Investing in the land: agricultural transition towards sustainable land use in the Philippines forest fringe

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5 Regression analysis of households' investment in land quality

> 'Policy makers are (rightly) interested primarily in more or less middle-of-the-road interpretation of data; tension, however, is what science grows on.'
> De Groot, 1992

One of the objectives of this research is to look at the various determinants of IQL at the household level that considered four villages described in Chapter 3. This household level analysis is done with the view that households ultimately make decisions in regard to the use of the land on the basis of their own capacity and motivations. Knowing what encourages (or discourages) households to make investments is fundamental in understanding the patterns of land uses and to formulate appropriate policy responses to the problem of forest degradation. I also consider on-site biophysical characteristics which are observed to vary considerably even within small land spaces. While analysis on land use decisions is made on the household level, this is not to ignore the inclusion of the context in which the overall decision-making of the household functions. Thus, dummies to represent the village-level effects are incorporated in the analysis.

At first, this chapter describes the relative importance of the major investments in land quality, namely; terracing, contour bunds, irrigation facilities, and agroforestry or tree planting. Then, the conceptual model of investment behaviour is presented as a framework for the econometric analysis to be used in this study. It proceeds with the discussion of the possible factors that influence households to invest or not to invest in IQL. Subsequently, the findings are discussed in the last section in the light of the hypotheses presented.

5.1 The major investments in land quality (IQL)

Table 5.1 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 rest solely on the household as a unit since it requires high capital and labor use, both family and non-family, to construct a productive unit of land. This maybe the main reason why, in the villages studied, only 28 plots out of 235 were terraced. The average area terraced is also low at less than half a hectare (about 0.40 ha) for all households who made terraces. Among the major investments, average labor required per hectare for terracing is highest at about 668 man-days ranging from an average of about 64 man-days per hectare in Quibal to as high as 1300 man-days in Villa Florentino. These high variations in the values reflect the material used in terracing as well as the slopes of the land to be terraced. This trend is similar in terms of cost[1] per household 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 are 46 plots out of 235 in the villages studied that were developed with contour bunds. The average productive area is about 0.49 ha while the total labor required per hectare of productive area is about 86 man-days. The total cost[1] per hectare per household is about Php 8,190. Vegetables, considered to be high-valued crops, are grown in these areas usually at two croppings per year. The revenue generated out of vegetable production is usually high enough to support more than the needs of the household.

Irrigation facilities are constructed in support for agricultural production in both rice terraces and contour bunds. Two types of irrigation facilities are used: i.e. the channel or canal system and the pipe or 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 'rainburst' mechanism attached to the pipes. The average total length of channel constructed is about 368 m although values vary much from as low as 60 m in Quibal to as high as 461 m in Villa Florentino. The average total cost per meter of channel irrigation investment is about Php 28.

Sprinkler irrigation system is only practiced in Balete and Villa Florentino with an average length of 751 m and average total cost per meter of Php 11.

Major tree planting activities are undertaken on 88 out of the 235 plots for all the villages with an average total area of 1.26 ha. In this study, 'major tree planting' means that the area planted with trees is greater or equal to 0.25 hectare per plot. Households usually termed these as their agroforestry and tree farms (reforestation area) which require average total labor of 27 man-days per hectare. This value is much lower than the other major investments.

The average number of household members that are capable to work in the farm is about 3.52 which is derived from the number of household members with age

[1] Total cost of investment per household (converted at the 1998 prices) is the sum of the value of household labor and hired labor. Household labor is valued at the market price.

Table 5.1 – The major investments in land quality adopted by households in Philippine villages (*barangays*)

Investments in land quality	Mean Values
1 Terracing	
Length, meters	404
Height, meters	0.90
Area, hectares	0.40
Labor required per hectare, man-days	668
Total labor cost per hectare, Php	77,905
No. of plots with terraces	28
2 Contour bunds	
Area, ha	0.49
Total labor required per hectare, man-days	78
Total labor cost per hectare, Php	8,190
No. of plots with contour bunds	46
3 Irrigation	
3.1 Channel irrigation	
Channel length, meter	368
Average labor required, man-day	32
Total labor cost of channel per meter, Php	28
No. of channels	26
3.2 Sprinkler irrigation	
Sprinkler length, meter	751
Average labor required, man-day	4
Total labor cost of sprinkler per meter, Php	11
No. of sprinklers	47
4 Major tree plantation (≥0.25 ha)	
Area, ha	1.26
Average labor required per hectare, man-days	27
Total labor cost per hectare, Php	2,300
No. of plots with trees	88

Note: The cost item presented in the table above is only the labor cost. Thus, the varying labor wage rate per hectare of Php 117 per man-day for terracing, Php 105 per man-day for contour bunds and Php 85 per man day for tree planting maybe due to the skills and labor specialization required for each investment category.

ranging from 15 years old up to 64 years old. If working household members are going to school, then they only contribute to about 30 percent of the total labor of 312 days per year. In this case, only the husband and wife are fully working in the farm. From this scenario, the total number of working days per year in a household is 766 man-days. Terracing requires 668 man-days per hectare which is equivalent to about 87 percent of the average household total working days. If labor for rice cultivation will be added, then the total labor required for rice farming system with terraces will be more than the average total household labor. Because of this, a household has an option of hiring outside labor or spreading out over several periods the establishment of the terraces. Making one-hectare plot with contour bunds in two cropping seasons per year requires on average about 20 percent of the total household labor. The construction of an irrigation channel requires about four percent of available household labor while sprinkler irrigation needs less than one percent. For tree plantation, the total labor requirement per hectare is only about four percent of the available total household labor. Labor requirement for terracing and making contour bunds increases if labor for irrigation facilities is added.

