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SMALLHOLDER ADOPTION OF SOIL CONSERVATION TECHNOLOGIES: EVIDENCE FROM UPLAND PROJECTS IN THE PHILIPPINES

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ABSTRACT

Soil erosion due to smallholder agriculture in upland areas of the Philippines is widely regarded as the country's most serious environmental problem. There have been many upland development projects involving the promotion of soil conservation and agroforestry measures. Yet adoption of such practices has been minimal. A research project was commissioned to investigate the technical and socio-economic factors limiting adoption of recommended soil conservation technologies. The project involved case studies of seven locations where conservation farming had been intensively promoted and adopted by a significant number of farmers. The research methods involved a combination of reconnaissance or rapid rural appraisal methods followed by a questionnaire survey of a sample of farmers from each site. This paper summarizes the project's findings regarding the farm-level factors associated with the adoption of recommended soil conservation technologies in the case-study sites. Its focus is on the attributes of the farm-household influencing the adoption-decision process, and the consequences of adoption at the level of the farm-household system. It was found that conservation farming technologies, particularly hedgerows, were widely seen by farmers who were aware of them as useful and even necessary, but it had required resource-intensive project intervention to get the adoption process going, and adoption was often constrained by farmers' specific circumstances, rather than their personal attributes and perceptions. A wider range of more profitable and less demanding conservation technologies was needed, promoted more flexibly and with greater, on-going support for farmers in their efforts to experiment with improved farming systems.

KEY WORDS: soil conservation; upland development; adoption; smallholders; farming systems; technology transfer; contour hedgerows; Philippines

INTRODUCTION

Soil erosion due to smallholder agriculture in upland areas of the Philippines is widely regarded as the country's most serious environmental problem (World Bank, 1989; Paningbatan, 1990; Garrity, *et al*., 1993). According to Sajise and Ganapin, 'the need for sustainable upland development ... is foremost in the national agenda ... [and] is an important facet of the Philippine Strategy for Sustainable Development' (1991: 31). There has been a plethora of upland development projects implemented by government and non-government agencies, many with international funding, and all with a significant component for the promotion of soil conservation and agroforestry measures among upland farmers (notably, contour hedgerow intercropping, in a package known as Sloping Agricultural Land Technology or SALT) (PCARRD, 1990; Garrity, *et al*., 1993). Yet it is widely felt that adoption of such practices has been minimal and that the problem of soil erosion and land degradation is not abating.

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A collaborative research project was commissioned in 1993 by the Australian Centre for International Agricultural Research (ACIAR) to investigate the technical and socio-economic factors limiting adoption of recommended soil conservation technologies by upland farmers (Cramb and Saguiguit, 1994; Cramb, ed., forthcoming). The project involved case studies of seven locations where conservation farming had been intensively promoted and adopted by a significant number of farmers (Garcia, *et al*., 1995–97; Cramb, ed., forthcoming). These studies were supplemented with bio-economic modelling to assess the on-farm costs and returns of alternative conservation measures (Nelson and Cramb, forthcoming).

This paper summarizes the project's findings regarding the farm-level factors associated with the adoption of recommended soil conservation technologies in the case-study sites (Tables I and II). Its focus is on the attributes of the farm-household influencing the adoption-decision process, and the consequences of adoption at the level of the farm-household system. Hence it does not directly analyse the characteristics of the technologies in question (either as originally promoted or as modified by farmers in the process of adoption), nor the influence of the social, economic or institutional environment on adoption, except to the extent that these are manifested in farm-household attributes (e.g. the tenure status of the farmer is a function of formal and informal land tenure institutions). Nor does it deal with lower-level consequences of adoption (at the field or cropping system levels) or higher-level consequences (at the catchment or regional levels). These aspects are considered in other papers arising from the project (Cramb, ed., forthcoming).

The aim of this paper is simply to analyse who adopted the technologies and what were the consequences for them. It is acknowledged that the concept of 'adopter' (and its converse, 'non-adopter') can be problematic, not least because of the 'pro-innovation bias' it tends to introduce into the analysis (Biggs, 1990; Biot, *et al*., 1995; Rogers, 1995; Sumberg and Okali, 1997). However, the use of these categories involves no presumption that those identified as non-adopters could or should adopt the technology in question. The starting point is merely the observation that some farmers in the case-study sites implemented the soil conservation technologies which were being promoted, and others did not. How did they differ? What was the impact? These questions, though limited in scope, are clearly relevant to understanding the problem of soil erosion in the uplands.

The research methods involved a combination of reconnaissance or 'rapid rural appraisal' methods (Chambers, 1997; Mikkelsen, 1995) followed by a questionnaire survey of a sample of farmers from within the project area (Table I). The reconnaissance methods included: a review of existing municipal and village documents; direct observation; semistructured interviews with focus groups and key informants; resource mapping; time lines; seasonal diagrams; and community histories. The formal survey was administered to a random sample of 70–120 farm-households drawn from the total population of farm-households in the project village(s) and, where feasible, from a neighbouring, non-project village. Respondents were divided into three categories: 'adopters' of the recommended soil conservation measures ; 'non-adopters' within the same setting, i.e. other farmers in the project village(s) who were thus exposed to the conservation project, but chose not to implement the technologies; and a 'control group', i.e. farmers in a similar setting, but from outside the project area, most of whom were not aware of the conservation technologies being promoted hence had not yet commenced the adoption-decision process. The survey typically involved a single, hour-long interview in the respondent's home, with husband and wife both present, supplemented in some cases with farm inspection. In one site (Domang) the survey was replaced by detailed case studies of ten households and in another site (Guba) only a reconnaissance survey was undertaken. Full details of research methods and analytical procedures for each site can be found in the original survey reports (Garcia, *et al*., 1995–97).

In the analysis which follows, the *attributes* of the adopters (or factors affecting adoption) were primarily examined in relation to the attributes of non-adopters within the project site, while the *consequences* of adoption were assessed where possible by reference to a control group. Individual and group perceptions of changes over time (i.e. the ten years or so since the conservation project had commenced) were used to supplement these cross-sectional comparisons. The meaning of 'adopters' obviously varies somewhat, both within and between sites, but in general the term refers to farmers who implemented contour hedgerows and/

Table I. Case-study sites, projects, technologies and data sources

Study Site (village, municipality)	Province, region	Project/ Organization	Main technologies	Sources of data				
				Rapid appraisal	Household respondents			Case histories
					A	N	C	
Tabayag, Argao	Cebu, Central Visayas	Mag-uugmad Foundation Inc. (MFI)	Bench terraces, rock walls, contour hedgerows	✓	50	28	25	–
Guba, Cebu City	Cebu, Central Visayas	Mag-uugmad Foundation Inc. (MFI)	Contour hedgerows, bunds and canals	✓	–	–	–	–
Pananag, Bansalan	Davao del Sur, Southern Mindanao	Mindanao Baptist Rural Life Centre (MBRLC)	Contour hedgerows (Sloping Agricultural Land Technology; SALT)	✓	49	24	–	–
Managok, Malaybalay	Bukidnon, Northern Mindanao	MUSUAN Project, Central Mindanao University (CMU)	Contour hedgerows	✓	47	57	–	–
Salogon, Brooke's Point	Palawan, Southern Tagalog	Upland Stabilization Project (USP), Department of Environment and Natural Resources (DENR)	Bench terraces, Contour hedgerows	✓	52	44	24	–
Magdungao, Passi	Iloilo, Western Visayas	Magdungao Agroforestry Project, DENR	Contour hedgerows, bunds and canals	✓	60	12	22	–
Domang, Kasibu	Nueva Vizcaya, Northern Luzon	Integrated Social Forestry Project, DENR	Contour hedgerows	✓	–	–	–	10

A = adopters; N = non-adopters; C = control group.

