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Living on the margin: Assessing the economic impacts of Landcare in the Philippine uplands

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In the Philippines, about 38 per cent of the population resides in rural areas where poverty remains a significant problem. In 2006, 47 per cent of all households in Bohol Province fell below the national poverty line, with the percentage even higher in upland communities. These households often exist in marginal landscapes that are under significant pressure from ongoing resource degradation and rising input costs. This paper first explores whether the adoption of Landcare practices in a highly degraded landscape has resulted in improved livelihood outcomes for upland farming families in Bohol. Second, it analyses the potential for the piecemeal adoption of these measures to deliver tangible benefits at the watershed scale. Finally, using a BCA approach, these outcomes are compared to the costs of the research and extension projects that have helped achieve them.

Key Words: Landcare, Philippines, livelihoods, poverty, watershed, ACIAR

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Introduction

Soil erosion remains a well-recognised problem in the Philippines uplands, resulting in a number of direct and indirect impacts on the livelihoods of the rural poor. Furthermore, the role that upland farmland plays in the provision of ecosystem services is increasingly being valued by the regional and global community. These services include watershed protection, carbon sequestration, and biodiversity, all of which are influenced by the livelihood activities of upland households. The challenges in these marginal upland areas are thus threefold: first, to increase the standard of living of rural communities through improvements in agricultural productivity; second, to achieve these increases without further undermining the capacity of future generations to maintain and improve their own standard of living; third, to provide the ecosystem services desired by the wider community without unfairly burdening rural communities that are already at the margin of survival.

In assessing the economic returns to investments in soil and water conservation (SWC), Blaikie and Brookfield (1987) concluded that only lands with high potential that are not yet badly degraded but under imminent threat provide an unequivocally good return on investment. Lands that are already degraded, particularly in the tropics, are typically difficult and expensive to rehabilitate when compared to the potential stream of benefits the investment may yield. In these circumstances, they argue, it is all the more necessary to give due weight to the option value of land, particularly when it is likely there will be no alternative means of livelihood for land-users in the foreseeable future (Blaikie and Brookfield, 1987, p 247).

The participatory development of cost effective alternative means of controlling soil erosion, such as those promoted by the Landcare Program in the Philippines, increased the adoptability of SWC for many upland households by reducing the high labour requirements associated with the construction of rock-walls, hedgerows, or bench terraces. While in absolute terms the benefits of investing in SWC in biophysically marginal environments may still remain economically marginal, the livelihood impacts generated through small increases in household income may be significant from the perspective of the adopting households, often surviving on income levels below the poverty line. At the same time, individual adoption of simple SWC can deliver additional benefits for fragile upland environments, with many of these benefits spilling over beyond the parcel or farm boundary. Therefore, where the operational and transaction cost associated with the programs that help bring about the adoption of these measures are minimal, investment in research and extension programs that induce SWC, even on marginal land, may achieve both positive private and public economic benefits.

The Landcare Program in the Philippines arose in the mid-1990s out of efforts by what was then the International Centre for Research on Agroforestry (ICRAF) and local farmer groups to promote SWC innovations among upland farmers in Northern Mindanao. The central practice that came to be rapidly and widely adopted in this region was natural vegetative strips (NVS) – unploughed contour strips taking up 10-20 per cent of a given field that provided a barrier to movement of soil and water down the slope and led in a few seasons to the formation of terraces. The technology is a low cost farmer adaptation of the contour hedgerow systems that were previously promoted in the region, but not widely adopted in its original form (Cramb 2000). Furthermore, the construction of NVS has often been the catalyst for additional livelihood investments, with many strips subsequently "enriched" with crops such as bananas and pineapples, and timber and fruit trees have also been incorporated into the farming system.

In this paper we evaluate the on-farm and watershed impacts of the Landcare Program in the Province of Bohol (Figure 1). The Program has been operating in over 20 upland barangays (villages) of three municipalities – San Isidro, Pilar, and Alicia – beginning in 2000. Central to the analysis is the livelihood outcomes that have stemmed from the adoption of NVS. Based on a livelihoods analysis, we show how the stabilisation of upland plots has induced various farm developments that have led to improved incomes for adopting households. We then analyse the opportunity costs arising from sediment accumulation in a reservoir located in the Municipality of Pilar. Using spatial watershed analysis, we evaluate the potential of Landcare to mitigate these impacts. Finally, using a benefit-cost analysis approach, these private and public outcomes are compared to the costs of the research and extension projects that have helped to achieve them.

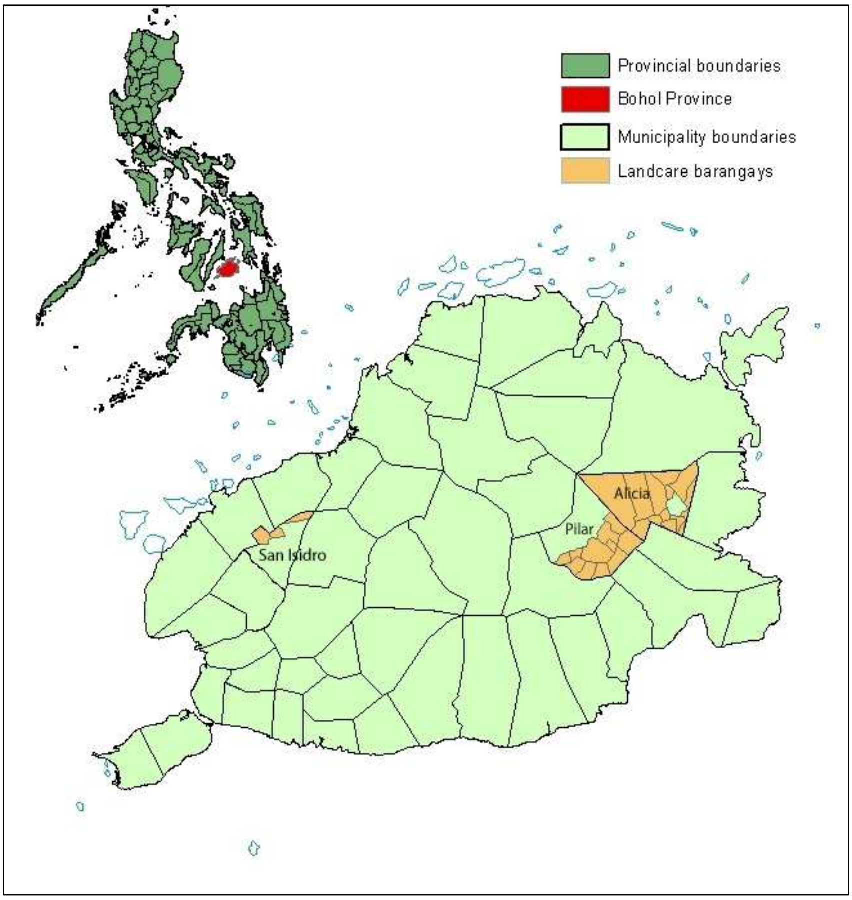

Figure 1 – Landcare extension sites in Bohol

A marginal upland existence

In the context of the Philippine uplands, the marginal existence of rural households is a multidimensional and interrelated concept (Blaikie and Brookfield, 1987; Cramb, 1998, 2007). Biophysically, the barangays in Bohol where the Landcare Program has been operating are characterised by severely degraded upland slopes and declining agricultural productivity. Large tracts of upland slopes have either reverted to relatively unproductive grasslands or are opportunistically cropped using surplus household labour in between the more productive paddy rice activities. The declining productivity makes the cultivation of most upland crops economically marginal, especially where resources (land, labour and capital) beyond the household's own supply are required. Therefore, for many upland households the production of crops such as maize, sweet potato, and cassava occur only at subsistence levels utilising minimal purchased inputs such as synthetic fertilisers or hired labour. Furthermore, recent increases in the cost of fertiliser have seen a further reduction in their use, making the problems of soil degradation even more apparent and resulting in ongoing changes to the farming activity mix.

In the Philippines, around 38 per cent of the population resides in rural areas and depends on agriculture as a source of livelihood (World Bank, 2007). Poverty in the country remains a significant problem, especially in marginal upland communities where a high percentage of households live below the poverty line. According to AusAID "poor productivity growth in agriculture, under-investment in rural infrastructure, unequal land and income distribution, high population growth and the low quality of social services lie at the root of rural poverty" in the Philippines (AusAID, 2008). These factors combine with increasing environmental and economic uncertainty, limiting the capacity of upland households to access the resources required for productivity growth or even to maintain their fragile foothold in the landscape.

Nationally, poverty is defined using two indicators – the income threshold and the food threshold. The income threshold refers to the minimum income required for an individual to meet their basic food and non-food requirements. The second and more severe measure of poverty, the food threshold, refers to the "minimum income required for an individual to meet the basic food needs which satisfies the nutritional requirements for economically necessary and socially desirable physical activities" (National Statistical Coordination Board 2008). Figure 2 shows the national incidence of poverty compared to that found in Bohol for 2000, 2003, and 2006.