Based on the above discussion, establishment of terraced plots is the most labor demanding investments. Households who are willing to terrace their plots often resort to the hiring of outside labor as discussed in Section 4.4.6 which accordingly requires also the households to generate cash income to finance the establishment cost of this kind of investment.

5.2 A conceptual model of investment behaviour

The problem of investment in improving the quality of the land is analyzed 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, labor, 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.

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. Short-term decision targets, covering food requirements of the households and cash to purchase consumer goods generated outside of the farm is influenced by the household needs. Aspirations and goals determine the choices and behavioural patterns of the households with a focus on how to realize future household wants. In developing countries like the Philippines, resources include not only physical resources 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 environment provide limits on the choice options available to households. Thus, an analysis of the households' decisions in IQL needs to consider the general decision-making context of the households.

The typical household described above can be incorrectly analyzed if standard micro-economic theory based on profit maximization is used. Although it has been commonly applied in the analysis of individual firms in developed countries, the assumption that the production and consumption decisions can be analyzed separately does not necessarily hold especially in developing countries. This is due to the existence of market imperfections in relation to labor, credit, land resources, and some basic food products. In this case, the proper framework considers the household as one who maximizes a utility function over time with respect to consumption and production including investments in land quality and others (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. [2] The constraints on the household are labor 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), labor availability (due to imperfect labor market), credit or cash availability (due to imperfect capital market), knowledge (including expectations) and time horizon (tenure and risks) and time discount (LaFrance, 1992 and Pagiola, 1993).

This reduced form for the investment behaviour is the basis for the study in this chapter. In principle, I analyze the household's choice between IQL and non-IQL as a function of household, farm and village characteristics using a binary model.[3] The model utilizes the use of a logistic distribution which subsequently allow for the calculation of marginal effects of the explanatory variables. The logit model for IQL is specified as (Greene, 2000):

$$\Pr[inv_i] = \frac{e^{\beta x_i}}{(1+e^{\beta x_i})}$$

where $\Pr[inv_i]$ is the probability of household i (i =1, 2, …104) to invest in IQL, x_i is a vector of explanatory variables and β is a vector of coefficients. The marginal effect of an explanatory variable x_{ij} on the probability of that household i investing in IQL is a nonlinear function of x_{ij} and β and is given by:

[2] In principle, the utility function can also include 'social goods' such as the well-being of others, for example, children (altruism) and social status.

[3] Hence, I focus on the *adoption* of soil conservation techniques rather than on the *intensity* of investment. I tried to estimate a model for the intensity of investment but this gave poor results, probably because of small number of observations. Also, almost all other empirical studies of IQL look at adoption rather than intensity of investment.

$$\frac{\partial \Pr[inv_i]}{\partial x_{ij}} = \Lambda(\beta x_i)[1 - \Lambda(\beta x_i)]\beta_j$$

where β_j is the coefficient corresponding to x_{ij}

$$\Lambda(\beta x_i) = \frac{e^{\beta x_i}}{1 + e^{\beta x_i}}$$

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

$$odds(x_{ij}) = e^{\beta_j}$$

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 $e^{\beta_1} = 2$ (i.e., the odds ratio) on the dummy variable 'with irrigation' this would indicate that households using irrigation technology are twice as likely to invest in land quality rather than not invest as compared to those households 'without irrigation', the reference group. An odds ratio equal to one indicates that there is an equal chance that the two groups of households will do IQL.

5.3 Explanatory variables in major investments in land quality and hypotheses

The general model of IQL is described in the previous section in terms of the incentives and disincentives of farm investments which depends on farm characteristics, the households' capacity to undertake investments and market circumstances (especially costs of inputs and prices of outputs). The mean values of explanatory variables in this study are shown in Table 5.2. These are data at the household level derived from the descriptive analysis in Chapter 4 and they are presented here to provide clear understanding of the factors which have been found in the literature to affect investment decisions of households. This is necessarily important in anticipation of the regression analysis.

The dependent variables are major investments in land quality, namely; terracing, contour bund, irrigation facilities and agroforestry or tree planting. The major investments 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 decision horizons of individuals which might affect their adoption. In terraces, contour bunds and irrigation facilities, called non-tree investments, the IQLs allow the growing of food and cash crops that make the households generate short-term benefits.

They, however, require high capital which limits adoption to cash-constrainted household. In the household survey, households are able to construct terraces through savings and current income. Tree planting has a longer gestation period than terraces, contour bunds, and irrigation facilities because fruit trees require 5 to 7 years before they economically bear fruits while forest trees can be harvested for markets only after a period of 7 to 10 years.

The explanatory variables are grouped into two categories: (1) household characteristics and (2) farm characteristics. The variables in each category are defined below including my hypotheses explaining their effects on the IQLs, the dependent variable.

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 investment, 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 5.2 gives the distribution of the dependent variable; the major investments in land quality with terracing, contour bunds and irrigation facilities as one category and tree planting as another category. It shows, for instance, that those households who invested in terracing, contour bunds and irrigation also do invest in agroforestry or tree planting with proportion of households of about 42 percent. The proportion of households who invest in agroforestry or tree planting that also invest in terracing is about 36 percent. This implies that some households in the four villages studied undertake various forms of IQL.

5.3.1 Households' 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 as regards to farming or even other decisions that change the family's long term goal and so their social life. There are four levels of education existing in the research area which 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.

Many researchers agree that the age of the household head might 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 schools and they might have longer time horizon. While older household heads may have and also attended seminars, conferences, and on-site farm visits, they are less likely to adapt their traditional practices. However, older people may have saved money to invest (lifecycle effect) and gained more knowledge through their actual experiences on 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.

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

In Table 5.2, household heads who invested in tree planting are significantly older (about 52 years old) than those who did not. A younger age is observed for those who invested in terracing, made contour bunds and irrigation facilities at 47 years old but it is insignificantly different from those who did not invest.

