Chapter 1

Introduction

R.A. Cramb and G.C. Saguiguit

HUMAN-INDUCED soil erosion and consequent degradation of agricultural land in the Philippine uplands has, during the past three decades, come to be recognised as a major environmental and socioeconomic problem. During this period there has been an increasing research effort intended to generate and test improved soil conservation technologies for upland farmers, much of it focused on biological technologies such as contour hedgerows or other forms of agroforestry. Parallel to (in fact, somewhat ahead of) this research effort, there has been a major expansion in the number of upland development projects based on the promotion of such conservation measures. However, it is widely recognised that the adoption of recommended soil conservation technologies by upland farmers has been limited. This has been attributed to a range of biophysical and socioeconomic constraints which make the recommended technologies inappropriate to the circumstances of upland farmers.

The SEARCA–UQ Uplands Research Project (ACIAR Project 1992/011) was developed in response to a need identified by SEARCA and ACIAR to improve the flow of appropriate soil conservation technologies to upland farmers (Blair and Lefroy 1991). The project's particular task was to conduct a socioeconomic evaluation of the conservation technologies being promoted by researchers and upland development agencies. The project adopted a farming systems framework for technology assessment, that is, one which takes as its principal reference the goals and circumstances of farmers in specific biophysical and socioeconomic environments. The assumption underlying this approach is that farmers are intentionally rational in their choice of technology. Hence failure to adopt recommended technology is due to a mismatch between the technology and the farmers' goals and circumstances. To identify such a mismatch and to design more appropriate solutions it is important to involve farmers themselves in the evaluation of technology. Only when new technology is adapted to farmers' local conditions is it fully developed and adoptable.

Rather than directly introducing new technology to farmers, the project aimed to assess the fate of conservation technologies already introduced in various upland project sites scattered throughout the Philippines (Figure 1.1). A combination of rapid appraisal and conventional survey techniques was used at these study sites to

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obtain feedback from farmers on technology adoption and adaptation. This feedback was intended to be of immediate use to researchers and upland development workers at those sites, as well as providing the basis for a more general socioeconomic assessment of the development and dissemination of conservation farming technology for the uplands.