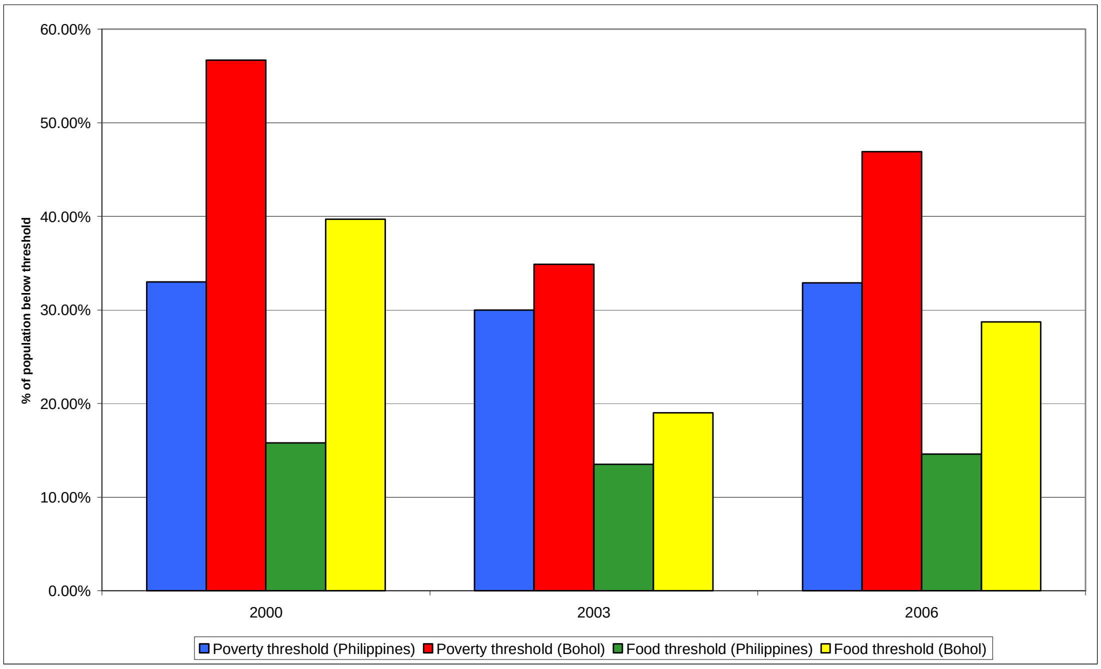

Figure 2 – Incidence of poverty in the Philippines and Bohol (2000 to 2006)

The changes in the incidence of poverty (Figure 2) cannot be viewed in isolation. As can be seen in Table 1, these poverty thresholds are dynamic in nature and are calculated each year based on the cost of living in a given location. For the Philippines as a whole there was little change in the percentage of the population below the income and food thresholds from 2000 to 2006. However, the number of households in Bohol whose income was not sufficient to purchase the basic food requirements increased from 2003 to 2006 (after a period of decline from 2000 to 2003). This is in part the result of a significant increase (32 per cent) in the estimated costs of subsistence over the same period. Therefore, while there may have been some improvements in nominal rural incomes over time, a large percentage of rural households survive at income levels around the poverty line, and can therefore fall on either side as a result of small changes in the costs of living.

Table 1 – Poverty and food thresholds for the Philippines and Bohol Province

Poverty Indicator (PHP/annum)	2000	2003	2006
Poverty threshold (Philippines)	11,458	12,309	15,057
Poverty threshold (Bohol)	9,762	10,032	13,610
Food threshold (Philippines)	7,707	8,149	10,025
Food threshold (Bohol)	6,851	7,424	9,803

Data source: National Statistical Coordination Board (2008)

Putting some perspective on these figures, in 2006 a family of five residing in Bohol would need to earn approximately PHP 186 (AUD 4.91) per day to meet their daily needs, of which PHP 134 (AUD 3.53) would be required to feed the household. Yet in 2006, around 47 per cent of all households in Bohol could not meet their basic needs. Furthermore, in many of the upland communities where Landcare has been operating the statistics suggest that over 90 per cent of the population are gripped by poverty.

Over 50 per cent of the population residing in both the municipalities of San Isidro and Pilar were considered to be living below the food or subsistence threshold in the census carried out in 2004 (Table 2). This means that over half the population did not have the minimum income required for the household to meet the basic food needs to satisfy nutritional requirements (PHP 8,161). Moreover, over 68 per cent of the population fell below the income threshold which refers to the minimum income required for a family to meet its basic food and non-food requirements (PHP 10,989).

Table 2 – Poverty Indicators for Bohol

BOHOL	**INCOME/YEAR**	
Food threshold (2004)	PHP 8,161	
Income threshold (2004)	PHP 10,989	
	San Isidro	**Pilar**
% below food threshold (2004)	50.3	54.0
% below income threshold (2004)	68.4	68.9

The Landcare Program is not implemented across the board within these municipalities, with the activities concentrated in those upland barangays where the technologies are seen as most appropriate. In San Isidro, for instance, the program has been implemented in only three villages – Baryong Daan, Candungao, and Masonoy. Figures 3 and 4 illustrate the average household income and the percentage of households below the income threshold in 2004 and 2007 for all villages in San Isidro. As can be seen, limited income growth in barangays such as Baryong Daan resulted in a significant increase in the number of households deemed to be under the income threshold. Alternatively, both Candungao and Masonoy experienced increases in average household incomes (PHP

11,592 and PHP 13,323 respectively) from a lower initial level, and a reduction in the number of households categorised as living below the income threshold.

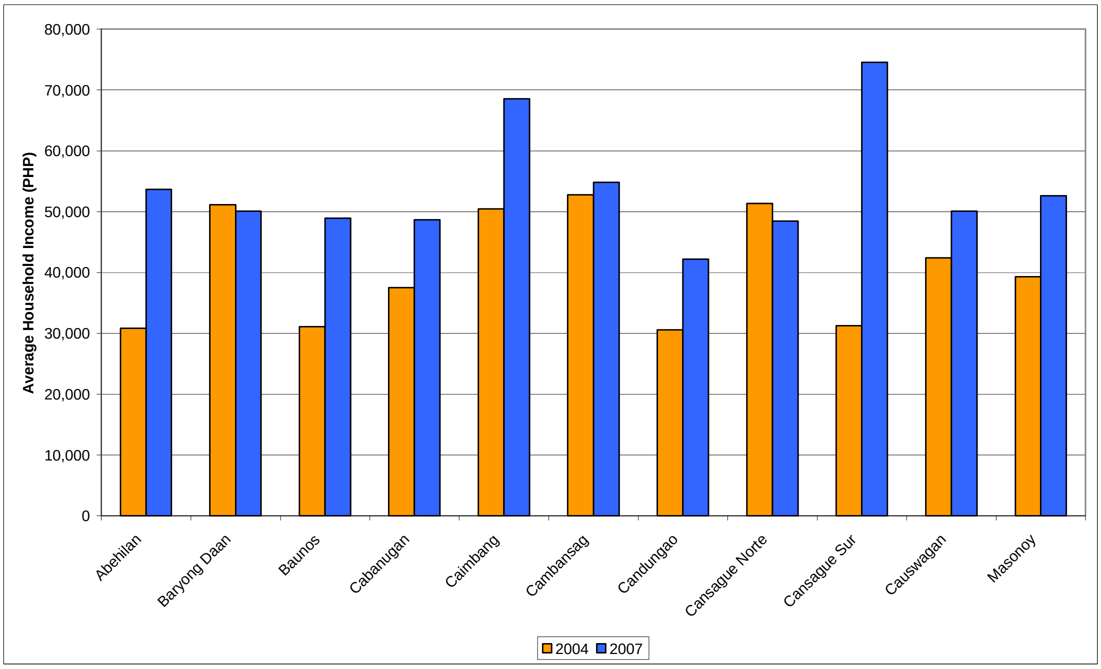

Figure 4 – Change in average household income in San Isidro, Bohol, by barangay (2004 -2007)

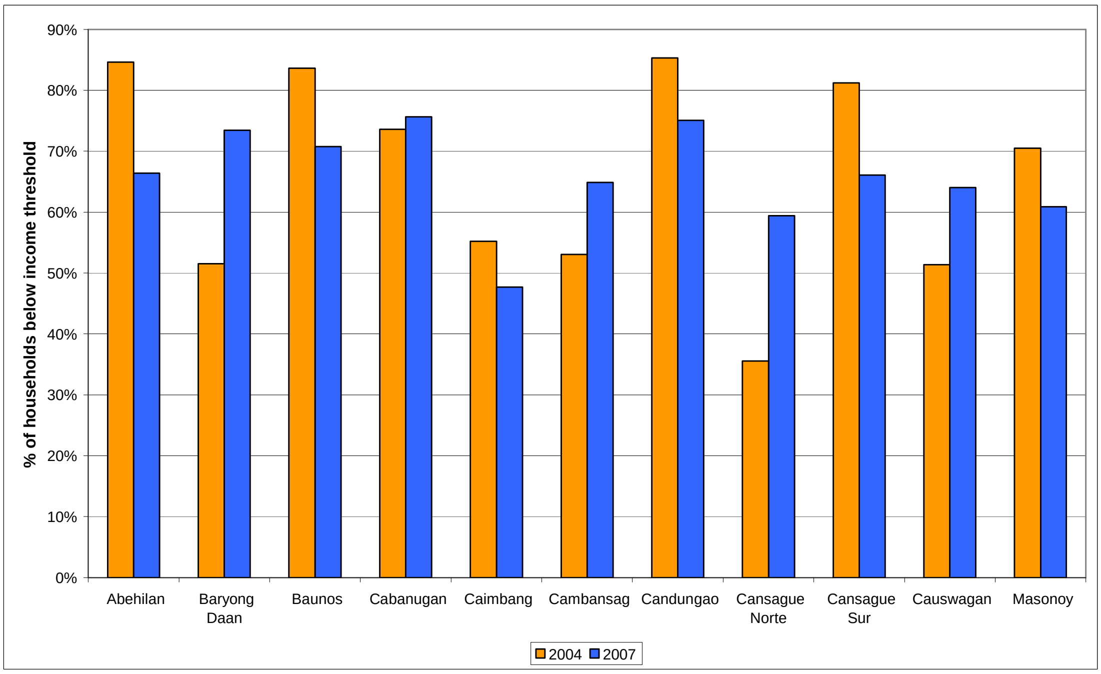

Figure 5 - Percentage of households in San Isidro below the poverty threshold in San Isidro, Bohol, by barangay (2004 – 2007)

These figures demonstrate that, in a period of increasing farm input costs and basic food prices, productivity growth is vital to maintaining basic living standards in these upland villages largely based on subsistence production. Furthermore, even small changes in household income can have meaningful livelihood outcomes for households that currently cannot meet their basic needs. In 2004, for example, PHP 2,828 was seen as the difference between an individual being only able to meet their daily food requirements, and being able to meet other basic non-food requirements.