In terms of educational level, households with investments in terracing, contour bunds and irrigation facilities tend to be less educated as shown by the high proportion of households at the lowest category of educational level (from no education up to the primary level). On the other hand, households with investments in tree planting and agroforestry tend to be more educated attaining especially the intermediate level.

Household size

A measure of the household size is the number of children plus the husband and wife where I use the equivalence scale of 1.0 for household head, 0.7 for other adults and 0.5 for household members with age less than 18 years old. In a Malthusian setting, a relatively large household size induces deforestation because farmers have to clear forestlands to support their household needs. In this case, a positive correlation between household size and deforestation is expected. An opposite relationship may occur (Boserup, 1965), however, if farmers are faced with land constraints and policy interventions that stimulate investments.

The household sizes of those who terraced, made contour bunds and irrigation facilities are larger than those who did not. For those who invested in tree planting, the household size is lower than those who did not. The differences in both categories however are insignificant from each other.

Table 5.2 – Means of explanatory variables of major investments in land quality and chemical inputs 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 asset	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 w/ 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 center, 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.

Number of working household members

This variable reflects the amount of labor that households have at their own disposal which is measured as the number of household members whose ages range from 15 to 64 years old including husband and wife. This households' 'own labor' is expected to have a positive effects on IQL which require labor counterpart not substitutable by hired labor. *Ceteris paribus,* I hypothesize that larger households are more capable to undertake IQL (Clay *et al.*, 1998).

In Table 5.2, the number of working household members are higher for those households who invested in all categories of IQL than those who did not but their differences are insignificant.

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 engaged in off-farm, non-farm and self-employment and 0 otherwise), has 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). However, a negative correlation reflects competition of labor 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 (with imperfect labor markets). In some ways, labor 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 of trees and allowing lands to fallow. In a previous Philippine research by Delos Angeles (1986), she observed a negative relationship between conservation adoption among Filipino 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 5.2, the a higher proportion of those households who had off-farm agricultural and non-farm income and self-employment invested in terraces, contour bunds and irrigation. It is a different scenario that exists in tree planting because the proportion of households with off-farm, non-farm and self-employment is lower than those who 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, corn, salt, coffee, sugar etc.). Expenses in clothing and school fees are usually made annually but were calculated on 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 one for household head, equal to 0.7 for household members with age equal to or greater than 18 years old and equal to 0.5 for other members of the household with age less than 18 years old. Material asset are those acquired by the households, such as 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 suggest that they have higher cash availability which is favorable to farm investments because they can hire labor 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. Thus, households with more wealth have greater capacity to do IQL but possibly less motivation because of alternative investment opportunities. This relationship may also hold true to material assets. In the regression analysis, the material assets variable is the only variable that is considered.

The average weekly equivalent per capita expenditure of households, who invested in terracing, contour bunds and irrigation facilities, are lower than those households who did not. This is the opposite in agroforestry or tree planting investments with the households who did invest having higher equivalent per capita expenditure than those who did not. The differences are, however, insignificant.

Table 5.2 also shows that the proportion of wealthy households, with wealth measured in terms of material assets such as cars, motorcycles, and household facilities, investing in terraces, contour bunds and irrigation is lower than those who did not. The opposite situation is observed in agroforestry and tree planting with higher proportion of wealthy households investing in this category. The differences between those who did invest and those who did not are insignificant in all categories of investments.

The problem of causality exists, however 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.

Knowledge of conservation techniques
This is measured as the number of conservation techniques reported to be known by the household heads. My 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 *et al.* (1996) found a positive correlation between adoption of level bunds and the number of conservation techniques known.

Table 5.2 shows that the number of SWC technologies known to the household heads is significantly higher in households with terracing, contour bunds and irrigation investments. On the other hand, the differences between those households who did invests in agroforestry and tree planting and those who did not are insignificant although the number of SWC technologies known to the households who invested is higher.

Man-land ratio
This 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 Boserup, the man-land ratio will be positively correlated with IQL. As shown in Table 5.2, however, households investing in land quality (all categories) have lower man-land ratio indicating an opposite relationship. The differences between those who invest in the different land quality improvements and those did not are 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 and elderly with ages 65 and above, relative to the total number of working household members. This variable is expected to have a negative relationship with investments since a significant number of children and elderly within a household can siphon off labor and money that maybe intended for IQL.

As shown in Table 5.2, the values of the dependency ratio for all IQL categories and chemical inputs have insignificant differences. The trend of the values, however, shows that dependency ratio is higher in households who invested in terracing, contour bunds and/or irrigation but lower values in those who invested in agroforestry and/or tree planting than those who did not.

5.3.2 Farm characteristics

Security of tenure
This variable is the proportion of plots owned by the farmers with secure tenure as exemplified by the presence of private title documents and CSC. It is expected that farmers make longer-term land improvements on landholdings that are owned (Clay and Reardon 1994; Burger and Oostendorp, 1999; and Shively, 1996). In many instances, however farmers' investments on their plots serve as proofs to obtain *de facto* if not *de jure* land rights. This hypothesis is also discussed in Chapter 4.

Table 5.2 shows a higher proportion of plots with secure tenure in all categories of the major investments. However, significant differences are 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 produc-

tion. I hypothesize that farmers with larger plot and farm sizes are more capable to undertake investments because they can spare land areas for terraces and irrigation channels, for fallow, and trees while putting larger portions of their lands under cultivation. From Chapter 4, a household study of Sengalawe (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 *et al.* (1996), and Shiferaw *et al.* (1996).