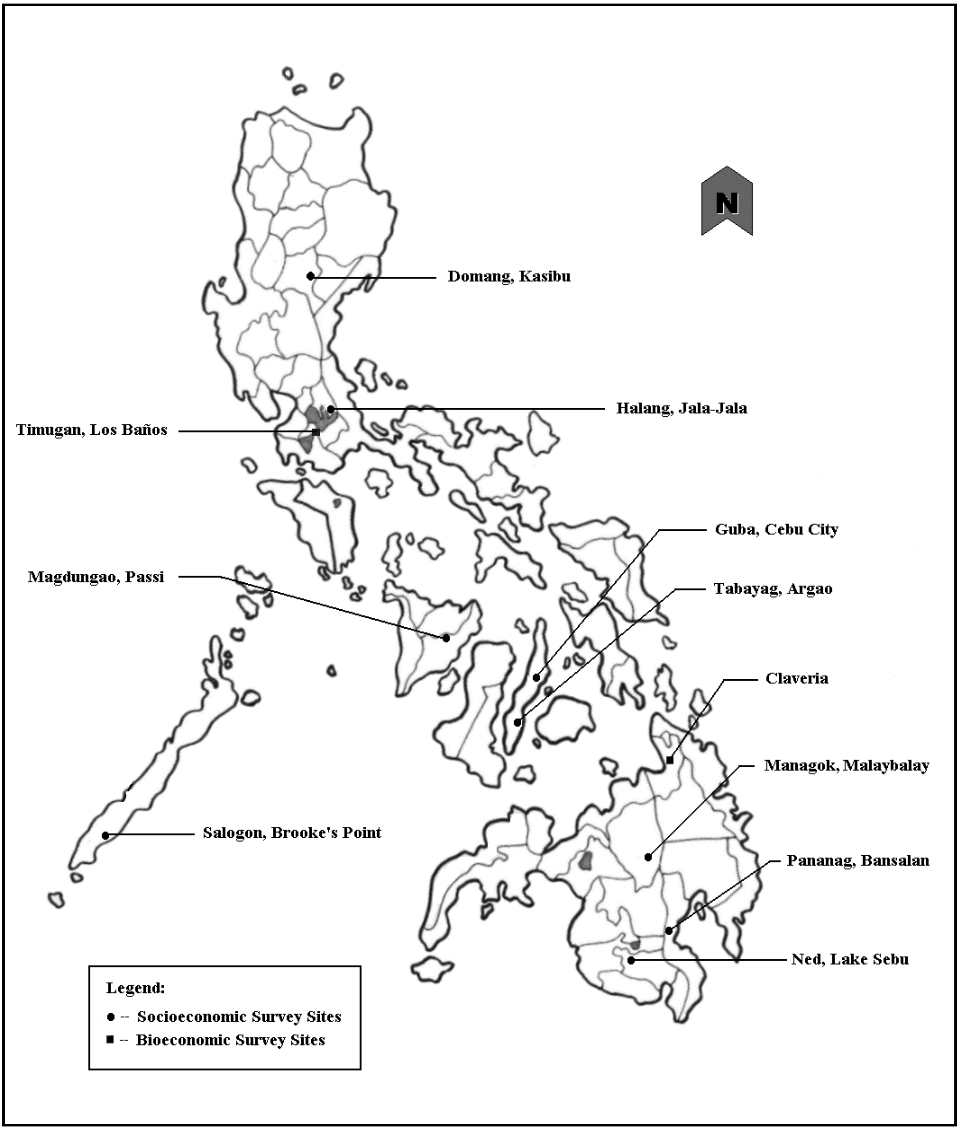

Figure 1.1. Location of Project 1992/011 survey sites.

Complementing the case studies, a bioeconomic modelling approach was used to provide improved estimates of the farm-level benefits and costs of soil conservation technologies. This involved first modelling erosion productivity relationships using experimental data from on-farm trials at two locations, then incorporating the results in a series of benefit–cost analyses based on detailed farm surveys at the same locations (Figure 1.1). Sensitivity analyses were conducted to extend the findings to a range of upland conditions, especially those encountered in the case study sites.

This monograph summarises the findings of the project. Chapter 2 reviews the overall approach used for the evaluation of soil conservation technologies. Chapter 3 sets the scene by using a political ecology framework to examine the macro-level processes behind the problem of soil erosion in the Philippine uplands. Chapters 4, 5, 6 and 7 report on the case studies of upland development projects, with particular emphasis on the promotion, adoption, adaptation and impacts of soil conservation technologies. Chapter 8 summarises the results of the bioeconomic modelling of farmer investment in the main form of soil conservation technology promoted, namely hedgerow intercropping. Chapters 9 and 10 report two specific adoption studies undertaken in conjunction with the project, while Chapter 11 presents the results of a related adoption study undertaken by staff of the International Rice Research Institute. The final chapter returns to the main theme, namely the evaluation of soil conservation technologies, and summarises the main conclusions of the project.

Chapter 2

Research Framework

R.A. Cramb

A Farming Systems Perspective

THE PROJECT approached the evaluation of soil conservation technologies for the Philippine uplands from a farming systems perspective, that is, one which attempts systematically to incorporate an appreciation of farmers' goals, preferences, resource constraints, technologies, and biophysical and socioeconomic environments in the planning, design and evaluation of new farm technologies and policy interventions (Shaner et al. 1982; Hardaker et al. 1984). As mentioned in Chapter 1, the project did not undertake the full farming systems research cycle but concentrated on providing feedback from farmers to researchers, field workers, and policy makers regarding new conservation technologies which had been variously promoted, adopted, adapted and rejected in a variety of specific farm settings.

Farming systems research emerged in the 1970s and has been characterised as (1) farmer-oriented, (2) systems-oriented, (3) problem-solving, (4) multi-disciplinary, (5) involving on-farm research, (6) providing feedback from farmers, (7) complementary to mainstream research and (8) iterative and dynamic (Merrill-Sands 1986). In the 1980s, farming systems research was further developed to focus explicitly on resource-poor farmers and to achieve greater farmer-participation at all stages of the technology/development process (Chambers and Ghildyall 1985; Chambers and Jiggins 1986; Chambers et al. 1989; Merrill-Sands and Kaimowitz 1990), a trend which has continued in the 1990s (Tripp 1991; Scoones and Thompson 1994; Chambers 1997). It was also given a more ecological focus, examining not only whole-farm systems but also agroecological systems (Conway 1985), including agroforestry systems (Raintree 1987). While Doolette and Magrath observed in 1990 that 'farming systems research has not commonly been applied to soil conservation' (1990, p.17), more recently the approach has been incorporated in the methodology of research into sustainable land use systems (Hart and Sands 1992; Garrity 1991), including the development of soil conservation technology (Norman and Douglas 1994).

Evolution of Farming Systems

A basic assumption of farming systems research is that farmers are intentionally rational in the way they manage their farming operations, including their choice of technology (Ruthenberg 1980). That is, they choose technology in order to further their goals, subject to the constraints imposed by resource availability and environmental conditions. This underlying rationality is reflected in the evolution of farming systems as circumstances change.