However, the question remains: Can the adoption of SWC practices deliver income benefits for adopting households in such a biophysically marginal environment? In 2006 102 household surveys were conducted with both adopters and non-adopters of landcare practices in the municipalities of San Isidro and Pilar to determine the onsite impacts of adopting landcare practices. Respondents were surveyed regarding the household's current livelihood activities, crop and livestock production and sales, land degradation problems, motivations for adopting SWC and agroforestry practices, reasons for non-adoption, perceived benefits of adoption, changes in input usage, and future plans for the farming system. This information was supported with information gathered during interviews with farmer groups and key informants.

Landcare in the uplands of Bohol

The Landcare farming practices have been evolving overtime to suit the biophysical and socioeconomic constraints of farmers in several sites in the central and southern Philippines, including the Province of Bohol (Newby and Cramb, 2007). Landcare in Bohol had two distinct phases. The research phase (2000-2004) involved an on-farm research project (implemented by ICRAF and funded by AECI, the Spanish government aid agency) that introduced NVS and agroforestry practices in San Isidro. From 2005, the Philippines-Australia Landcare Project (funded by ACIAR and AusAID) implemented an extension phase in San Isidro, Pilar, and Alicia, through training in contour farming, nursery establishment, and tree propagation; cross-site visits to San Isidro; and collaboration with municipal agricultural staff.

The success of the expansion of the Landcare Program from Mindanao to Bohol hinged on the fit between the technologies and farmers' livelihood assets and strategies. As in Mindanao, there was rapid adoption of the various Landcare practices (Figure 6), particularly during the extension phase post-2005. This was despite the marked biophysical and agronomic differences between the farming systems in Bohol and northern Mindanao (Newby and Cramb 2007). In particular, in Mindanao acid upland soils predominate and the major subsistence and cash crop is maize, whereas Bohol has calcareous soils and the dominant farming system combines lowland rice for subsistence and coconuts for cash.

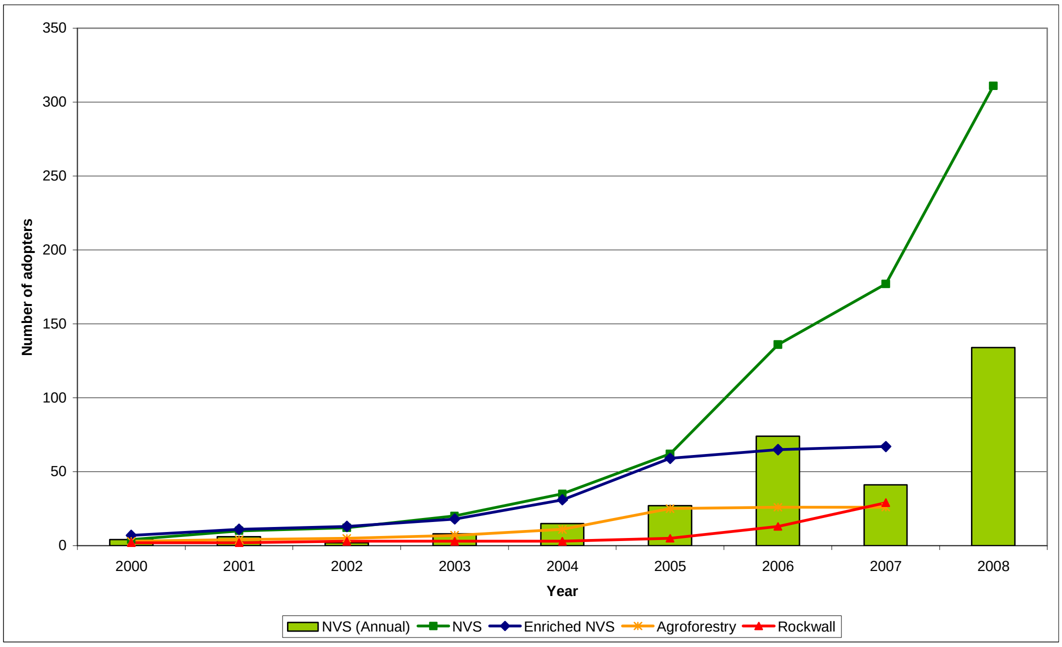

Figure 6 – Adoption of Landcare practices in Bohol

In addition, whereas in Mindanao NVS was adopted on the main farm, in Bohol adoption occurred on supplementary plots that were used for maize, roots crops, and vegetables, or had been left fallow due to prolonged degradation and were used for grazing. Likewise the labour allocated to these plots tended to be spare labour in between the peak periods for rice and copra production. Hence adopters tended to produce more maize, vegetables, and root crops than non-adopters (Figs. 7 and 8) as the implementation of NVS encouraged them to bring degraded land back into production and/or add more inputs because of the now improved returns.

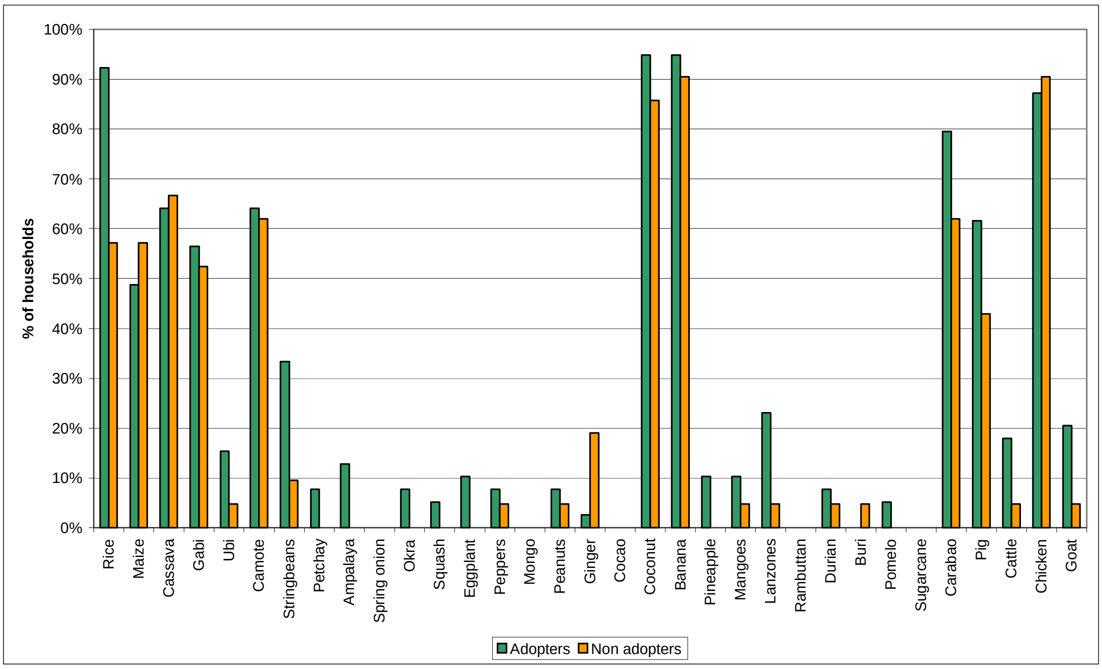

Figure 7 – Farm activities of adopters and non adopters in San Isidro

The evidence from both Mindanao and Bohol suggests that the initial adoption of NVS creates a stable platform on which other livelihood activities can be built. Perennial crops such as bananas and pineapples can be planted in the NVS at the same time or soon after the establishment of the strips (so-called NVS "enrichment"). Vegetable crops in the alleys also soon become feasible once soil erosion and runoff have been reduced and natural terrace formation occurs behind the contour strips.

In San Isidro, it was largely only NVS adopters who were growing vegetable crops beyond household requirements to sell in nearby markets. Almost all farmers in San Isidro had some coconut palms and bananas somewhere within their farm. Adoption of NVS typically resulted in the expansion of these activities by planting them along newly established contour lines, often on land that was previously fallow. Some farmers were also beginning to diversify their banana production by planting varieties with a higher market value when sold beyond the local barangay markets. A large number of adopters had also integrated fruit trees into their farms, either along the contour or on the farm boundary. In the current phase of the Landcare Project, agro-enterprise training is being conducted with farmers so that they can better meet the quality and quantity demands of markets beyond the local area. However, changes in these production techniques need to be evaluated against the resource constraints of the overall farming system. For example, more intensive activities in the uplands may begin to utilise labour beyond the surplus available between the household's paddy rice activities.