Table II. Profiles of case-study sites

Study site	Rainfall		Soils	Elevation (m above sea level)	Dominant slopes (%)	Population density (persons per km^2)	Dominant cropping system(s)
	Amount (mm per year)	Dry months (<100 mm)					
Tabayag	1500	Jan.–May	Alkaline clay/loam	250–700	30–50	150	Maize–maize Coconut
Guba	1700	Feb.–Apr.	Acidic heavy clay/loam	200–600	8–50	240	Maize–maize Maize–vegetables
Pananag	2500	Jan.–Apr.	Acidic clay/loam	500–1000	10–50	140	Maize–maize Maize–vegetables Coconut; Coffee
Managok	2500	Feb.–Apr.	Acidic clay	400–1000	5–70	300	Maize–maize Maize–vegetables Coffee; Fruit
Salogon	1600	Jan.–Apr.	Neutral-acidic clay/loam	100–1000	5–60	70	Upland rice Maize–maize Fruit
Magdungao	1800	Jan.–Apr.	Neutral-acidic clay	50–300	5–50	130	Maize–maize Rainfed rice Vegetables
Domang	2400	Dec.–Mar.	Acidic clay/loam	50–1000	30–50	50	Rainfed rice Maize–maize Vegetables

or bench terraces (sometimes with rock walls) on all or a substantial part of their farms. It is likely that the adoption process was largely complete in most sites, the studies being conducted 10–14 years after the commencement of the conservation project; as Lindner (1987) notes, this is important if cross-sectional comparisons are to be valid.

EXTENT OF ADOPTION

The 'adoption process' in each study site began with the commencement of a project which sought, among other things, to promote conservation technologies (Table I). Though many farmers had already invented or adopted various conservation practices (including such measures as ploughing across the slope and piling rocks or crop debris in lines across the slope), none had adopted contour hedgerows or dryland bench terraces (with or without rock walls), the two principal technologies promoted. Hence the role of the project in initiating the adoption process was crucial and needs to be taken into account in analysing farmers' adoption decisions. In some cases the prior decision was to participate in the project in order to receive whatever benefits were on offer (e.g. livestock dispersal, stewardship contracts, farm tools and inputs, subsidies) and a concomitant of that decision was the implementation of recommended conservation technologies. In general, however, the decision to adopt contour hedgerows or bench terraces, while brought to a head and facilitated by the presence of a project, and often involving group activity, was in Rogers' (1995) terms an 'individual-optional' decision, as opposed to a 'collective' or 'authoritarian' decision. The following paragraphs summarize the available data on the extent and rate of adoption in each case-study site.

At Tabayag, a World Neighbours project (which eventually gave rise to a farmer organization, the Mag-uugmad Foundation Inc. [MFI]) began in 1981 with the formation of a labour-exchange group (alayon) of five members (although two pulled out after two weeks, objecting to the high labour requirement for rock wall construction). By 1993, around 50 per cent of the 159 households in Tabayag had adopted rock-wall terraces and/or hedgerows on their maize farms and the diffusion process within the village was largely complete (though follow-up visits indicated there was still some adoption occurring). There was little evidence of diffusion beyond the project village.

At Guba, another World Neighbours-MFI site, extension began in 1981 with the recruitment of a progressive farmer (who had already received a 'best farmer' award) and the formation of a working group of five farmers (his siblings) to implement conservation measures – primarily contour bunds, canals and hedgerows. The main crops grown in the alleys were maize (for subsistence) and, increasingly, vegetables and flowers for the Cebu market. By 1982, 23 farms had been developed and in the following two years there was rapid uptake, facilitated by the employment of part-time farmer-trainers. By the mid-1990s, adoption of the recommended technologies was reported for over 1000 farm-households in ten villages spread over 78 km^2. This represented perhaps 30 per cent of the population of potential adopters in those villages. However, a reconnaissance survey in 1996 found that adoption had reached a ceiling and, in many cases, hedgerows were not being maintained or re-established.

At Pananag, the project was more drawn out. Initial contact with Mindanao Baptist Rural Life Centre (MBRLC) – the developers of Sloping Agricultural Land Technology (SALT) – occurred in 1980, extension efforts began in 1984, and an intensive extension effort was undertaken between 1989 and 1992. By 1991, around 50 per cent of farm-households had adopted contour hedgerows (not the full SALT package) on at least part of their maize farms, and by 1994 this figure was around 70 per cent. There had been some diffusion to relatives in a neighbouring village.

At Managok, an Integrated Social Forestry (ISF) Project of the Department of Environment and Natural Resources (DENR) began in 1983, and the MUSUAN project of Central Mindanao University (CMU) operated from 1988 to 1992, promoting contour hedgerows. The MUSUAN project reported 60 adopters, but in 1994 there were only 47, the decline being due to death, outmigration, discontinuance, or double-counting. This represented 20–40 per cent of upland households within the project's target area. Adopters generally established hedgerows throughout their maize farms. There was no evidence of wider diffusion.

At Salogon, the government's Upland Stabilization Project began in 1982 and wound up in 1990. The major conservation measures promoted were contour hedgerows and bench terraces for both upland rice (the staple crop) and maize (the main cash crop). Most adoption occurred in 1985 and by 1990 the adoption curve had levelled out. In the 1995 survey, 54 per cent of the sample were classified as adopters on the basis that they had implemented contour hedgerows or bench terraces on part (mostly 10–50 per cent) of their farms. In many cases, however, the technologies were not being maintained, confirming the view of a key informant that only 5–10 per cent of the land development existing at the end of the project was still in evidence.

At Magdungao, an ISF Project began in 1979 and the government's Magdungao Agroforestry Project was implemented from 1982 to 1991, by which time 87 households had participated in the project, involving among other things the adoption of contour hedgerows and/or bunds on their maize and vegetable farms. This represented 80 per cent of the potential adopters within the village. By the time of the survey in 1995, the level of adoption was still around 80 per cent, though many adopters had not maintained their contour bunds. A significant proportion (28 per cent) of the adopters surveyed had not participated in the project but had adopted of their own accord or had inherited farms from adopters. There was evidence that diffusion to farmers in neighbouring villages was minimal, depending mainly on contact between close relatives.