Boserup (1965) shows how farming systems have evolved historically so as to intensify land use as population pressure on the land increases. Forest-fallow systems evolve into bush-fallow, then short-fallow systems and finally annual or even multiple cropping. Each stage requires a greater labour input per hectare and per worker, therefore a transition from one stage to the next only occurs when the growth of population makes it necessary to increase total food output from a given area of land. In the course of this evolution, technologies are adopted sequentially to suit the requirements of each stage. For example, under short-fallow systems the plough is adopted to cope with the grasses in the fallow which were previously shaded out by forest regrowth.

Pingali and Binswanger (1987) confirm and extend Boserup's analysis, taking into account the characteristics of different soil types and agroclimatic zones, including the problem of soil degradation. For humid zones they argue that, historically, as population density increases, farming moves from the more easily cultivated upper slopes towards the lower slopes and swamplands which, although they require a greater labour input, provide higher returns to investment in land improvement, especially in the case of irrigated rice cultivation. That is, the bottom lands are the least preferred under low population densities but become the focus of intensification efforts as population density reaches high levels. However, where bottom lands are limited in extent or population growth exceeds their capacity to absorb further labour inputs productively, intensive cultivation is gradually extended into the middle and upper slopes, at the expense of communal grasslands and forest.

In the Philippines case, the intensification of the lowlands has indeed begun to level off and the failure of industrialisation to absorb surplus labour has led to the recent and current migration back into the uplands (see Chapter 3). The implication of Pingali and Binswanger's (1987) analysis is that this is the least preferred option of the farmers concerned because the returns to agricultural investment and intensification in the uplands are low, resulting in a low-yield/low-input equilibrium. This means that the returns to investment in soil conservation are also likely to be low, increasing the risk that serious soil degradation will occur. The problem is compounded when the adjacent grasslands and forestlands are subject to open access, resulting in overgrazing and overcutting as well as the unregulated upward extension of the cultivation frontier. Such situations call for the development of new technologies which raise the returns to land conservation and improvement for the farmer, and modified institutional arrangements, such as private land tenure or enhanced community control over common resources, which increase the incentives for conservative management.

The evolutionary perspective provided by Boserup (1965) and Pingali and Binswanger (1987) suggests that the adoption of improved technologies by upland farmers will be a function of the degree of intensification of their farming system. With regard to the adoption of agroforestry technology, Scherr remarks that 'there has been little systematic assessment of the relationship between changing agroforestry technology and underlying patterns of change in farming systems.' As a consequence, 'practitioners lack a theoretical and conceptual framework for evaluating the suitability of agroforestry intervention strategies, or particular types of agroforestry technologies. The resulting ad hoc selection of interventions often leads to the failure of agroforestry projects and missed opportunities to build on farmers' own trends to intensify agroforestry land use' (1992, p.1). Raintree and Warner (1986) analyse the development of agroforestry technology in relation to the intensification of shifting cultivation systems and examine the different agroforestry options which open up at different stages of intensification. Such analysis suggests, for example, that for shifting cultivation systems, research on managed forest-fallows is likely to be more useful than research on more intensive alley cropping (i.e. hedgerow) technologies, which are only likely to be adopted by farmers practising permanent cropping (Garrity et al. 1993).

In addition to population-induced intensification of farming systems, the growth of market opportunities resulting from general economic growth and improvement in rural infrastructure induces the commercialisation of farming systems (Myint 1973; Ruthenberg 1980 chs 1,10; Pingali 1995). This may reinforce the tendency to more intensive production of traditional food crops in order to produce a marketable surplus, or it may result in a shift in farming systems towards different crop and livestock products to satisfy urban demand. The commercialisation process also affects the use of purchased inputs due to lower farm-gate prices and more widespread availability of seed, fertilisers, pesticides, farm equipment and credit (Tomich et al. 1995). The impact of commercialisation on soil conservation could be positive or negative, depending on the characteristics of the crop and livestock enterprises which are subject to increased commercial demand (e.g. an expansion of commercial maize or vegetable production may lead to greater erosion whereas an expansion of commercial fruit and timber production may help conserve the soil). Other things being equal, the increased value of commercial production would be expected to provide additional incentive to invest in soil conservation measures, as well as providing the additional cash needed for such investment (Tiffen et al. 1994). On the other hand, the higher opportunity cost of farm labour resulting from improved access to urban markets may discourage labour-intensive conservation works (Pandey and Lapar 1998).