The values of the plot size and farm size exhibited similar trends in relation to the dependent variables; i.e., both have higher values in all categories of investments. This means that households with large areas have higher tendency to invest in land quality. Insignificant differences for the variable farm size, however is observed in any of the major investments while a significant differences is 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 are continuously cultivated by the farmers until the time of investments in land quality. My hypothesis regarding this variable is ambiguous. Long cultivation results to declining yields so that an investment on 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 to the Malthusian 'poverty cycle'. In conditions of low fertility, plots require increasing labor 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 at shorter period.

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

Plot slopes, soil types and distances
Plot slopes are defined in three categories, namely flat slopes (0-3 %), rolling/moderately sloping (4-17%) and steep slopes (≥18%) while the soil types are defined in two categories, namely clay loam and sandy loam. These variables are transformed into a household level data by getting the average of the plots within a household. I hypothesize 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 5.2, higher proportion of plots with steep slopes are in investments in terracing, contour bunds and irrigation while investments in agroforestry and tree planting has higher proportion of plots in the rolling to moderately sloping plots. However, significant differences are observed for the investments in terracing, contour bunds and irrigation.

In terms of soil types, the proportion of plots with clay loam soil types is higher in any of the categories of IQL. Households perceived that these soil types have lower fertility caused by continuous cultivation. Table 5.2 shows, however, that soil types do not differ significantly in any category of IQL.

Likewise, 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 center have similar trend 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 village center, significant difference is only observed in terracing, contour bunds and tree planting.

Table 5.3 presents the pairwise correlation matrix for the explanatory variables. In the table, it shows that dependency ratio (*depend* in the table) is strongly correlated to age (correlation –0.59), size of plots (sizem) is strongly correlated with total size of plots (totsize) (correlation 0.73), distance to home (dishomm) is strongly correlated to distance to village center (disbgym) (correlation 0.57), number of working household members (hhwork) is strongly correlated with household equivalent size (hhequiwt) (correlation 0.72) and the village dummy for Kapatalan (villd2) is strongly correlated with wealth dummy (wealtdu1) 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 center and number of working household member is dropped in the regression analysis. The village dummy Kapatalan and wealth dummy variables are retained, however because of their relevance to determining village and wealth effects, respectively. Man-land ratio and total landholdings are also retained because of their pervasive-

Table 5.3 – Pairwise correlation coefficients of the different household variables*

	age	inter	second	hhequiwt	manland	hhwork	depend
age	1.00						
inter	0.01	1.00					
second	-0.13	-0.37	1.00				
hhequiwt	0.11	-0.19	0.03	1.00			
manland	-0.05	0.10	-0.06	0.01	1.00		
hhwork	0.39	-0.09	0.03	0.72	-0.02	1.00	
depend	-0.59	-0.15	0.05	0.29	0.02	-0.39	1.00
nrknow	-0.01	-0.16	0.10	0.04	-0.13	0.05	0.04
employ	-0.16	0.13	-0.03	0.02	-0.03	0.04	0.10
secure	0.05	-0.04	0.10	-0.06	0.06	-0.04	-0.10
totsize	0.18	-0.10	0.02	0.15	-0.47	0.16	-0.16
sizem	0.30	0.02	0.10	0.11	-0.37	0.07	-0.25
percult	0.03	0.19	-0.11	-0.12	0.21	-0.01	-0.11
percawt	0.16	-0.08	0.06	-0.19	-0.01	-0.08	-0.19
wealtdu1	-0.30	0.02	-0.19	-0.10	-0.01	-0.32	0.38
dishomm	0.23	0.06	0.05	0.11	-0.24	0.09	-0.28
disbgym	0.10	0.12	-0.06	-0.06	-0.24	0.02	-0.23
slopecd1	-0.12	-0.04	0.17	-0.03	0.34	0.01	-0.04
slopecd2	0.27	0.09	-0.12	0.02	-0.24	0.13	-0.22
slopecd3	-0.18	-0.06	-0.01	0.01	-0.02	-0.15	0.27
soilcd1	-0.17	-0.06	-0.01	0.04	0.16	-0.002	0.09
soilcd2	0.17	0.06	0.004	-0.04	-0.16	0.002	-0.09
villd1	-0.26	-0.01	0.05	-0.003	0.07	-0.07	0.19
villd2	0.39	0.08	0.05	0.04	0.03	0.18	-0.43
villd3	-0.10	0.18	-0.05	-0.13	0.01	-0.08	-0.02
villd4	-0.06	-0.25	-0.05	0.10	-0.10	-0.04	0.27

	nrknow	employ	secure	totsize	sizem	percult	percawt
nrknow	1.00						
employ	-0.24	1.00					
secure	-0.04	0.07	1.00				
totsize	0.27	-0.03	-0.01	1.00			
sizem	0.12	-0.02	0.17	0.73	1.00		
percult	-0.15	0.14	-0.03	-0.18	-0.26	1.00	
percawt	-0.01	-0.06	0.06	0.06	0.02	-0.11	1.00
wealtdu1	0.12	0.07	-0.26	-0.11	-0.27	0.05	-0.22
dishomm	-0.04	-0.11	0.15	0.49	0.81	-0.18	-0.01
disbgym	-0.23	-0.07	-0.004	0.27	0.40	-0.06	-0.11
slopecd1	-0.11	0.05	0.11	-0.24	-0.23	0.21	0.04
slopecd2	-0.23	0.06	-0.09	0.23	0.30	0.003	0.01
slopecd3	0.33	-0.11	0.005	-0.05	-0.13	-0.17	-0.04
soilcd1	0.06	-0.11	-0.06	-0.21	-0.27	0.07	-0.07
soilcd2	-0.06	0.11	0.06	0.21	0.27	-0.07	0.07
villd1	0.02	0.05	0.22	-0.22	-0.21	-0.03	-0.01
villd2	-0.06	-0.15	0.18	0.17	0.51	-0.15	0.02
villd3	-0.49	0.20	-0.20	-0.21	-0.28	0.39	0.06
villd4	0.53	-0.10	-0.20	0.26	-0.01	-0.21	-0.07