At Domang, an ISF Project operated from 1986 to 1993, mainly promoting contour hedgerows. From 1989 to 1991 farmers were paid P6 (US$0·25) per linear metre of hedgerow established (e.g. one community leader received a total of P16 000). The site was upgraded to a model site in 1990 and received more intensive extension. By 1991, the majority of residents were reported to have adopted hedgerows. In 1993, the site was 'devolved' to the municipal government, after which extension activity became practically non-existent. However, at the time of the survey in 1996 there were 78 adopter-households or 90 per cent of the Domang population. Hedgerows were being maintained, but there was no expansion on to additional land. The alleys were being used for maize, upland rice, and a range of commercial vegetables and field crops. Diffusion beyond the village was almost non-existent, and where adoption did occur it was not well implemented due to poor understanding of the principles and techniques involved. It should be noted that bunded irrigated rice terraces (an indigenous technology for the Ifugao members of the village population) were being constructed before the project began and continued to be developed at the time of the survey.

ATTRIBUTES OF ADOPTERS

In this section, three broad sets of attributes affecting adoption are considered: (1) the personal attributes of the principal decision-maker; (2) his or her perceptions, both of the problem of erosion and of the recommended technologies; (3) the attributes of the farm, including physical and economic attributes. The adoption factors are analysed sequentially, the main form of quantitative analysis being pairwise comparison of means and proportions for 'adopters' and 'non-adopters', though interactions between factors are also examined where this seems relevant. Full multivariate analyses of adoption were conducted for particular sites (Shively, 1996; Garcia, 1997) and these tend to confirm the conclusions drawn from the simpler approach reported here. The advantage of this less formal approach is that it enables the qualitative data to be woven into the discussion of the quantitative data, producing a more coherent overall explanation of farmers' responses.

Personal Attributes

The personal attributes of the household head were hypothesized to be important influences in the adoption decision. This assumes that he or she was the main decision-maker with regard to farming matters or, to the extent that decision making involved reaching a consensus between the head and spouse, that the personal attributes of the head can be taken as a proxy for the attributes of both decision-makers. The extent to which

other household members were involved in decision making was not investigated, though in most cases it was likely to be minimal because the household typically comprised a nuclear family with dependent children.

The age of the household head was a significant factor in Tabayag, but not elsewhere. The average age of adopters at the time of the survey was 38 (at the time of adoption, 32), and of non-adopters, 50. This was probably because of the emphasis on bench terracing and the construction of rock walls at this site. This was difficult, laborious work requiring intensive group activity which would have been less appealing to older farmers. There was an interesting case at Tabayag of a non-adopter household which, by the time of a follow-up visit three years after the original survey, had adopted bench terracing and rock walls because the son had taken over the role of household head and farm decision-maker. This suggests that, where age is a factor inhibiting adoption, the adoption process may not be complete within a given locality until households have moved through their normal development cycle and management has passed to a younger person.

Adopters at Tabayag also had more formal education (5·2 years) than non-adopters (2·8 years); many had completed primary school and some had secondary education. This presumably enabled them to respond more readily to the training in conservation farming provided by the project, particularly the technical work of terrace layout and construction, though it may have been merely a reflection of their age. Elsewhere adopters had slightly more education than non-adopters, but the differences were not great. The best-educated adopters were in Managok (5·9 years of education) and the least educated in Salogon (1·7 years).

In most cases there was no difference between adopters and non-adopters in the proportion of female-headed households. Again at Tabayag, however, 21 per cent of non-adopters but only six per cent of adopters were in this category. In commenting on the technologies promoted at this site (particularly rock walls), 25 per cent of non-adopters said they were 'not suited to women'.

Adopters and non-adopters differed little in household size or number of dependants, though in Tabayag adopters had smaller households on average, probably reflecting their younger age, hence that the households were at an earlier stage of the development cycle.

There was considerable cultural homogeneity at most sites, except at Pananag where indigenous Bagobo and immigrant Cebuano lived together. The adoption rate was higher for Bagobo farmers (77 per cent) than Cebuano (52 per cent), perhaps reflecting the Mindanao Baptist Rural Life Centre's emphasis on helping cultural minorities. Religious affiliation also did not vary much within sites, again with the exception of Pananag. In this case, although the level of adoption among Southern Baptists (87 per cent) was above the average (67 per cent), Catholic households also had a high adoption rate (77 per cent).

In many cases, farmers had migrated to the village from elsewhere in the municipality or from further afield. In Managok, for example, over 75 per cent of household heads were immigrants to the village, often from a lowland setting. However, there was no difference between adopters and non-adopters in this respect.

No attempt was made to measure 'personality traits', such as attitudes to risk or achievement motivation. However, both adopters and non-adopters were asked to comment on the reasons for non-adoption and their responses are interesting. In Magdungao, 37 per cent of adopters and 42 per cent of non-adopters attributed non-adoption to 'laziness'. Similarly, in Tabayag 38 per cent of adopters and 21 per cent of non-adopters saw lack of interest or laziness as a factor preventing more rapid adoption; a few also referred to non-adopters as individualistic and content with their existing ways. A number of adopters in Tabayag (14 per cent) considered that non-adopters were suspicious of the 'communist-like' activities of the farmers' groups (alayon) which had been formed to learn about and implement the technologies. In Domang, a number of farmers had a negative and suspicious attitude towards everything to do with the DENR's Integrated Social Forestry Project, in some cases because of conflict with the DENR's predecessor (the infamous Bureau of Forest Development) during the Marcos era. They remained on the fringes of the community and were semi-derisively labelled pilosopo (recalcitrants? oppositionists?) because of their attitude. In one case, however, a pilosopo proved to be a highly articulate and competent farmer who understood the problem of soil erosion and had coherent reasons for his unwillingness to adopt contour hedgerows. In general, these negative perceptions of non-adopters were more likely to have reflected antipathies between factions within the community than an objective assessment of personality traits.

Perceptions

Perceptions of farm problems and options to resolve them are partly a function of personal attributes (e.g. age, education, experiences) and partly of farm attributes (Sinden and King, 1990). The perceptions reported in the surveys, of course, relate to a time *after* exposure to and involvement in the project and, in the case of the adopters, after several years' experience with the technology. Hence, it cannot be assumed that they correspond to the perceptions at the time of the adoption decision. Even farmers' recollections about their past perceptions may have been coloured by their present point of view. Nevertheless, the information discussed below provides considerable insight into the way farmers in the case-study villages viewed soil erosion and the recommended soil conservation technologies.

Perceptions of soil erosion

Almost all farmers were aware of the process of soil erosion, but many did not see it as a major problem. In Tabayag, 89 per cent of non-adopters recognized that soil erosion was occurring on their farms, but 61 per cent thought the rate of soil loss was 'slow'. Adopters, obviously, were also aware of soil erosion, but early adopters said they had not understood the impact of soil erosion on crop production until World Neighbours began their extension work in the village in 1981. For 90 per cent of adopters a primary motivation for adoption of terraces, rock walls or hedgerows was 'to control soil erosion', and 98 per cent perceived that soil erosion had decreased since adoption.