In Pilar, adopters were more likely to grow maize and, as in San Isidro, to have integrated vegetable crops into their newly contoured parcels. The higher proportion of adopters engaged in maize cropping (73 per cent compared with 42 per cent for non-adopters) was also influenced by the provision of hybrid maize seed to some adopting farmers by the municipal government. Adopters were also favoured in the distribution of planting materials for pineapples, fruit trees, and coconuts.

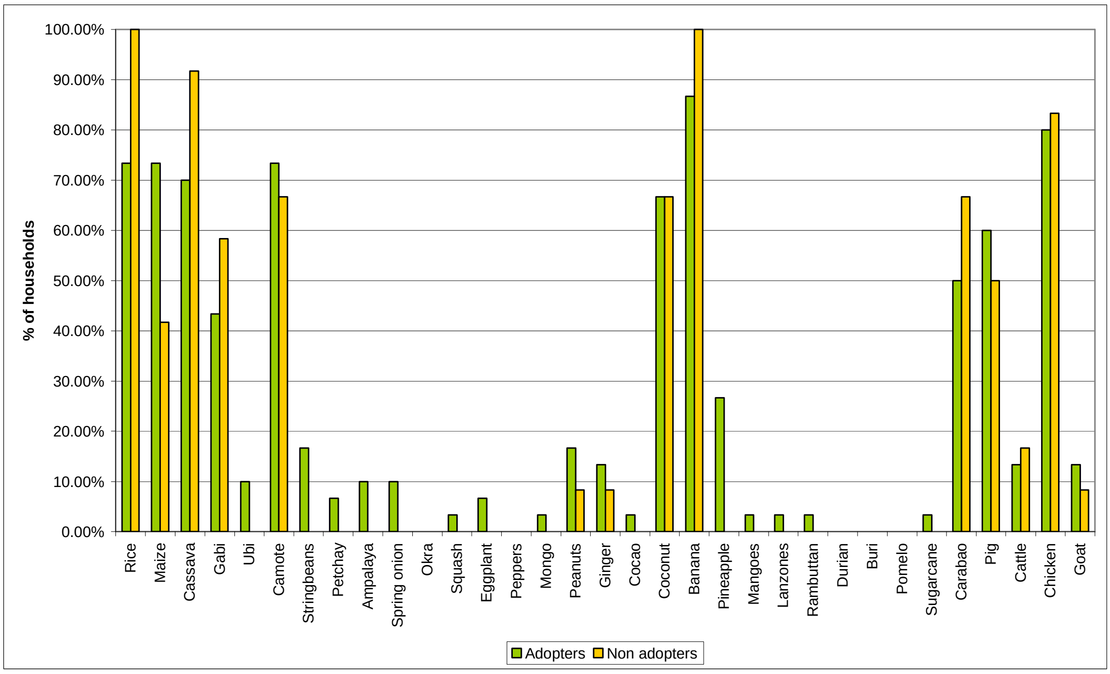

Figure 8 – Farm activities of adopters and non adopters in Pilar

Farm development pathways

During the wider household survey it became apparent how diverse and dynamic the farming systems were, with farm activities changing from season to season. At the household level, the livelihood impacts of adopting contour farming and other agroforestry systems depended largely on the initial livelihood platform an individual household could draw on to support further farm developments. This platform included access to land and labour resources; the existing level and frequency of cash income; the current food security situation; and the resilience of the household to unfavourable production conditions. Beyond these factors, livelihood activities were also influenced by access to social capital as well as interaction with a range of government and non-government programs that provided training and support for agricultural activities.

Given the wide diversity in circumstances facing farming households throughout the uplands of Bohol, the scope and magnitude of impacts at the household level are also highly variable. Furthermore, the process of farm development is an ongoing one with households continuing to respond to a range of internal and external pressures, making investment decisions as resources become available. For example, small shocks such as the death of a water buffalo, used for draught power, can have large implications for a household's activities. Therefore, the impacts described in the following section should be viewed as a 'snapshot' of the extent of impacts that have arisen within farming systems influenced by the Landcare Program in Bohol.

A series of six case studies conducted from 2006 to 2008 are used by Newby (forthcoming) to capture the range of land use pathways (Figure 9) after the initial adoption of NVS. The endpoint for an individual parcel of land may lie at any point along the farm development pathway. While the general trend illustrated in Figure 9 shows a move to farming systems with a higher importance placed on commercial crops, it is important to note that these farms may also move back along the pathway in response to shocks that threaten the household's survival.

It is evident, however, that the adoption of NVS plays a critical role in facilitating ongoing farm development, but if households cannot access the resources to make the next step along the pathway (i.e., some form of enrichment) the benefits of adopting NVS in marginal environments may be limited and short-lived.

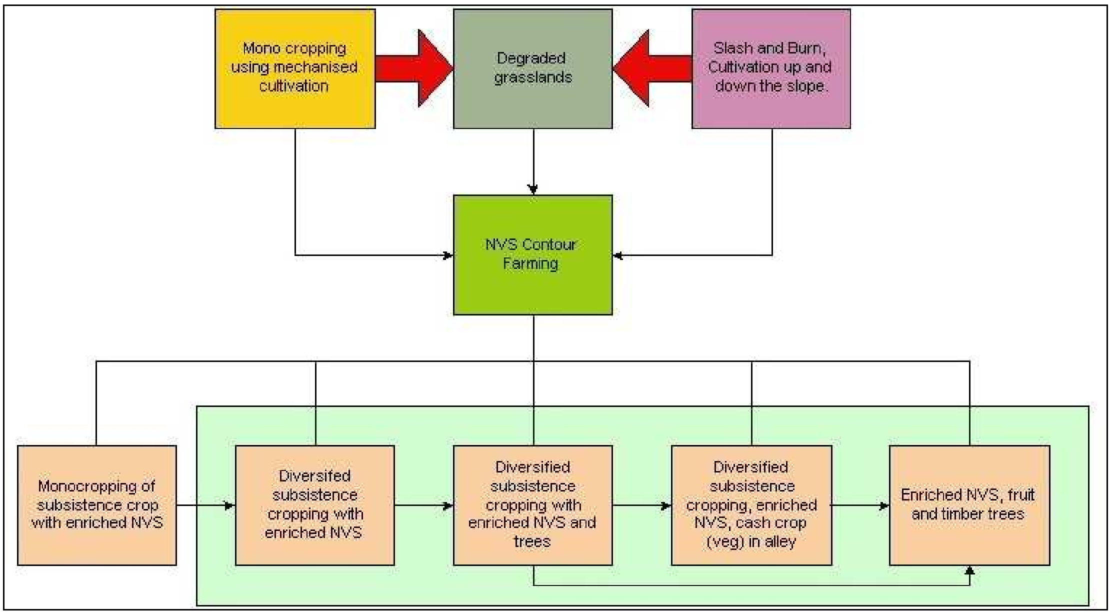

Figure 9 – Farm development pathways

Impacts on household livelihoods

Farmers who had adopted Landcare practices frequently reported having higher incomes since doing so. As indicated, this increase was largely the result of changes in farming practices made possible by establishment of contour barriers rather than any direct yield benefits in existing crops. Adoption of NVS in marginal areas does not lead to significant increases in the productivity of subsistence crops, especially where fertiliser use is already low and declining. Where adoption of contour farming was carried out on fallow land used to graze livestock, there was a perception among some recent adopters that adopting NVS would increase soil productivity, but this seems unlikely in the long term. In many cases, the relative importance of the upland parcel in terms of producing subsistence or cash crops changed over time to become more focused on the latter. This was largely where households had a reliable source of food generated from paddy activities.

For each of the activities identified by the households the level of production for the preceding 12 months, the quantity sold, and price received were recorded. These data were used to estimate the gross cash incomes of adopters and non-adopters (Table 3). Gross cash income includes the income from off-farm and non-farm activities such as carpentry, wage labour, and government honorariums. Also presented in Table 3 are the average cash incomes of adopters and non-adopters from farming activities, and the cash incomes from upland cropping activities (i.e., leaving out income from rice, coconut, and livestock activities).

Adopting commercial crops on NVS plots also increased production costs, with farmers using synthetic fertilisers and agrochemicals more freely on activities that generated additional cash flow. Given the small scale of many of the activities it was difficult to measure these costs directly. Hence costs for the various activities were estimated using key informants in conjunction with secondary data. These standard activity budgets were then used to develop ratios of net income to gross income for each crop. On this basis each of the gross cash income figures in Table 3 were converted to net cash income.

