable soil conservation practices' adoption: an analysis for the Dominican Republic*. IFPRI, Washington.

Delos Angeles, M., 1986. *Economic analysis of households in upland community*. Philippine Institute for Development Studies (PIDS), Manila.

Feder, G. and O'Mara, G.T., 1981. Farm size and the diffusion of green revolution technology. *Economic Development and Cultural Change,* 30 (1), 59-76.

Fujisaka, S. and Wollenberg, E., 1991. From forest to agroforest and logger to agroforester: a case study. *Agroforestry systems,* 14 (2), 113-129.

Geertz, C., 1963. *Agricultural involution: the process of ecological change in Indonesia*. University of California Press, Berkeley.

Greene, W.H., 2000. *Econometric analysis*. 4th edn. Prentice Hall International, Upper Saddle River.

Just, R.E. and Zilberman, D., 1983. Stochastic structure, farm size and technology adoption in developing agriculture. *Oxford Economic Papers,* 35 (2), 307-328.

Lipton, M., 1989. Responses to rural population growth: Malthus and the Moderns. *Population and Development Review,* 15 (Suppl.), 215-242.

Murton, J., 1999. Population growth and poverty in Machakos district, Kenya. *The Geographical Journal,* 165 (1), 37-46.

Netting, R.M., 1993. *Smallholders, householders : farm families and the ecology of intensive, sustainable agriculture*. Stanford University, Stanford.

Pender, J., Jagger, P., Nkonya, E., et al., 2004. Development pathways and land management in Uganda. *World Development,* 32 (5), 767-792.

Pender, J.L., 1998. Population growth, agricultural intensification, induced innovation and natural resource sustainability: an application of neoclassical growth theory. *Agricultural Economics,* 19 (1/2), 99-112.

Pender, J.L. and Kerr, J.M., 1996. *Determinants of farmers' indigenous soil and water conservation investments in India's semi-arid tropics*. International Food Policy Research Institute (IFPRI), Washington. EPTD Discussion Paper no. 17.

Platteau, J.-P., 2000. *Institutions, social norms and economic development*. Harwood Academic Publishers, Amsterdam.

Reardon, T. and Vosti, S.A., 1995. Links between rural poverty and the environment in developing countries: asset categories and investment poverty. *World Development,* 23 (9), 1495-1506.

Semgalawe, Z.M., 1998. *Household adoption behaviour and agricultural sustainability in the Northeastern Mountains of Tanzania: the case of soil conservation in the North Pare and West Usambara Mountains*. PhD Thesis, Wageningen University, Wageningen.

Shiferaw, B. and Holden, S.T., 1996. *Resource degradation and adoption of land conservation technologies in the Ethiopian Highlands: a study in Andit Tid, North Shewa*. Agricultural University of Norway, Ås. Discussion Paper no. D-31/1996.

Shively, G.E., 1996. *Assets, attitudes, beliefs, and behaviors: explaining patterns of soil conservation adoption among low-income farmers*. SEARCA, Los Baños. Working Paper no. 19.

Tiffen, M., Mortimore, M. and Gichuki, F., 1994. *More people, less erosion: environmental recovery in Kenya*. Wiley, Chichester.

Zaal, F. and Oostendorp, R.H., 2002. Explaining a miracle: intensification and the transition towards sustainable small-scale agriculture in dryland Machakos and Kitui districts, Kenya. *World Development,* 30 (7), 1271-1287.