In Pananag, 90 per cent of adopters were aware of soil erosion on their farms prior to adoption, and 84 per cent indicated that they adopted hedgerows to control erosion. Most non-adopters perceived that erosion was occurring 'rapidly' (63 per cent) or 'moderately' (25 per cent). However, when both groups were asked to list their major farming problems, 37 per cent of adopters listed soil fertility and erosion, compared with only four per cent of non-adopters.

In Managok, where slopes were very steep and erosion clearly a serious problem, farmers reported moderate to severe soil erosion on 90 per cent of their parcels of land. This was most commonly perceived as rill and gully formation, but sheet erosion and loss of fertility were also recognized. In this case, 26 per cent of adopters and 33 per cent of non-adopters listed soil erosion as an important farming problem, second only to the lack of working capital for farm inputs. This high degree of awareness of soil erosion and its perception as a problem by 'non-adopters' was reflected in their behaviour, in that 32 per cent of farmers in this category reported using other erosion control measures on 26 per cent of their parcels. These measures included planting across the slope, tree planting, planting in gullies, piling of maize stover in furrows across the slope, strip planting, placing debris in gullies, planting along the contour, and piling rocks in rows across the slope. Most indicated that these measures were their own ideas, but other sources of information included other farmers and school education.

In Salagon, awareness of erosion processes was reasonably high; most farmers recognized that erosion was caused by heavy rainfall and lack of ground cover. However, about half the farmers in each category could not say where the eroded soil went to, and a similar proportion felt that no one was affected by soil erosion. Significantly, no farmer (adopter or non-adopter) listed soil erosion among their farming problems. The same was true at Magdungao. At both these sites the quality of adoption was poor, and there was a high incidence of discontinuance.

Perceptions of soil conservation

Awareness of recommended conservation practices was generally high within the project area, particularly of those components which were permanently visible once implemented on a neighbour's farm. For example, at Magundgao all adopters and non-adopters knew of contour hedgerows. However, awareness of the A-frame, used to locate the contours, was less widespread, being reported by 95 per cent of adopters and 50 per cent of non-adopters. Knowledge of how to use the A-frame was probably even less widespread. This indicates that information about *how to implement* conservation practices diffuses much more slowly within a

population of potential adopters than does information about the *existence* of the practices. At Tabayag, however, even awareness of contour hedgerows was not widespread, perhaps partly due to the project's location in the upper catchment and largely beyond the roadhead. While 100 per cent of adopters were aware of the technology, only 57 per cent of non-adopters reported awareness. At the same site, 92 per cent of adopters were aware of contour ploughing, but only 36 per cent of non-adopters.

Opinions about various aspects of the recommended technologies were sought. In Pananag, non-adopters disagreed with statements that there was no need for contour hedgerows (SALT) or that the technology was difficult to learn, but were more inclined to agree that there was too much work involved, that it took too long to get the benefits, and that there was no credit or financial assistance to assist the farmer to adopt. These opinions seem to suggest a positive underlying view of the technology, but an inability to adopt it because of labour and capital constraints (confirming the interpretation of these constraints given below).

At Managok there was no difference between adopters and non-adopters in their stated opinions about contour hedgerows (except that about a third of non-adopters gave no response to all questions/statements, indicating perhaps that the technology had not occupied their minds). Non-adopters disagreed with the statement that there was no need for contour hedgerows, but mostly agreed that hedgerows required too much work to establish, took up too much land, harboured pests and were too weedy. Nevertheless, adopters gave a similar set of responses.

At Salogon, negative perceptions of hedgerows were more common, but again there was close similarity between the views of adopters and non-adopters (reflected in the high incidence of discontinuance at this site). While only 23 per cent of adopters and 34 per cent of non-adopters agreed that there was no need for contour hedgerows, a majority of both groups agreed that hedgerows required too much labour to establish and maintain, that they prevented burning-off, that they harboured weeds, pests and diseases, that they reduced the harvest of maize and rice, and took too long to provide benefits. Adopters were evenly divided on most of these issues, hence the perceptions of the two groups did not greatly differ.

Farm Attributes

Farm size, location and physical attributes

Farm size was a characteristic associated with adoption at Pananag and Managook but not elsewhere. At Pananag, adopters' farms averaged 3·5 ha, more than twice the average for non-adopters (1·7 ha). At Managok the difference was not so great, adopters averaging 3·2 ha and non-adopters, 2·6 ha. One explanation is that a larger farm size enabled adopters to increase the maize area to offset the area lost to hedgerows, thereby maintaining total food production and minimizing consumption risk. Relatedly, larger farms also often had larger individual fields, which meant a larger net area for cropping, providing some economies of scale in the use of labour and draught animals (see below). More generally, larger farms reflected both greater incentive and greater capacity for adoption. The reasons why farm size was not a significant factor at other sites seem clear. At Salogon and Magdungao adoption was not very decisive or long-lasting and was influenced more by factors other than farm size (though an earlier evaluation reported farm size – and the value of farm assets – to be factors affecting adoption at Magdungao). At Tabayag, adoption was decisive, but population pressure on the land was greater than at the other sites and almost all farms were small, averaging 1·7 ha.

In most cases farmers resided on their farms, though typically they also operated a second, or even a third field at some distance from their residence. The average distance from the residence to the farmer's fields did not differ between adopters and non-adopters (though for a given household, conservation measures were more likely to be implemented on fields closer to home). In Salogon, however, indigenous Palawano farmers tended to live in small hamlets, hence the journey to the farm could be quite time consuming. In this case, adopters' fields were on average only seven minutes from their residence, whereas non-adopters averaged a 39 minute journey. The greater distance may have discouraged them from adopting the recommended conservation practices and/or discouraged project staff from promoting and establishing the practices on their farms.

While all farms were located in a region of steeply sloping land, there was variation between and within farms in land type (soil type, topsoil depth, slope, stoniness, etc). Insufficient farm-specific data were collected to permit systematic discrimination between adopters and non-adopters on the basis of land type. However, in Managok, where slope measurements were taken, most fields had slopes well in excess of 15 per cent, irrespective of adoption category. It was apparent in Tabayag, where rock walls were being promoted, that a major motivation for adoption was simply to remove rocks from the field to increase cultivability. Farmers operating fields which were less rocky were, understandably, less likely to adopt rock walls, though they may have adopted contour hedgerows. More important, perhaps, was the finding that 68 per cent of non-adopters, but only 12 per cent of adopters, had fields in which rocks had already been removed to some extent and placed in loose piles across the slope. Often this had been done many decades ago by the current operator's predecessors. Farmers with fields in this condition perceived, perhaps correctly, that further work to construct rock-wall terraces was unnecessary.

In Domang, where ten detailed household case studies were undertaken, it became clear that the physical attributes of the farmers' fields could be important factors affecting adoption. One farmer was a 'poor adopter' partly because his only field had highly broken terrain, making contour farming difficult to implement. In another case, a non-adopter had two small (0·5 ha), moderately sloping (30 per cent) fields at some distance from the homestead, and a larger (1 ha), steeper (30–50 per cent) field which was rocky and less cultivable. He did not want to establish hedgerows on the smaller fields because erosion was considered less of a problem and the areas remaining after hedgerows had been established would make them not worth farming; he considered that boundary planting was all that was required for small fields. His larger field he preferred to put entirely under perennials.