Table 3 – Average household gross and net cash incomes of adopters and non-adopters in San Isidro and Pilar (2005)

SAN ISIDRO	Adopters (PHP)	Non-Adopters (PHP)	Difference	
			(PHP)	(%)
GROSS CASH INCOME	34,968	20,012	14,956	75
GROSS FARM CASH INCOME	29,404	14,273	15,132	106
GROSS UPLAND INCOME	15,591	4,749	10,842	228
NET CASH INCOME	26,122	15,395	10,727	70
NET FARM CASH INCOME	20,558	9,656	10,902	113
NET UPLAND INCOME	11,255	3,466	7,789	225
PILAR				
GROSS CASH INCOME	23,044	22,078	966	4
GROSS FARM CASH INCOME	22,037	10,798	11,239	104
GROSS UPLAND INCOME	14,159	5,705	8,454	148
NET CASH INCOME	13,294	17,285	3,991	-23
NET FARM CASH INCOME	12,287	6,005	6,282	105
NET UPLAND INCOME	6,418	2,694	3,723	138

In both San Isidro and Pilar the gross and net cash income from upland crops was two to three times higher for adopters than for non-adopters. Apart from coconuts, the two sources of cash income that separated adopters and non-adopters were banana and vegetable production (Figure 10). These two activities were most closely related to the adoption of Landcare practices. The integration of bananas and vegetables into the farming system not only increased the absolute level of income but also the frequency of income flows. With coconuts responsible for generating such a large proportion of income but only harvested three times a year, households had to mange these peaks and troughs in income. This often resulted in farmers forward-selling the coconut harvest to a middleman at a lower price in order to purchase household goods or farm inputs (Rojo Balane, pers. com., 2008). Hence crops associated with Landcare improved the performance of the farming system in several respects.

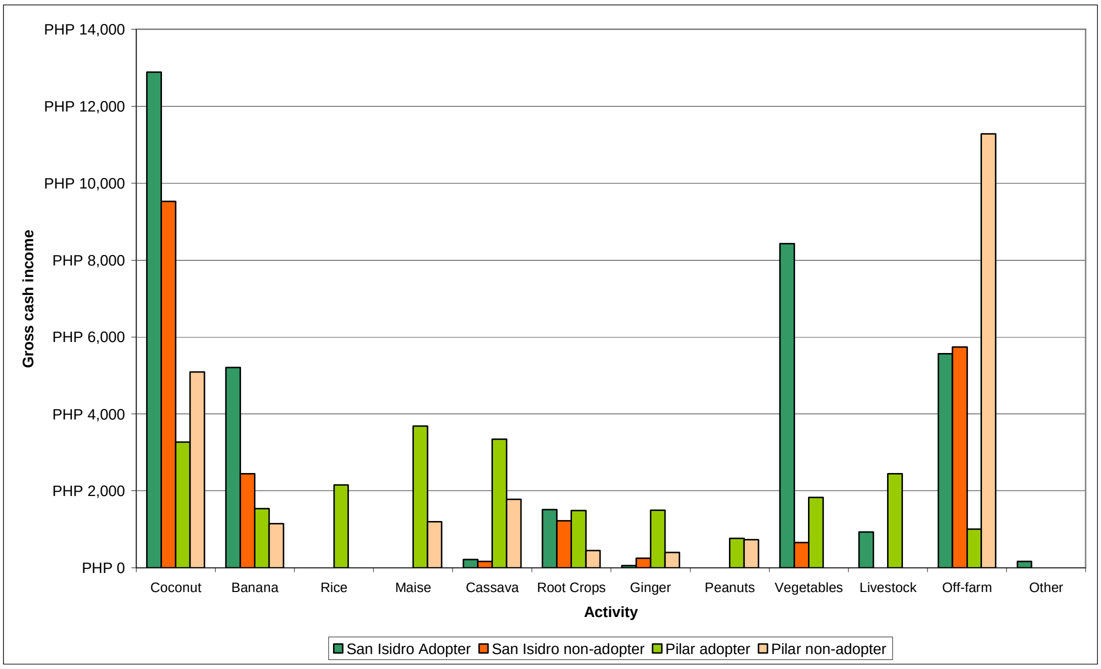

Figure 10 – Value of gross cash income derived from livelihood activities

It should be noted that these increases in income were from a very small base, often from income levels below the poverty line. Therefore, while in absolute terms these changes may seem insignificant, from the perspective of the adopting households the increases in cash income often resulted in significant livelihood outcomes. As indicated previously, PHP 2,828 in 2004 was viewed as the difference between an individual meeting only their food requirements and being able to also meet other basic needs. Given a high percentage of the population are living on incomes around the food and income thresholds, the small changes indicated in Table 3 would have significant livelihood benefits for adopting households.

The aggregate on-site benefits of adopting Landcare practices is determined by the level of adoption of NVS and the degree to which households invest in further activities made possible on the more stable hillsides. Income values were assigned to the adoption of NVS and enriched NVS based on the survey results outlined in Table 1. Given that the majority of adopters of NVS in Pilar had yet to enrich their contours, the difference in net upland income for Pilar was assigned to the initial adoption of NVS (PHP 3,723). Rather than using the incomplete enrichment data, a one year lag was assumed before enrichment would take place on these adopters' farms. It was also assumed that 90 per cent of households that adopted NVS would go on to enrich that parcel in the subsequent year, with the remaining 10 per cent remaining with NVS only. Enriched NVS was valued at the difference between the net upland income of adopters and non-adopters in San Isidro (PHP 7,789).

The estimated annual on-site benefits of the adoption of Landcare practices are shown in Figure 11. As can be seen, adoption of NVS was assumed to have peaked in 2008, meaning that enrichment subsequently peaked in 2009. In reality it is expected that there will be some ongoing adoption as a result of farmer-to-farmer transfer and ongoing activities of the municipal governments. However, the evidence suggests there is no significant spill-over to municipalities beyond the Landcare sites without some form of extension program, and that ongoing adoption within the existing sites is limited by shifting local government priorities.

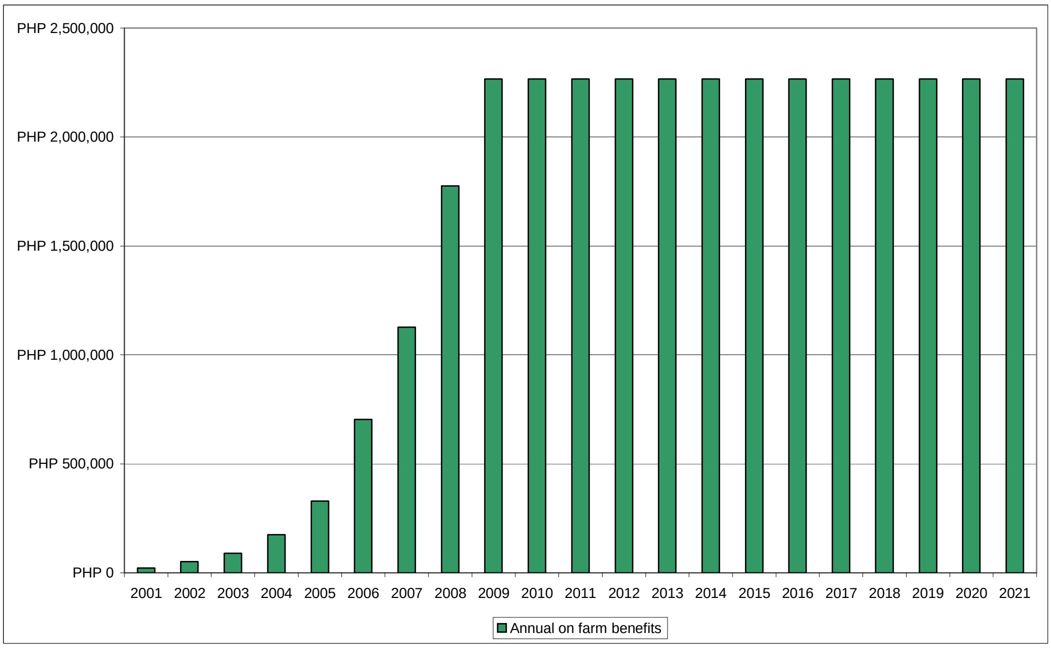

Figure 11 – Estimated annual on-site benefits of Landcare in Bohol

Offsite impacts on irrigation farmers

In Pilar, one of the clearest impacts of erosion due (in part) to upland cropping has been the sedimentation of the Malinao Dam. The dam was designed to serve about 4,960 hectares of adjoining agricultural land since 1996 and has a catchment area of about 13,800 hectares. The problem of sedimentation is acutely obvious given that much of the sediment has accumulated in the live storage component of the reservoir and can be observed as the dam is frequently empty. An estimated 400,000 cubic metres of sediment accumulated in the dam in the eight years to 2004 (BSWM 2006).

The impact of sediment accumulation in Malinao Dam is realised in the form of foregone irrigation benefits due to reduced storage capacity. Sediment that accrues in the active storage reduces the ability of the dam to capture surplus water during peak inflow events and store it for use in times of deficit. Sediment therefore reduces the airspace of the dam, leading to more frequent spills from the dam once capacity has been reached. Assuming that a cubic metre of sediment displaces a cubic metre of water, it is estimated that around 400,000 cubic metres of water storage capacity have been displaced by sediment accumulation. Any additional water that spills beyond this amount would have been lost even if no sediment had accumulated in the reservoir. Furthermore, if the reservoir is never subsequently empty then the opportunity cost of sediment is one off. For example, if the dam is at full capacity and irrigation use draws down the level by 2 million cubic metres, the water level will be at the same height in both the with- and without-sediment cases, and therefore water will spill at the same point when the dam fills again. However, once there is no water left in the live storage, the cost of sediment will be incurred again given that water could have been drawn down further if there was no sediment, increasing the airspace in the dam to capture future inflow. This is the case in the Malinao Dam, which is often empty twice a year in response to irrigation activities in the two cropping periods.