Table 5.3 (continuation)

	wealtdu1	dishomm	disbgym	slopecd1	slopecd2	slopecd3	soilcd1
wealtdu1	1.00						
dishomm	-0.39	1.00					
disbgym	-0.14	0.57	1.00				
slopecd1	-0.07	-0.09	-0.14	1.00			
slopecd2	-0.25	0.29	0.28	-0.44	1.00		
slopecd3	0.31	-0.24	-0.19	-0.33	-0.70	1.00	
soilcd1	0.04	-0.23	-0.10	0.13	-0.09	-0.01	1.00
soilcd2	-0.04	0.23	0.10	-0.13	0.09	0.01	-1.00
villd1	0.03	-0.21	-0.22	-0.21	-0.29	0.47	0.08
villd2	-0.61	0.62	0.33	0.03	0.29	-0.33	-0.06
villd3	0.13	-0.18	0.11	0.32	0.16	-0.42	-0.01
villd4	0.45	-0.23	-0.22	-0.15	-0.16	0.28	-0.01

	soilcd2	villd1	villd2	villd3	villd4
soilcd2	1.00				
villd1	-0.08	1.00			
villd2	0.06	-0.33	1.00		
villd3	0.01	-0.33	-0.33	1.00	

*Note: age=age of household head, inter=dummy (1,0) for intermediate level of education, second = dummy (1,0) for secondary and college level of education, hhequiwt = equivalent household size, man-land = man-land ratio, nrknow=number of knowledge in SWC technologies, employ = dummy (1,0) for any household member engaged in off-farm/nonfarm/self-employment, secure = investment plot with secure tenure, totsize = average total landholding, sizem = average size of plots, percult = number of years of continuous cultivation on plot before investment, dishomm=average distance of plots from residence, disbgym = average distance of plots to village center, wealthdu = dummy for wealth (1,0), slopecd1 = dummy for flat slope, slopecd2 = dummy for rolling slope, soilcd1 = dummy for clay loam soil, villd1 = dummy for Balete, villd2 = dummy for Kapatalan, villd3 = dummy for Quibal.

ness in literatures concerning soil and water conservation adoptions and the fact that the multicollinearity coefficient is only almost 0.5. All other variables have correlation below 0.5 in absolute value with others.

5.4 Definition of regression variables

Table 5.4 presents the summary statistics of the variables for the regression model. Out of the 104 households surveyed, only 95 observations are included in the analysis because the remaining 9 household surveys contain missing in - formation on any of the variables considered.

Regression analyses are done separately for the combined IQL of terraces, contour bunds and irrigation facilities and the combined IQL of agroforestry and tree planting. The category terraces, contour bunds, and irrigation facilities are treated as one category because of the nature of the investments of having crop cultivation as the main activity. Combining agroforestry and reforestation as a tree-planting category is due to the characteristics of this investment of generating accrued benefits for a long period.

The variable **age** refers to the age of the household heads, who are either males or females, at the time of the survey. It is observed that female-headed households are widows whose husbands have died such that she makes major decisions concerning the family. Many times, assistance or opinion of her eldest son is being sought. The average age of household heads for this study is about 47 years old with the youngest of 24 years while the oldest is 81 years old. **Education** indicates the level of education completed by the household heads. Under education variable, **up to primary** level includes no education up to the first four years of stay in school while the **intermediate** level is the additional two years beyond the primary level. The **secondary** variable of education includes those households who completed education beyond the secondary level of education. The omitted education category is the category variable, **up to primary**.

Household size variable is transformed into the equivalent household size and estimated by incorporating corresponding weights for each household member; that is, the household head is given a weight of 1, other household member with age greater or equal to 18 years old has equivalent weight of 0.7 and any household member with age less than 18 years old has equivalent weight of 0.5. In its equivalent value, this is a measure of the equivalent number of household members living in one roof house including the husband, wife or extended family members such as grand parents. The average equivalent household size is about 4 with a maximum of 8. **Man-land ratio** is the ratio of the average number of household size over the total landholdings of the households. This ratio indicates the average number of people per unit area owned by each household in the study sites with 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 is engaged as hired laborer for other farmers (off-farm) or for business employer in urban areas (non-farm) during off-season farming, or engaged in handicrafts, small store keeping, and vending (self employment) and equals zero, otherwise. About 76 percent of the households have at least one household member engaged in off-farm/non-farm employment and self-employment. **Knowledge of SWC techniques** variable is a measure of the number of soil and water conservation techniques known by the household heads, such as; contour plowing, cover crops, hedgerows, agroforestry, reforestation, green and animal manuring, sprinkler and channel irrigation, and contour bunds. The average number of SWC techniques known to the households is about 4 while the maximum is 10. Some household heads have no knowledge at all of SWC technologies. The variable **security of tenure** equals one if a household has at least one plot with secure tenure, and is zero otherwise. About 65 percent of the households in this study have at least one plot with secure tenure. **Material asset** is a dummy variable for household ownerships such as cars, motorcycles, and household facilities, which is considered as a proxy for wealth. It is equal to one if a household owns at least anyone of these items and zero otherwise. Due to measurement problems and endogeneity, this variable is not considered in the initial analysis but it is later considered in the succeeding analysis to test its effect on the other variables. On average, about 41 percent of the households at least own a car, motorcycle, or household facilities.