Not only was field size seen to be important, but also field orientation; a field oriented across the slope (i.e. with a short downslope dimension) was considered less suitable for hedgerows because they would have to be too closely spaced for convenient management of the alley, whereas on a field with a long, narrow slope hedgerows could be more spaced out.

The steepness of the slope was also important. While a relatively shallow slope meant that adoption of contour hedgerows was seen as less urgent (as in the example above), steeply sloping land encouraged adoption for reasons other than soil conservation. Farmers pointed out that ploughing across steep slopes can only be done in one direction because the plough does not penetrate deeply enough when the mouldboard is pushing the soil upslope. This necessitates carrying the plough back to the starting point at the end of each pass, considerably increasing the time and effort for land preparation. Contour hedgerows can lead to the rapid formation of flatter terraces which permit ploughing to be done in both directions, thus saving labour as well as soil.

At Magdungao, farmers also made the point that the location and spatial arrangement of fields was important for the implementation of technologies designed to redirect water flow (e.g. contour canals), which could not be usefully implemented on a small, isolated field. On the other hand, it was not feasible to implement recommended fertility-enhancing practices, such as composting, on anything other than very small, intensively managed vegetable plots.

In some cases, farmers had both upland and lowland fields. It was hypothesized that access to a lowland field would reduce the incentive for adoption of conservation measures on the upland area. However, in Managok, 30 per cent of adopters had access to a field on the adjacent plain (used for bunded rice production), compared to 23 per cent of non-adopters. Adopters had somewhat larger lowland fields and accordingly produced and sold more rice. In Magdungao, 73 per cent of adopters and 83 per cent of non-adopters had a small (on average 0·4 ha) field in one of the inland valleys in which they cultivated lowland or bunded rice. Hence access to a lowland field did not appear to discourage adoption of conservation technology, at least in situations where upland activities remained dominant. In Domang, however, there was evidence from individual farmers that where lowland fields were available, priority was given to them to the detriment of conservation practices in upland fields. In part, this was because lowland rice production was less risky (in terms of yield and price) than upland crops, as well as being the staple food of this community.

In most cases, adopters and non-adopters had very similar land-use and farming systems prior to the advent of the conservation project. At Magdungao, however, there was some evidence that adopters placed greater emphasis on commercial vegetable production and had a more diversified farming system than non-adopters.

Land tenure

Land tenure was an important factor affecting adoption. However, in general, the official classification of the land (that is, whether the land was Public Forest Land or Alienable and Disposable [A&D] Land) was not significant. In most cases both adopters and non-adopters were occupying Public Forest Land. Indeed, farming lands in Pananag lay entirely within Mt Apo National Park. Where both types of land occurred within the case-study village (e.g. Tabayag), adopters were more or less equally represented in each zone.

Nevertheless, the land classification had a minor influence in Salogon, where the recommended conservation practices (terraces and hedgerows) were only reluctantly adopted during the period of the Upland Stabilization Project (USP). In this case, 32 per cent of non-adopters had one or more parcels of A&D Land, compared with only 17 per cent of adopters. Of parcels classified as A&D Land, only 13 per cent were reported to have conservation measures (terraces or hedgerows), whereas 39 per cent of parcels classified as Public Forest Land had been developed in this way. That is, the likelihood of conservation measures being applied to Public Forest Land in Salogon was three times that of their being applied to A&D Land. Though very few farmers held a formal land title, it seems that those with A&D Land were under less pressure to follow the stipulations of the USP, which issued Certificate of Stewardship Contracts (CSCs) for farmers on Public Forest Land if they adopted the recommended conservation measures, and threatened to withdraw cultivation rights completely if farmers flouted project requirements (particularly the ban on shifting cultivation). A similar phenomenon may have occurred at Magdungao where 92 per cent of non-adopters had some A&D Land, compared with only 52 per cent of adopters, though this may also have been because the Magdungao Agroforestry Project targeted farmers with less secure tenure.

At Domang, where all households were relatively recent immigrants to an area of public lands, and many had been involved in an earlier dispute with the Bureau of Forest Development and a large grazing leaseholder in which an attempt was made to evict them, the opportunity to obtain CSCs was seen by most as an attractive way to obtain security of tenure in the eyes of the state, and hence was an inducement to adoption. However, some non-adopters had refused to be involved in the project because they were holding out for the land to be reclassified as A&D, with full titles issued.

Apart from these examples, however, farmers appeared to be confident in their ownership rights, despite the absence of formal title. Within the local community, land ownership was secure and land transactions (sale, rental, mortgaging) took place routinely. Many would pay land tax to the municipal government to reinforce their claim, the tax declaration certificate serving as a 'pseudo-title'.

Hence the main tenure issue affecting adoption was tenancy. In Pananag, 38 per cent of non-adopters were tenants, compared with only four per cent of adopters. The tenants rented land from absentee land owners in the town of Bansalan, many of whom forbade them to develop the land with SALT. In commenting on possible reasons for non-adoption, 30 per cent of adopters and 42 per cent of non-adopters who gave a response agreed that not owning the land gave no incentive to adopt.

In Managok, 39 per cent of non-adopters were tenants, compared with 19 per cent of adopters. In this case, 46 per cent of adopters and 48 per cent of non-adopters who responded to the question agreed that tenancy was an obstacle to adoption. Their comments were that the owner would be the long-term beneficiary, that there was no assurance that the tenant would benefit, that the owner might disapprove, or simply that it was up to the owner to decide. On the other hand, the minority who disagreed with this view suggested that adoption may enhance the landowner–tenant relationship and that, in any case, hedgerows could benefit the tenant in the short term.

Evidence from Guba illustrates the complexity of the tenancy issue. In this site, there was widespread adoption of contour hedgerows, much of it (about 30 per cent) on tenanted land. However, the important

thing to note is that tenancy arrangements here were generally long-term and stable. Moreover, the Department of Agrarian Reform was in the process of issuing Certificates of Land Transfer to tenants in some villages, causing some landlords to hand over their land in anticipation. Hence tenants had considerable security of tenure. Where landlords did play a role in the adoption decision, this varied from (a) *forbidding* the tenant to establish soil conservation measures to (b) *requiring* the tenant to establish soil conservation measures, on pain of eviction. The reasons given by key informants for the former attitude were that such landlords were typically urban-dwellers and not familiar with the purpose of the recommended technology, and they feared that allowing the tenant to develop the farm would strengthen the latter's claim to the land. It was also observed that tenants who adopted contour hedgerows were more likely to establish grass hedgerows than shrub legumes because of the lower establishment and maintenance costs. Perhaps there is scope for upland projects to seek to involve landlords as stakeholders in the process of farming systems development, though in many cases this would not be feasible.