In the original feasibility studies conducted for the Bohol Irrigation Project it was estimated that the construction of the Malinao Dam would allow 4,960 hectares (100 per cent of the service area) to be cropped with rice during the wet season, and 60 per cent of this area in the dry season. It was also estimated that during the wet season each hectare would need to be supplemented with 570 mm of water from irrigation, which is equivalent to 5,700 cubic metres of water per hectare. During the dry season the requirement was estimated to be 690 mm/ha, although over the smaller target area (Table 4).

Table 4 – Malinao Dam design parameters

Season	Target Area (ha)	Cropping intensity (%)	Irrigation (mm/ha)	Irrigation (CM/ha)	System requirements (MCM)
Wet season	4,960	100	570	5,700	28.27
Dry season	2,980	60	690	6,900	20.56
Total		160	1,260	12,600	48.83

Source: JICA

The system is highly dependent on inflows and cannot store enough water to irrigate even a small fraction of its service area. In the absence of inflows the dam at full capacity at the beginning of the wet season could provide enough water to service around 18 per cent of the target area. Similarly, the main canal's capacity is 11.8 cubic metres per second and could empty the dam in around 118 hours in the absence of inflow when run at full capacity.

If it is assumed that, with sedimentation, the amount of water delivered to each hectare of land remains the same, a reduction in the area irrigated is necessary. If 100 per cent of the 400,000 cubic metres of sediment that had accumulated by 2004 had replaced active storage, then in that year 70 ha of wet season irrigated area was lost and 58 ha of dry season area, totalling 128 ha of foregone rice area due to sediment. Each year more sediment accumulates in the dam, further reducing the possible area of rice production (Figure 12). Also presented in Figure 12 are the annual values and discounted values of these losses, based on data for the per hectare net returns to rice production in the irrigation scheme (OIDCI 2006).

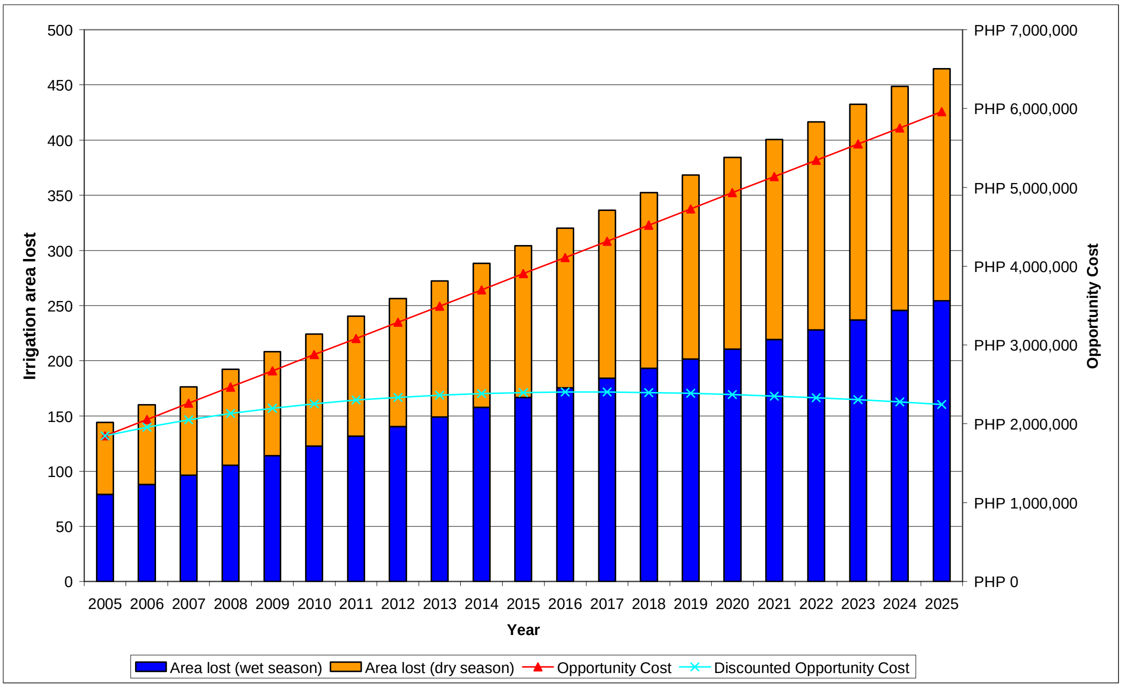

Figure 12 – Opportunity cost of sediment accumulation in Malinao Dam

While there is little doubt that sediment accumulation is reducing the capacity of the dam, in reality the significance and distribution of these impacts are largely determined by other factors, including the timing of rainfall events during the growing season, the institutional arrangements that determine the allocation of water between users, and the value of alternative land uses. Furthermore, the ability of the voluntary adoption of soil and water conservation practices in the upper watershed to mitigate these costs may be limited.

For tangible benefits to be realised at a watershed level, some critical mass of adoption is required before the plot-level impacts flow through to the wider community in any measurable quantity. The Landcare Program has provided training in soil and water conservation techniques in only a subsection of this watershed. Furthermore, the practices are targeted at upland (non-rice) parcels. While these plots produce some of the highest erosion rates (BSWM 2006), they are not the dominant land-use activity in the watershed, and there are numerous filters and sinks between the upland plots and drainage lines, including rainfed rice paddies. In Figure 13 a terrain analysis model, TauDEM (Tarboton 2003), was used to model the downslope influence of parcels of land classified as non-rice agricultural land within Pilar. This function tracks where contaminants such as sediment are expected to move through the landscape using a multi-direction flow algorithm.

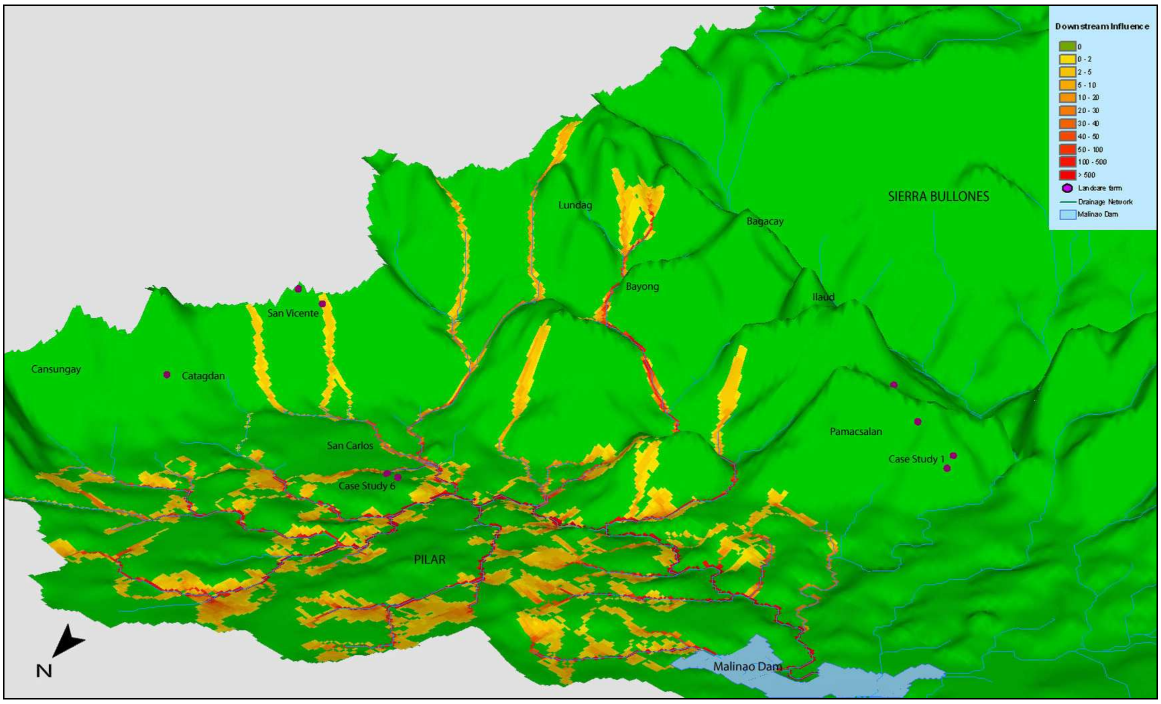

Figure 13 - Downslope influence from all non-rice agricultural land in the Municipality of Pilar

The model was used to analyse the incremental adoption of Landcare practices on agricultural land within Pilar. A transport limited accumulation function was used to determine how this land-use change influenced the relative reduction in sediment delivered to the drainage network (Tarboton 2003). Three scenarios were used to determine how progressive adoption within the target area would influence sediment delivery. First, land-use change was allowed to occur randomly within the target area. Second, those areas with the highest plot levels of erosion were targeted for adoption first. Third, the areas closest to the drainage network were given priority. The results of these simulations are shown in Figure 14.