Table 5.4 – Descriptive statistics of model variables

Variable	No. of observation	Mean	Standard deviation	Mini-mum	Maxi-mum
Investment in land quality					
Investment in T, CB and/or IF	95	0.36	0.48	0	1
Investment in AF and/or TP	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 with off/nonfarm, 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	1063.7	2188.2	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

For farm characteristics, **total landholding** is, in hectares, the total area of lands owned or occupied by each household which could be an indicator of wealth such that wealthy households have large landholdings. On average, each household owns 4.28 hectares. **Years of continuous cultivation** variable is the number of years the plots are continuously cultivated by the households till investments were made (if any) on the plots. The average number of years of continuous cultivation before investments in land quality is about 6 years with some households making the investments immediately or after less than a year of cultivation. The **distance to home** variable is given in meters which refers to the average distance of plots to the residences of each household. Its effect to IQL is manifested in travel time and transportation costs so that lands located far from the households receive less care and attention. The slope and soil types are presented as dummy variables. The slope variables **Flat slopes, Rolling slopes** and **Steep slopes** indicate the share of plot slopes within the households with slope ranges 0 to 3 percent, 4 to 17 percent and with slopes of equal or greater than 18 percent, respectively. Steep slopes variable is the omitted variable for the slope dummies. For soil types, **Clay loam** and **sandy loam** are the share variables which indicate the share of plots within households that have clay loam or sandy loam soil types. Sandy loam is the omitted variable for soil types which will be the basis for comparison. Table 5.4 shows that, on average, the proportion of plots with rolling to moderate slopes is highest at about 49 percent while the proportion of steep slopes is about 32 percent. On the other hand, the average proportion of plots within households with clay loam soil types is about 57 percent of the plots have clay loam soil types and about 43 percent are 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.

5.5 Regression results and discussion

Table 5.5 presents the results of two logit regressions for the four Philippine villages. In the first regression model, it combined the IQL in terracing (T), contour bunds (CB), and irrigation facilities (IF) while the second regression model considers agroforestry (AF) and tree plantation (TP). The reason for this aggregation of the investments is discussed in Section 5.3.

Generally, there are more parameters on the household variables than on the farm characteristics that are significantly different from zero at a 90 or 95 percent level of significance. 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 as regards to IQL.

5.5.1 Household characteristics

The regression results show that the age of the households is positively correlated in both categories of IQL with significant relationships. This indicates that the older the household heads, the higher the probability that they invest in the various IQL. *Ceteris paribus*, 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 might indicate 'life-cycle effects' on IQL which means that household heads have increased their savings and gained more experiences through the years resulting to investments.

Household heads who finished the intermediate levels significantly invest 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 of those household heads who attained high education in sustainable farming. With high education, these household heads may have engaged in wage labor or in other livelihood enterprises apart from farming. Household heads with low or no education, on the other hand, invest more likely in terracing, contour bunds and/or irrigation facilities and less likely in agroforestry and/or tree plantation. This reflects the preference of these households to make investments in land quality that generates benefits in a short period of time.

The household size variable has positive relationship in the regression for both IQL categories. This relationship is, however insignificant indicating that labor availability in the households has no effect on investment. This may be due to the existence of well-functioning labor market in the study villages which indicate that working household members can easily find job apart from their own farm.

Households with off-farm, non-farm, and self-employment incomes are much more likely to invest in IQL. This relationship is 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 is about 7 times higher than those households without other income for terracing, contour bunds and/or irrigation. Reardon and Vosti (1995) and Clay (1998) have 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 imperfections of credit markets in the villages because credit availability can put the households to be in a favorable cash liquidity situation making their off-farm, non-farm and self-employment income in IQL unimportant.

Table 5.5 – The ß-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		
	ß	Odds ratio	Prob. value	ß	Odds ratio	Prob. Value
Household (Hh) characteristics:						
Age	0.06*	1.06	0.07	0.09*	1.10	0.04
Education: (w/ 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 & 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:(w/ 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: (w/ sandy loam as basis for comparison)						
Clay loam	0.25	1.28	0.73	-0.06	0.94	0.94
Village characteristics:						
Village effect: (w/ V. 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, n	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 a significantly different from zero at the 95 percent level.

The numbers of SWC techniques known to household heads are positively correlated with IQL in all categories. The relationships are also strong except for the tree planting since settlements. This means that households who have more knowledge on SWC techniques are more inclined to do IQL which confirms the hypothesis. Shiferaw *et al.* (1996) also concluded that Ethiopian farmers have higher probability to adopt level bunds at the plot level with an increase in the number of known conservation techniques. This result may indicate the positive role of extension programs on IQL which increase the level of informa tion 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 who started investing may want to learn more SWC technologies afterwards.

Households invest more likely in IQL when they have secure tenure as shown by the positive regression results. The regression coefficient though is very in - significant. The possible explanation for the insignificant results may be due to the fact that investments facilitate the households for the acquisition of land rights. Russel (1986) and 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 imply the practice of agroforestry or establishment of tree farms on their lands.

For the man-land ratio variable, households with a high ratio appear to invest more likely in terracing, contour bunds and irrigation but they less likely invest in tree planting. Although statistically insignificant, this does not support Boserupian visions (e.g. Tiffen*et al.* 1994) and theory of Chayanov (1996). This could be explained by the existence of well-functioning labor market in the study villages as indicated above. Outside of the farm, household members who are able to work are undertaking off-farm and non-farm income activities in lieu of their need to invest their labor time in tree planting. In the study villages, households are not isolated (as opposed to Chayanov's formulation of a 'closed economy' condition of a household) from all buying-and-selling possibilities of product outputs and labor. Even taking at a higher level of analysis as in the Boserupian theory and the works of Tiffen *et al* (1994), the existence of a well-functioning labor market allows households to trade their surplus labor for goods that provide greater utility negating their investments in tree planting.

The material assets variable is a proxy for wealth such that those households with cars, motorbikes, television sets, and refrigerators are wealthy while those who do not have are poor. The regression results for IQL since settlement show that wealthy households are less likely invest in terracing, contour bunds, and irrigation facilities and more likely invest in tree planting. This relationship is however, weak although various researches in some areas (Clay, 1998 and Shively, 1996) found that wealthy households are capable to have their lands under fallow and also, they are not compelled to undertake investments to meet their daily needs for food and cash.