Some farmers were utilizing land as mortgagees, that is, they had advanced money to the landowner in return for the right to cultivate the land. This was only important in Tabayag where up to 22 per cent of non-adopters held land by mortgage, compared with one per cent of adopters. Clearly a mortgagee would be unlikely to invest in permanent improvements such as bench terracing, rock walls, or even hedgerows, given that the land could be redeemed at some point.

Labour, working capital, and cash income

While in most sites farmers identified labour as an important reason for non-adoption ('labour shortage', 'technology requires too much work', 'technology too laborious', 'not enough time'), in all cases the size of the full-time resident labour force did not differ significantly between adopters and non-adopters (though it is noteworthy that at Pananag non-adopters were less likely to own a draught animal). Even in Tabayag, where the technology (terraces and rock walls) was the most labour-intensive (to construct 10 m of rock wall 1 m high required a team of eight men working for a day), adopters averaged 1·6 workers per household, compared with 2·1 for non-adopters. There was some evidence that in Pananag and Managok non-adopters were more likely to be engaged in off-farm employment (mainly wage work on other farms), which would have reduced the labour available to establish and maintain conservation measures. This suggests that the 'lack of time' for conservation measures may have been more a matter of 'lack of cash income' (see below), hence a need to allocate spare household labour off-farm (an example of livelihood diversification for 'survival' rather than 'accumulation'; cf. Ellis, 1997).

A lack of working capital to purchase farm inputs, particularly fertilizer, was identified as an important problem by most farmers, adopters and non-adopters alike. Many farmers obtained credit, mostly in the form of loans for fertilizer from traders, with the crop as security. The duration of the loan was one crop season or about four months, and the implicit interest rate was high (e.g. averaging 96 per cent p.a. at Magdungao). There was no obvious difference between adopters and non-adopters in their use or sources of credit. Hence the lack of cheap, long-term credit for farm development was a general constraint, though adopters found this constraint less binding because of greater initial farm cash income and, in most sites, the provision of some form of project assistance. In Tabayag, the project obtained German (GTZ) funding to provide credit for the purchase of fertilizer by members of the farmers' association (i.e. adopters).

In every site, adopters had higher cash income than non-adopters. To some degree this was a *consequence* of adoption (or at least of project participation) rather than a factor contributing to adoption, but in many cases it was clear that adopters were more commercially oriented and had a greater cash flow. This probably facilitated adoption, both by increasing the demand for investment in conservation measures (there being a higher return to investment in land improvement) and by providing the means for investment. In Tabayag, adopters' average cash income was P5500, compared with P1900 for non-adopters; the main sources of this higher cash income were livestock and vegetable production. In Pananag, adopters averaged P18 900 and non-adopters P7200. This was partly due to project-induced income effects, particularly the sale of

legume seed and livestock, but also due to higher income from maize, other annuals and coffee. In Managok, adopters averaged P19 900 and non-adopters P13 800, the former obtaining more income from maize, rice and small business, and the latter obtaining more from wage work (again suggesting different types of livelihood diversification between the two groups, as mentioned above). In Salogon, the difference was not so great, adopters averaging P11 700 and non-adopters P9700, the difference being mainly due to greater maize sales. In Magdungao, adopters average cash income was higher than at any other site at P20 800, mainly due to the sale of vegetables; non-adopters also had high cash income, averaging P16 200.

In many cases the distribution of cash income among adopters was skewed to the right, and for Pananag it was clearly bimodal. This indicates that the category 'adopters' included a smaller subgroup with considerably higher cash income, which probably reflected their overall innovativeness and success as farmers. In other words, the adopters may have included a group of what Lindner, *et al*. (1982) refer to as 'genuine innovators', and a group of 'followers' who, through being located close to a genuine innovator, 'have access to a high-quality, low-cost source of information about innovation productivity at a very early stage in the overall diffusion process' (Lindner, *et al*., 1982: 104).

FARM-LEVEL CONSEQUENCES OF ADOPTION

As Rogers (1995) points out, the consequences of adopting innovations have been understudied, reflecting the 'pro-innovation bias' in much diffusion research, i.e. the assumption that the innovation in question is desirable. However, the consequences of adoption may be desirable or undesirable, direct or indirect, and anticipated or unanticipated. In this section, the main consequences for the farm-household are discussed: (1) those relating to the operation of the farming system (labour use, input use, the balance of farming activities) and (2) those relating to the outputs of the farming system (household food supplies and farm cash income). As mentioned in the introduction, the consequences or impacts of adoption at the plot or field level, and the off-site impacts of soil erosion and conservation are considered elsewhere (Cramb, ed., forthcoming). In analysing the farm-level consequences of adoption, there is an additional comparison between 'adopters' and the 'control group', on the provisional assumption that both groups were in a broadly similar situation before the technology was introduced. However, such comparisons were moderated by respondents' perceptions of changes over time on their own farms and by qualitative data from group appraisal sessions.

Operation of the Farming System

Labour use

The consequences of adoption for labour use within the farming system were variable. All adopters understandably reported increased labour requirements for *establishment* of the conservation technologies. In the case of hedgerows, for agronomic reasons this coincided with the beginning of the crop season and so generated a peak load on the household's labour resources. With bench terraces and rock walls, the work could be done in the off-season. The use of labour-exchange groups facilitated establishment tasks, particularly in the case of terraces and rock walls, but did not substantially reduce the overall labour requirements or (in the case of hedgerows) the seasonal labour peak. At Salogon and Magdungao, the project hired a team of workers to assist farmers in establishing the technologies. It is not clear to what extent farmers in other sites hired labour for this work.

The implications for *on-going* labour requirements were less clear-cut. Adopters at Tabayag reported increased labour requirements for farm maintenance (e.g. pruning of hedgerows) and fertilizer application (the use of organic fertilizer had increased), but decreased labour in other areas, particularly land preparation (due to flatter, more cultivable alleys). At Pananag, farmers reported a decrease in labour requirements due to the smaller area cultivated, but an increased requirement for pruning hedgerows and, in many cases, the harvesting of hedgerow seed for sale. Managok farmers also reported an increased requirement due to maintenance of the hedgerows. The net effect of hedgerows was probably an increase in on-going labour requirements, but the extent depended on the species and vigour of the hedgerows and the frequency and

difficulty of pruning. For terraces, the net effect was probably a decrease in on-going labour requirements because the terraces and rock-walls themselves required little maintenance, but field operations were made easier.

The consequences of adoption for women's work corresponded to those for crop and field maintenance in general. At Managok, women reported an increase in work required for hedgerow maintenance, but a decrease due to a reduction in the area cultivated, reduced weeding requirements, and reduced work required to ameliorate the effects of soil erosion. The dominant view was that there was no overall increase in women's workload. However, at Magdungao, 52 per cent of adopters reported a net increase in women's workload due to maintenance of hedgerows and contour bunds, the latter requiring frequent repair. At Salogon, 58 per cent of adopters said the amount of work undertaken by women had increased, but this was largely due to their role in the care and maintenance of fruit and forest tree seedlings disbursed by the project rather than the maintenance of conservation measures as such.