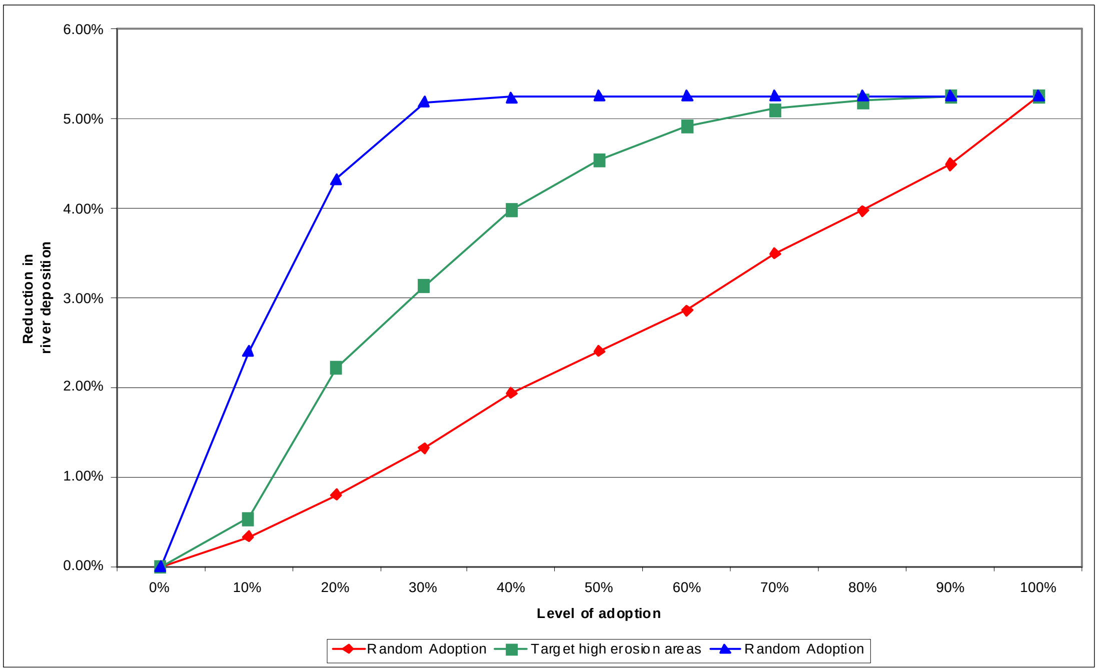

Figure 14 – Relative reductions in sediment delivery as a result of land use change

Given the relatively small percentage of the entire watershed that is classified as appropriate for contour farming, even when 100 per cent of the target area was converted to agroforestry the relative reduction in sediment delivered to the watercourses was small. The ability for land-use change to abate sediment delivery was also driven by the intensity of the simulated rainfall event. During high-flow events the conservation measures resulted in smaller relative reductions in sediment delivery, especially where high-erosion sites were targeted first.

It is recognised that the scale of the land-use classification data used was not sufficient to reflect the many small upland parcels cropped with maize and other upland crops. Nevertheless, the results show that the spatial distribution of adoption is likely to be as important as the extent of adoption when it comes to delivering off-site benefits. This reflects the views of Van Noordwijk et al. (2004) who stress the importance of the location of filters within the landscape. Even though filters may only occupy a relatively small fraction of the total area, they intervene with lateral flows and have a large impact per unit area (Van Noordwijk et al. 2004).

Using the estimates from the terrain modelling, the ability for Landcare-induced land-use change in the uplands to reduce the amount of sediment reaching the Malinao Dam was estimated. The base year was converted to 2005, with the lost capacity before this date considered sunk and irreversible. Figure 15 shows the annual benefits in saved off-site costs generated by land-use change that results in a 2, 4 and 10% reduction in sediment delivery.

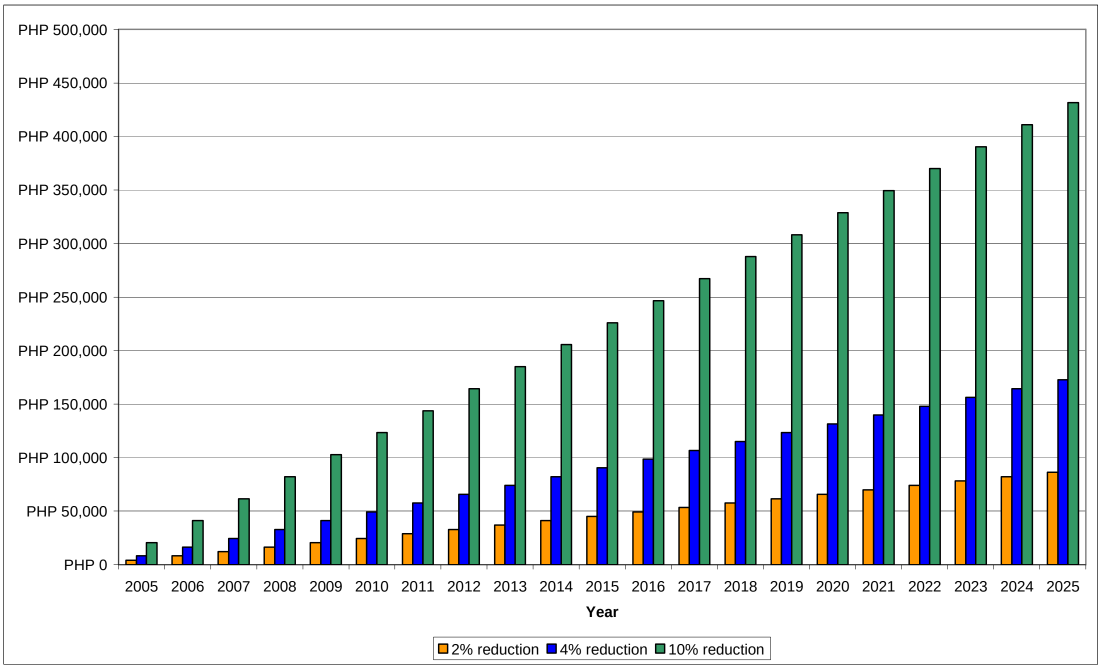

Figure 15 – Annual saved off-site costs of sediment accumulation as a result of upland land-use change.

An economic evaluation of Landcare in Bohol

The on-site and off-site benefits of the adoption of Landcare practices presented in Figures 11 and 15 appear to make a prima facie case for the Landcare intervention in Bohol. These benefits, however, need to be considered alongside the costs of the various projects that have helped to achieve the land-use changes, including the costs of the research and extension projects and the counterpart activities of local governments. These costs are shown in Figure 16. Importantly, many of the potential impacts of the initial AECI-funded ICRAF research project regarding the propagation of fruit and timber trees has not been included in the benefits, given the uncertainty regarding how these activities will perform on upland farms in Bohol.

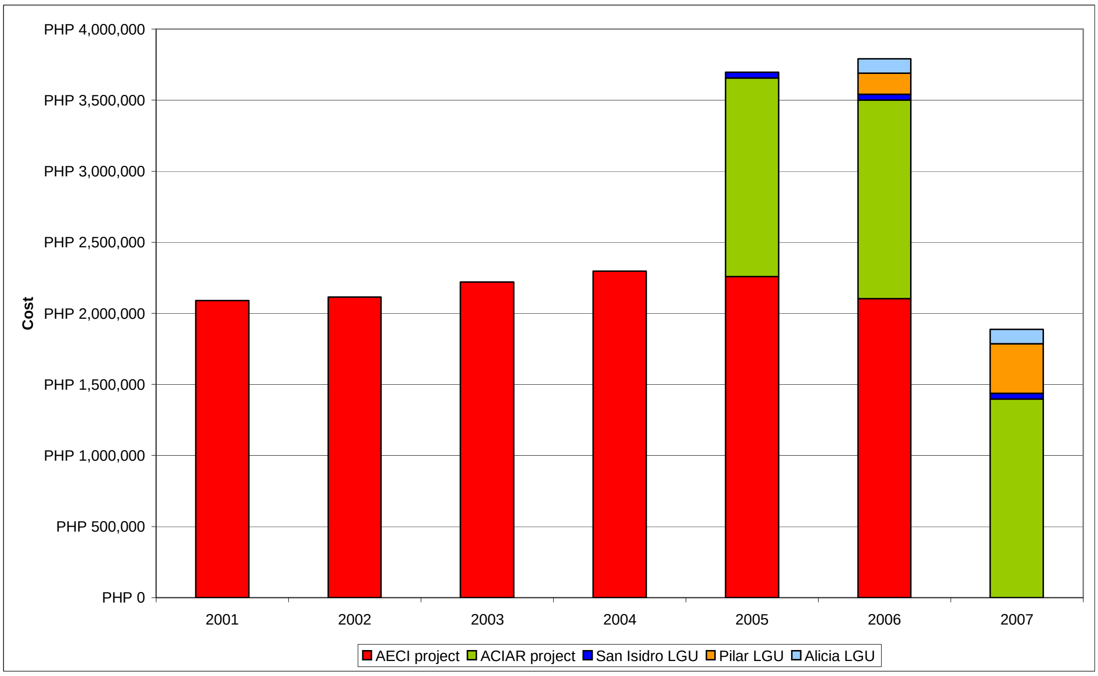

Figure 16 – Cost of the research and extension phases of the Landcare Program in Bohol by agency

The sum of on-site benefits and off-site benefits for Malinao dam are presented in Figure 17, showing that dominance of the former. There are other impacts of sediment delivered to watercourses in San Isidro and Alicia, such as impacts on coastal ecosystems, that are not included in the analysis. For example, in the Maibojoc Bay, north of the mouth of the Abatan River which drains much of San Isidro, all coral reefs have been covered to some extent by fine sediment for a length of coast of around three kilometres. According to German Development Service (DED) research, all reefs within three kilometres of the mouth of the Abatan have been destroyed by an increase in water turbidity and a further three kilometres of reefs are being covered. Given that corals need clear water and hard substrate to settle, the presence of smothered coral reefs implies a recent change in the sedimentation reaching the bay (Jose Antonio Cabo, pers. com. 2008). However, as was the case in Pilar, the relative contribution of small-scale land-use change on upland parcels is not likely to have significant impact on the total amount of sediment delivered to these coastal ecosystems. Therefore the composition of the benefits is likely to remain dominated by the on-site benefits accruing to the adopting households.