The insignificant effect plus endogeneity problem of the material assets variable with IQL makes the result difficult to interpret.

5.5.2 Farm characteristics

The farm characteristic variable that is statistically significant at the 99 percent level is the number of years of continuous plot cultivation in the regression for investments in agroforestry and/or tree plantation. It is insignificant (but negative) for investment at settlement in terracing, contour bunds and irrigation. Platteau (1996) theoretically described a scenario of farmer's 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. But, the results of the regression suggest that the longer the plot is cultivated, households are less likely to invest leading to the Malthusian 'poverty trap'. However, because I do not have a given exogenous measure of fertility at the point of investment, I used the period of cultivation till investment as a proxy. This proxy, however may suffer from endogeneity as it is defined in terms of the investment 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[4] indicate the ambiguous effects of this variable to 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 labor constraints to undertake conservation investments. Likewise, large farmers could allow plots to fallow such that they are less pressured to undertake conservation investments. In similar vein, households with smaller landholdings are more likely to undertake IQL than households with large landholdings because those with smaller landholdings might have recognized that IQL are vital to their livelihoods in the short run as well as in the future. In contrast, Feder and O'Mara (1981), Fujisaka (1993), and De los Angeles (1986) found out that farmers with large landholdings are more likely adopt soil conservation.

The insignificant positive relationship between investments and distance of plots to home as shown in the regressions indicate that other factors might have influenced investment decisions of households, such as; planting of trees on

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

land boundaries, profitability of investments regardless of distances, and advances in technology.

Investments in land quality are more likely in plots with steep slopes for terracing, contour bunds and/or irrigation facilities which maybe due to greater returns to conservation investment (Adegbidi *et al.,* 2004 and Pender *et al*, 1996) considering the effects of this variable to the expected costs and benefits of conserving the plots. Likewise, investments in terracing, contour bunds and/or irrigation facilities are more likely in clay loam soil types but investments in agroforestry and/or tree plantation are less likely invest for this type of soil. Although the relationship is weak, this result reflects the preference of farmers in making terraces and contour bunds in lands with clay loam soil types.

For village dummies, the regression analysis shows that controlling for the differences in household and farm characteristics, farmers in Balete are most likely to invest in terracing, contour bunds and/or irrigation facilities. In particular the probability that these investments are undertaken in Balete is 9 times higher than in Villa Florentino. Farmers in Kapatalan are most likely to invest in agroforestry and/or tree planting, but less likely in terracing, contour bunds, and/or irrigation facilities. Among the villages and compared to Villa Florentino, farmers in Quibal are least likely to undertake IQL.

5.6 Investment decision factors: reflections on the hypothesis

The econometric analyses discussed above provide empirical evidence that household-specific variables, farm characteristics as well as village conditions influence households' decisions on investments in land quality. The econometric evidence presents a set of findings that characterize the trends of IQL in my study villages. These findings may conform or contrast my hypotheses which were developed from previous researches.

Old people invests more

Age of household heads significantly influences IQL; i.e., older household heads are more likely to practice sustainable land use systems than younger ones. This shows a life-cycle effect on investments which means that as the household heads grow older they were able to save enough money and gained knowledge and skills for IQL. On the other hand, this result also indicates that IQL have been undertaken in a staggered and continuous manner such that the household heads have accumulated more as they grow older.

The experiences in upland environment of older households might have generated their willingness to undertake IQL realizing that they can easily recover the costly investments on their lands even if the benefits can only be derived over a longer period. For example, the Ifugao tribes have been known to undertake massive terracing in the Cordillera Mountains known collectively as, Banaue rice terraces. The households' perception of leaving the trees they planted to their children is also a positive factor for the older households to invest on their lands. This perception is usually expressed when households are informally asked why they are willing to undertake costly investments.

More people, not more investment

The increase of household size and man-land ratio does not lead to more investments. This is opposed to Boserup's theory of agrarian change and Tiffen's observation in Kenyan agricultural development. This discrepancy maybe explained by that we may have different socioeconomic environments like labor market that also influence household decisions. Chayanov (1966), for example, concluded that farm labor input depends on household composition only in cases of missing or imperfect labor markets. In such situations, an increase in the household size would lead to IQL. In my study areas however, households can easily find farm labor that could be tapped for any farming activities including IQL. Reversedly, large households can also participate in wage labor in other farms or in urban areas where labor is in demand.

Additional income apart from farming is important

Income generated from off-farm, non-farm and self-employment are utilized by the households to finance IQL. This is based on that households value their lands so much as their main source of livelihood. Farming produced their subsistence level or even a surplus production such that any income outside of the farm can now be used for land improvements. This is in conformity with my hypothesis that off-farm income provides the necessary capital for investments in sustainable land use systems. Clay (1998), from a study of Rwandan farmers, supports my findings who concluded that non-farm income is 'an important source of own liquidity.' In an economy of underdeveloped or imperfect credit markets, nonfarm income is used to buy material and labor inputs needed for sustainable farming.

In contrast to my 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. Farmers had shown reduced interests in farming some of whom have started businesses that competed not only for capital investments but also labor. This contradiction may be due to the situation in my study villages in which households look at small businesses (*sari-sari* store, handicraft, etc.) not competing with farming but, instead small businesses are supporting farming both as a strategy to generate capital for investments and as marketing outlets of production outputs. Likewise, the households are able to make adjustments in their schedules such that activities in businesses conforms with land investments because farming is still considered to be a top priority and that business is not a prime option for the households.