Farm inputs

The main input of interest was fertilizer. In Tabayag, farmers maintained or decreased their use of inorganic fertilizer, but in many cases increased their use of organic fertilizer. There was cross-sectional evidence of an overall increase in applied N following adoption. This was attributable to the increased retention of applied nutrients following farm development, hence a greater incentive to build up soil fertility. At the same time, a project initiative led to the commercial supply of organic fertilizer to the farmers' organization and the provision of credit for purchase of fertilizer.

In Pananag, farmers reported decreased use of purchased fertilizer, again because of the increased effectiveness of the fertilizer applied and, to some extent, the use of hedgerows and livestock (goats) for nutrient cycling. In Managok, too, farmers indicated a decrease in the use of inorganic fertilizer because of higher soil fertility attributable to soil conservation measures (perhaps partly reflecting a need to offset losses due to erosion and partly a catching up with the available seed-fertilizer technology for maize production). Likewise in Magdungao, adopters generally reported a decrease in the use of inorganic fertilizer and non-adopters an increase.

However, in Salogon half the adopters reported an increase in fertilizer use, but this reflected an independent (though partly project-induced) trend towards more intensive, commercial maize production rather than the adoption of conservation measures which, as noted, was not very long-lasting.

Balance of farming activities

The impact of adoption on the combination of activities in the farming system was difficult to disentangle from general farming trends, on the one hand, and project-induced changes, which were not necessarily linked to conservation measures, on the other. At Tabayag, a small group of adopters (20 per cent) had expanded commercial vegetable production on their conservation plots. For most adopters and non-adopters, however, there had been no change in this activity. At Pananag, adopters reported an increase in production of vegetables and other annual crops since adoption, whereas non-adopters reported a decrease over the same period. There was no apparent impact on this activity at Managok or Salogon, though, as discussed below under the heading of food supplies, there was an increase in commercial maize production on conservation plots, but this had been occurring before the project and was part of a general trend among the farmers concerned. Magdungao and Domang farmers were also steadily expanding the area of bunded rice, again, independently of adopting dryland conservation measures.

Tree crop activities were increasing in some sites (e.g. Pananag, Salogon and Magdungao), but in most cases this was a result of seedling dispersal by the project concerned, and was taken up by adopters and non-adopters of conservation technology alike.

Livestock development activities were sometimes linked to the adoption of hedgerows. In Tabayag, where intensive goat production was promoted in conjunction with shrub legume hedgerows, half the adopters reported increased livestock production due to increased numbers of goats and better feed supplies. The

same approach was followed at Pananag with a similar outcome. At other sites, there was no obvious link between adoption of conservation measures and livestock activities, though at Magdungao it was reported that hedgerows of Napier grass had to be removed because the production of biomass was too great for the number of livestock.

Outputs of the Farming System

Food supplies

In Tabayag, where maize was grown almost entirely for subsistence, adopters averaged 980 kg of maize per cropping, 55 per cent more than both non-adopters and control group farmers. This was mainly due to greater use of and response to fertilizer on the terraced fields; there was no difference in cropped area. Hence 28 per cent of adopters were self-sufficient in maize, compared with 11 per cent of non-adopters and eight per cent of the control group; most, however, remained net purchasers of maize. That these cross-sectional differences reflected changes associated with adoption was confirmed by farmers' comments about trends in their farming system since the time the project began; 92 per cent of adopters said their maize production had increased, compared with 32 per cent of non-adopters and 36 per cent of the control group.

In Pananag, SALT maize farms averaged 2140 kg yr^{-1} whereas non-SALT maize farms averaged 840 kg yr^{-1}. The difference was due to greater cultivated area and higher yields on SALT farms (the latter primarily due to increased fertilizer use and effectiveness). As to trends, 63 per cent of adopters said output of maize had increased, and 59 per cent said maize yield had increased.

In Managok, where maize was both a staple food and the major cash crop, there were no major differences in yield, production, sales or income. Regression analysis indicated that yield was a function of the use of hybrid maize and fertilizer, not hedgerows. Thus, while 68 per cent of adopters said maize yield and output had increased, compared with only ten per cent of non-adopters (indeed, 53 per cent of non-adopters said yield had decreased), this probably reflected greater adoption of seed-fertilizer technology which occurred concurrently with the adoption of hedgerows. For 1993, 66 per cent of adopters and 32 per cent of non-adopters indicated that production met or exceeded household requirements.

In Salogon, where rice was the staple and maize the major cash crop, most adopters, non-adopters and control group farmers said that their output of rice and maize had decreased. There was no difference between adopters and non-adopters in the yield or total output of rice or maize, though both groups had significantly higher maize yields than the control group due to greater use of hybrid maize and fertilizer. This appeared to be the major effect of the project at this site, rather than changes in conservation practices.

In Magdungao, 43 per cent of adopters said their household food supply had increased, but this referred primarily to rice which was increasingly grown in bunded fields, not on the sloping upland fields to which conservation measures were applied. The response from non-adopters was similar.

Farm cash income

The consequences of adoption for farm cash income were sometimes difficult to disentangle from pre-adoption differences in income, as discussed above. In Tabayag, 90 per cent of adopters said farm cash income had increased. Yet, as noted, adopters averaged P5500, non-adopters P1900, and the control group P4700, the last figure corresponding more or less to a weighted average of the first two. This suggests that adopters merely had higher cash income than non-adopters to begin with. Their income advantage over non-adopters was mainly due to higher sales of livestock (goats, cattle, carabao and pigs). While intensive goat-rearing based on the utilization of hedgerows as fodder was part of the project, not all adopters followed this practice and, in any case, the revenue from goats did not account for much of the difference in livestock income.

In Pananag, adopters averaged P18 900 and non-adopters P7200 (there was no suitable control group for this study). The difference was due to greater revenue from maize, other annuals, coffee, legume seed and livestock. Most of these activities (other than coffee) were at least partly related to adoption of contour hedgerows. In particular, legume seed was harvested from hedgerows and sold to the MBRLC, providing an

important new source of cash for the adopters. Hence, 75 per cent of adopters said their income had increased. However, the main reason for the difference in cash income was the difference in farm size, as can be seen by comparing incomes on a unit area basis – P5400 per hectare for adopters and P4200 per hectare for non-adopters.

In Managok, adopters received P19 900 in total cash income and non-adopters, P13 800, the former earning more from maize, rice, cash perennials, livestock and business. The difference was also apparent in farm cash income – P15 500 compared with P11 000. Again, while some of the difference may have been a consequence of adopting conservation measures, most was due to the difference in farm size (farm cash income per hectare was P4800 for adopters and P4200 for non-adopters) and the greater uptake of seed-fertilizer technology noted above. Hence, 70 per cent of adopters said farm cash income had increased, compared with 9 per cent of non-adopters (54 per cent of non-adopters said it had decreased).

In Salogon there was little difference in cash income between adopters and non-adopters, but these two groups earned substantially more from maize than control group farmers. Hence adopters' cash income averaged P6100, that of non-adopters, P5000, and that of the control group, P1700. As explained above, this was because of the greater use of seed-fertilizer technology in the area of the project's influence, not because of the use of conservation measures.