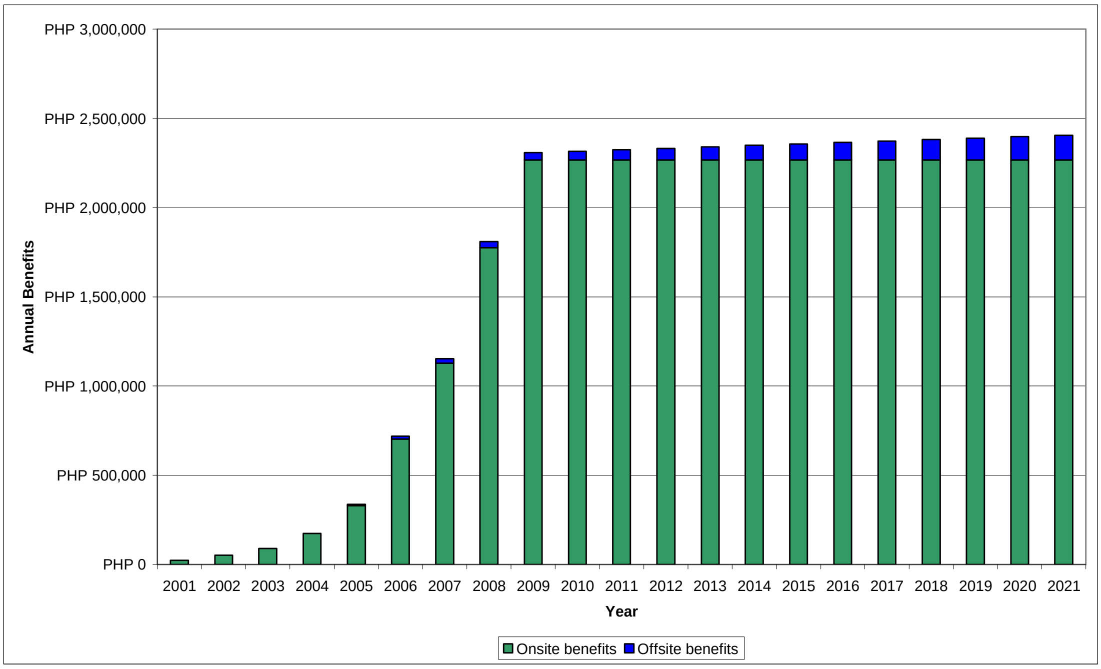

Figure 17 – Annual on-site and off-site benefits of Landcare[3]

Combining the costs (Figure 16) and the benefits (Figure 17) it can be seen that the Landcare intervention in Bohol is characterised by early net costs associated with research activities that give way to net benefits later in the period as adoption increases during the extension phase (Figure 18). While the returns to the extension phase of the project are significant compared to the earlier phase, it is important to emphasise that the rate of adoption in this phase builds on the foundations laid during the research project in San Isidro. It is unlikely that the accelerated adoption seen from 2006 would have been possible without first establishing this key node that allowed for the transfer of knowledge and the training of extension staff and farmers through cross-site visits.

Even given these early costs, the Landcare Program has a positive NPV of PHP 3,249,278 for the 20 year period simulated (2001-2021) using a 5% discount rate. The benefit-cost ratio is relatively small (1.22), though, as indicated, some of the potential longer-term benefits of the research activities have not been included. The internal rate of return (IRR) is a modest 7.4 %. The on-site/off-site composition of these benefits is 29:1, indicating that the Landcare Program is justified primarily by its impact on livelihoods in the marginal upland communities where it operates.

[3] The onsite benefits are the aggregate for all three Municipalities whilst the offsite benefits are limited to the estimates for Pilar where the Malinao Dam is located.

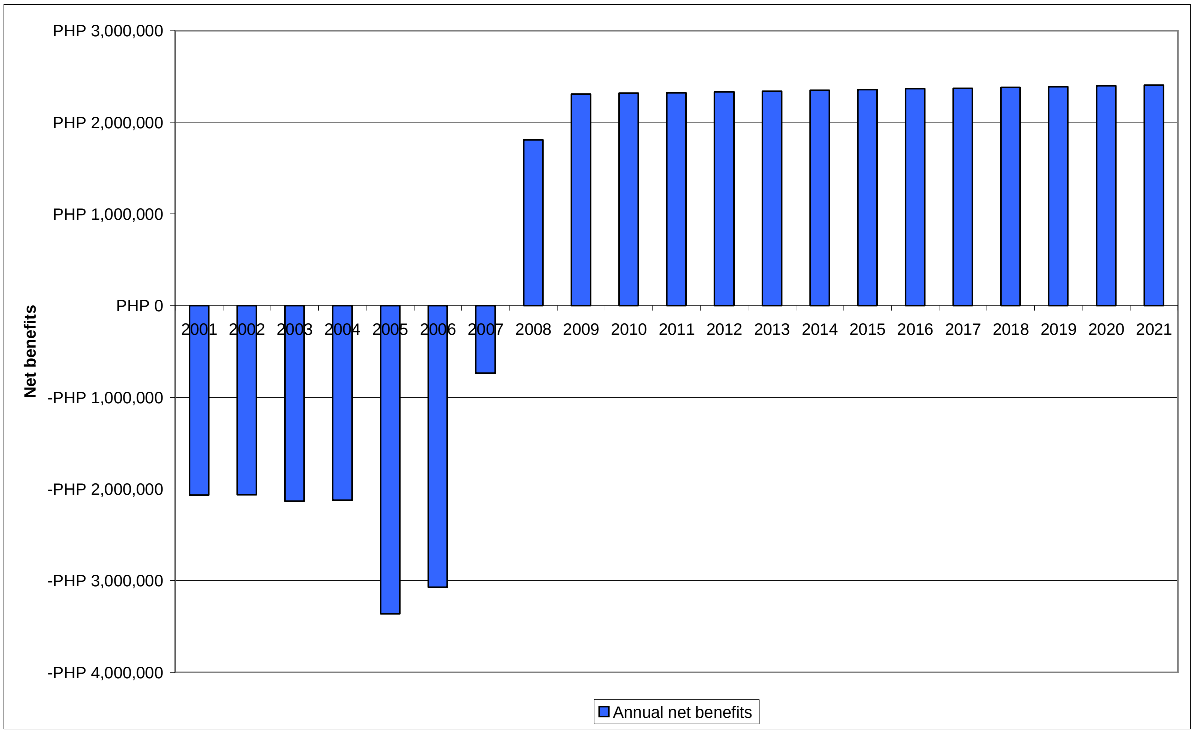

Figure 18 – Annual net benefits of the Landcare Program in three municipalities in Bohol

Table 5 illustrate how variations in two key assumptions (returns to enriched NVS and the potential for Landcare to mitigate sediment accumulation) influence NPV. The result is quite robust except for the lowest values of the two variables, though the NPV remains modest at best.

Table 5 – Sensitivity analysis

Value of enriched NVS per household		**Landcare reduction in sediment delivery**		
		2%	**4%**	**10%**
- 20%	**PHP 6,231**	-PHP 175,105	PHP 138,823	PHP 1,080,604
	PHP 7,789	PHP 3,145,801	PHP 3,459,728	PHP 4,401,509
+ 20%	**PHP 9,347**	PHP 6,466,706	PHP 6,780,633	PHP 7,722,414

The inclusion of the costs and benefits of the associated pre-history to the ACIAR-funded project in Bohol is important when evaluating the viability of establishing a SWC research and extension project in a relatively new site, as was the case in Bohol. It would therefore be misleading to omit these costs and assume that the transfer of the Landcare Program to a 'green-field' site could achieve the rates of adoption experienced during the extension phases of the program (post-2005) without the initial investment. However, expansion of the program into other nearby municipalities that can draw on the original research or learning hub can result in rapid adoption at relatively low cost. For example, the BCR of the expansion into Pilar and Alicia is estimated to be around 4.3 with an IRR of 35 per cent.

Conclusion

There is no denying that soil erosion in upland communities of the Philippines remains a serious problem, undermining the livelihoods of rural households and contributing to externalities elsewhere in the watershed. The development and dissemination of low-cost, adoptable soil conservation practices is fundamental to achieving improved livelihoods for the upland households in these marginal environments.

We conclude that the economic impact of the Landcare Program in Bohol is positive, even when taking into account the prior investment in research and training. The major beneficiaries of the Program are the individual households who adopt the conservation farming package, these benefits largely generated by the opportunities that arise once the hillslopes have been stabilised. Though the absolute increase in income is small, its significance for the adopting households is large, with adopting households having on average twice the level of farm income as non-adopters. This had the potential to lift households above the rural poverty line allowing them to meet their basic requirements.

The focus on small farmer development does not deny the seriousness of downstream watershed problems arising from upland agriculture. While this analysis concludes that the downstream impacts of land-use changes associated with the Landcare Program in Bohol will be of marginal importance over any time period of economic interest, there are still positive off-site benefits. However, the focus and primary justification of the Landcare Program should remain on improving the productivity and livelihoods of upland farmers, with these downstream impacts being seen as side benefits of what is essentially a livelihoods program.

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