It's what households know that determines investments

Knowledge of soil conservation techniques enhances IQL such that households who have more knowledge gained from whatever sources have more tendencies to follow sustainable farming. Sustainable farming practices, such as agroforestry and tree farm establishments, building of terraces, and contour bunding, that are promoted in extension programs, have all contributed to farmers' adoption intensity of IQL. Clay *et al.* (1998) observed that, in Rwanda, farmers who had more exposure to soil conservation technologies are more capable to establish hedgerows than other farmers.

Does tenure really matter?

Households' control of land through the various forms of security of tenure existing in the Philippines does not significantly influence IQL. This may be due to the policy of the government that allow households to obtain *de facto* if not *de jure* land rights using investments as evidences for their long stay in the lands. Likewise, investments in land quality, such as terracing, agroforestry, and tree planting, are promoted by the government in extension programs which served as good evidences to show their capability to protect the forest environment.

The importance of farm characteristics

Farm and plot variables are important considerations for IQL. Households are less likely to make investments in their plots with longer cultivation period and more likely to invest in plots that are located in steeper slopes. They tend to do less IQL after exhausting the fertility of the soil due to longer cultivation which the households felt or perceived when the yields of annual crops are declining. Thus, decreased income from farming due to declining yields of crops jeopardized the capacity of the households' shift to sustainable land uses. In this situation, government and non-government assistance is very important to help households sustain their needs during the process of improving the quality of the land because the benefit from the investments in the land is in the long run.

Investments in land quality (terracing, contour bunds and/or irrigation facilities) are also undertaken more in steeper slopes probably because households have knowledge of the severity of soil erosion and its effects on their livelihoods. Thus, investments to conserve the land pay a high return as well as ensure sustainable farming income. This trend is consistent with the research findings of Clay *et al*. (1998) from Rwanda concluding that farmers tend to make more conservation investments in lands of medium steepness.[5]

The households did not show preferences to undertake investments in land quality in plots that differs in the types of soil. However, the clay loam soil is described by the households as sticky with low soil fertility but it is favourable for terracing because of its high water holding capacity. Hence, households adopt

[5] But households are discouraged to make investments in lands with the steepest slopes.

conservation investments in plots with clay loam soil especially when other favourable physical conditions are found out, such as adequate source of water supply and availability of rock and soil materials needed for terracing. Households perceived their *kaingin* plots to have sandy loam soil types that contain high soil nutrients so that they are less likely do IQL on these plots.

The village-level effects of IQL: the role of ethnicity and the government
Each village can be characterized by the concentration of the major IQL. Households in Balete are mostly investing in contour bunds and irrigation facilities with little investments in tree planting and terracing. They are perceived to continue investing on these IQL. Tree planting can be observed mostly in Kapatalan but they tend to plant more fruit trees rather than the traditional coconut-based agroforestry. Although households in Quibal invest the least as compared with the other barangays, they tend to plant both forest and fruit trees. Households in Villa Florentino are investing in all major IQL but more on terracing and irrigation facilities. Since trees are perceived to be an integral part of terraces, they tend to plant more trees especially in upstream watersheds to maintain continuous water supply. In support to crop diversification, particularly vegetable production, making of contour bunds are also gaining importance.

Thus, IQL might have been influenced not only by household and farm variables but also ethnicity and public policy variables. 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 mountain, 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.

The role of government in IQL should not be discounted. As described in Chapter 2, upland development projects implemented since the 1970s have various effects in the four villages. Although hedgerows promoted in these projects are not well adopted, households in the villages persistently adapted farming techniques consistent with their traditional knowledge and skills and the government objectives of forest protection. For example, ISFP, later known as CPEU, has been implemented in Balete which promoted the adoption of hedgerows, agroforestry, and communal reforestation for the project participants. Now, contour bunds are used by the households instead of hedgerows which proved to be effective in controlling soil erosion. Households in this village also adopted various types of agroforestry and reforestation which conform with what are promoted by the government.

Before the implementation of ISFP in 1989, households in Kapatalan were already practicing some forms of agroforestry that emerged in response to environmental conditions prevailing in the area. The projects' contribution to forest protection is observed to be significant on the households' continuity of developing their agroforestry and establishing forest plantations.

Households in Quibal are doing the least IQL. Before CFP, their primary source of livelihood was illegal logging and fuelwood gathering. The implementation of CFP in early 1990s has created awareness among villagers of the need to protect the forests. In addition, households participated in the project's income-generating activities such as reforestation and agroforestry establishment. Today, households went back to upland farming, planted trees either in land boundaries or within their plots, and established mango-based and banana-based agroforestry.

No government projects have been implemented in Villa Florentino but I see the local government unit's role in their IQL. Being one of the registered *barangays* of the municipality of Diadi, *barangay* officials received funds from the government through the municipality, known as Internal Revenue Allotment (IRA). This is calculated based on population, revenue collected from economic activities present in the village, and physical area of the village. Part of this fund is used for honorarium of the village officials while the other portion is used for village infrastructure. The officials are then required to submit reports regularly concerning people's needs and the village development plans in the areas of social services, agriculture, and environment. Through regular visits and evaluation of accomplishments, village households are pressured to do the IQL with little assistance from outside to show to the 'outside world' their capability to protect the forest resources adjacent to their settlements. Years earlier, they rejected an effort of DENR to include them in an ISFP implemented in the adjacent village. Their negative response to the project should not be understood as a refusal of the idea of conservation and conservation strategies encouraged by the project, but more of the provisions of the project and the fear that their lands be taken by the government once the project is implemented. Thus, this challenge to do IQL without ISFP and with LGU support encourages them to do more investments. This is reinforced by the cultural factors of Ifugao identity; that is, rice terraces as a symbol of high social status, the need to give terraced plots as inheritance to their male children and their pride of the Ifugao exploits in the famous Banaue rice terraces.