In Magdungao, mean cash income for adopters and non-adopters was very similar and significantly greater than for the control group. However, the mean for non-adopters was inflated by a small number of households receiving remittances. Comparing farm cash income, the figures were P19 100 for adopters, P13 600 for non-adopters and P12 500 for the control group. The main reason for the greater income of adopters was higher production of vegetable crops and, to a lesser extent, coffee. Hence, again, the difference was not a consequence of adoption.

SUMMARY AND CONCLUSION

The process of adoption of conservation farming technologies in the case-study sites was complex and highly variable, and could not be separated from the process of intervention in the villages by government and non-government agencies implementing upland development projects. The case-study sites represented a sample of the better-resourced and more successful projects, yet in general adoption rates were low and diffusion beyond the project site almost non-existent. Even at Guba, the most successful example of long-term, widespread adoption, there was clear evidence of discontinuance. The implications for the vast areas of the uplands not in proximity to the 'nodes of diffusion' created by well-resourced upland projects are not encouraging.

Three broad sets of farmer attributes were examined in relation to adoption: personal attributes, perceptions, and farm attributes. In general, readily measurable personal attributes of farmers (age, education, etc) were not important in explaining adoption. However, age and gender were factors where strenuous work was required to implement the technology (i.e. terracing and rock walls), older farmers and female farmers being less inclined to adopt such measures. Less easily measured traits related to 'innovativeness' and 'managerial ability' were clearly important, particularly among early adopters. Such traits are usually readily identified by community members and experienced extension workers, and were probably correlated with initial levels of farm diversification and cash income.

Awareness of soil erosion was relatively high, but farmer perceptions of soil erosion as a problem varied, partly due to differences in farmers' knowledge, but mainly because of objective differences in soil and farming conditions (e.g. fallow systems versus continuous cropping). Perceptions of erosion clearly had an effect on adoption behaviour. Perceptions of and attitudes to the recommended technologies appeared to be well informed, based on the direct or indirect acquisition of site-specific knowledge over several years. Adopters and non-adopters shared perceptions regarding the labour requirements for establishing and maintaining the technologies, the loss of plantable area, and the delay in obtaining benefits, as well as the undesirable side effects of some forms of hedgerow on weeds, pests and diseases. Nevertheless, contour

hedgerow technology in particular was widely seen (at least *within* project villages) as useful and necessary, easy to learn and easy to acquire (though acquisition of planting materials was clearly a problem in some cases). Beyond project villages, however, there was very little awareness or knowledge of the recommended technologies (particularly regarding methods of implementation), indicating that diffusion does not occur without facilitation.

There were many farm-specific factors which influenced adoption. Adoption was more likely on larger farms. The physical features of individual fields were also important: adoption of hedgerows in particular was more likely on fields which were larger, steeper, had more erodible soils, were located close to the homestead, had relatively uniform terrain, and were oriented down rather than across the slope. In the case of rock walls, obviously the rockiness of the field was a predisposing factor, whereas the prior construction of rock lines discouraged further development. Ownership of lowland fields discouraged investment in upland fields in some contexts.

Land tenure was a major factor, but its influence was high conjunctural. The classification of the land as public or private was only important where farmers occupying public land felt their tenure was insecure *vis-à-vis* the state, in which case stewardship contracts with the government (and the conditions that went with them, including conservation measures) appeared attractive. Otherwise tenancy was the major issue. In general, tenancy discouraged adoption or led farmers to adopt less costly measures, such as grass hedgerows, but the crucial factors were the awareness and attitude of the landowner, which varied enormously.

The labour requirements of the technologies were an important consideration, but the farm-household's labour supply was not a major factor in itself. Rather, it was related to cash flow concerns and the need to use spare labour off-farm in preference to implementing conservation measures. Relatedly, cash income was an important factor promoting adoption, particularly for a subgroup of adopters with high cash income. While all farmers experienced a credit constraint, farmers with higher cash income were less bound by it and therefore able to invest more labour and working capital in their own farms.

In short, differences in personal attributes and perceptions as such were not a major factor explaining differences in adoption within project villages; rather it was the appropriateness or relevance of the technologies to the farmer's specific circumstances (the farm factors) which was the key, emphasizing the need for technologies to be adapted to different sets of farmer circumstances. Analysis of these farm-specific constraints to adoption can assist in the development and promotion of a wider range of technology options (e.g. low-cost, quick-return options for resource-poor, tenant farmers).

The consequences of adoption for the farm-household were difficult to disentangle; in general they were positive, though not substantial. The impact on the farming system was mainly in terms of labour use. There was an unavoidable requirement for a high initial investment of labour which, particularly in the case of hedgerows, created an early-season labour peak. There was also a redistribution (from land preparation to hedgerow maintenance) and a net increase in on-going labour requirements, though this varied from site to site depending on the specific form of hedgerow technology used. There was some evidence that the effectiveness of fertilizer use on conservation plots was increased, encouraging some farmers to apply more and some to apply less; in general, the nutrient cycling aspects of hedgerow technology were overshadowed by use of purchased fertilizer. The balance of farming activities was changing, but not as a direct consequence of adoption. Some farmers (e.g. in Guba and Tabayag) were expanding commercial vegetable production on conservation plots and in some sites hedgerow technology was tied to intensive goat-rearing.

The consequences of adoption for food production were largely indirect. Where adopters obtained increased yields and output this was largely because they had stabilized their sloping land and so were willing to invest more in seed-fertilizer technology. Sometimes the latter phenomenon was a general effect of the project, so that farmers in the project village, who were non-adopters of the recommended conservation technology, nevertheless produced more food than farmers in neighbouring villages, due to increased use of improved production technology. To assess the direct, long-term consequences of conservation technology

for food crop yields and production requires a modelling approach, such as reported by Nelson and Cramb (forthcoming).

The consequences for farm cash income were also indirect and not very important, except in specific cases where hedgerows were productive in their own right (e.g. providing fodder for goats or seed for sale), but these gains could perhaps have been achieved more efficiently in other ways. Most differences in income between adopters and non-adopters were not related to the use of conservation measures, but to differences in farm resources and management ability. The main direction of causation was thus in reverse: better-off, more commercial farmers were more likely to adopt conservation measures.

In conclusion, conservation farming technologies, particularly hedgerows, are widely seen by farmers who are aware of them as useful and even necessary, but it has required resource-intensive project intervention to get the adoption process going, and adoption is often constrained by farmers' specific circumstances (rather than their personal attributes and perceptions). A wider range of more profitable and less demanding conservation technologies is needed, promoted more flexibly and with greater on-going support for farmers in their efforts to experiment with improved farming systems. This implies a need to pursue a major programme of adaptive research and extension in the uplands, which better accommodates the range of farmers' goals and circumstances. Norman and Douglas (1994) provide guidelines for the kind of programme required, incorporating soil conservation and land husbandry into a process of farming systems development. However, as argued elsewhere (Cramb, forthcoming), the higher-order, politico-economic constraints to implementing such a programme in the Philippines are formidable.

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