Constraints to Adaptation of Farming Systems

The assumption of farmer rationality which is central to the farming systems perspective implies that farmers who own their own land will not knowingly allow their soil to degrade, so long as the benefits from investments in soil conservation exceed the costs (Edwards 1991). This proposition calls for a close examination of farmer initiatives in managing their resource base before any interventions are planned, as well as underlining the need for a 'collaborative' or 'collegial' relationship between researchers and farmers in the development of new technology (Merrill-Sands and Kaimowitz 1990; Scherr and Muller 1990). At the same time, the proposition points to a number of reasons for the emergence of soil erosion as a problem.

First, for many soil conservation technologies, the benefits to the farmer do not in fact exceed the costs (Capistrano and Fujisaka 1984; World Bank 1989; Jayasuriya 1991). Low-income farmers in particular may be so preoccupied with short-term survival that the long-term benefits of soil conservation are heavily discounted, resulting in their apparently irrational rejection of recommended soil conservation technologies (Fujisaka 1991). Farmers' near-universal aversion to risk may also inhibit their willingness to invest in soil conservation if the proposed changes to their farming systems are perceived to have highly uncertain outcomes (Anderson and Thampapillai 1990). Moreover, farmers frequently do not have secure property rights over the land they farm and their incentive to undertake investments which have a pay-off only in the long term are correspondingly reduced. In addition, farmers in marginal uplands, especially those with insecure tenure, typically lack access to credit, limiting their capacity to invest in soil conservation (Anderson and Thampapillai 1990).

Farmers may also lack knowledge about the impact of their farming practices on the rate of soil erosion, or about improved farming practices which can reduce erosion. While there is good evidence that long-established farmers are well aware of adverse trends in their resource base and have a fund of indigenous technical knowledge to help them cope (e.g. Fernandez and Serrano 1990; Scherr 1992), it is also true that too-rapid intensification, particularly if it is associated with in-migration from a different agroecological zone, may exceed farmers' capacity to adapt (Edwards 1991; Fujisaka 1991). There is also the consideration that soil erosion in the uplands may be causing significant off-site damage, hence the rational farmer's level of investment in soil conservation may be sub-optimal from society's point of view (Anderson and Thampapillai 1990). Finally, farmers may be inhibited from pursuing rational soil conservation measures because of the perverse effects of government policies, such as those which distort the relative prices of annual food crops and perennial crops (Anderson and Thampapillai 1990; Jayasuriya 1991).

In brief, assuming farmer rationality does not imply that whatever farmers do is necessarily optimal, particularly if the possibility of new technologies is taken into account. An awareness of the range of factors listed above suggests ways in which technologies could be developed to fit better within farmers' constraints, as well as ways in which policy interventions could be designed to modify those constraints.

Technology Development

In the conventional view of agricultural research and development, technology emanates from 'upstream' activities in the formal research system and is adapted by 'downstream' research until it is ready for dissemination to farmers (Biggs 1990; Biggs and Clay 1981). Anderson and Hardaker (1979) use an analogy from home economics rather than hydrology, speaking of quarter-baked (notional), half-baked (preliminary) and fully-baked (developed) technology. In a similar fashion, Scherr and Muller (1991) refer to the development of agroforestry technologies in terms of experimental, prototype and off-the-shelf technologies. For example, the notion of contour hedgerows for alley cropping on sloping land provides the basis for detailed experimental work on a contour hedgerow system which indicates that such a system is technically feasible and can increase crop yields, reduce soil erosion and provide additional products and services. However, this preliminary or prototype technology is not fully developed, or ready for 'off-the-shelf' implementation, until it is adapted to the specific goals and circumstances of individual farmers, for example, through modifying the cropping pattern, the choice of hedgerow species, the management of the hedgerow, and so on.

In practice, this means that the process of technology development cannot be separated from the process of technology adoption by farmers (discussed below). As Anderson (1993) notes, adoption and adaptation are intertwined in that adaptation of the technology frequently occurs in the process of implementing it on-farm, a phenomenon which Rogers (1995) terms 'reinvention'. Sumberg and Okali (1997) go further, arguing that such adaptation is the norm, resulting from an on-going process of 'farmer experimentation'. This experimentation is not confined to a few research-oriented farmers, but is the process by which almost all farmers incorporate technology into their farming systems. Technology supplied by the formal research and extension system thus becomes 'raw material' for farmer experimentation. In terms of the above analogies, rather than acquiring a 'fully-baked' technology 'off-the-shelf', farmers can be viewed as shopping around for 'ingredients' or technological components which they incorporate into their own recipes. In other words, technology is only fully developed or adapted as part of a specific, operational farming system.

Methods for evaluating new technology vary with the stage of technology development. According to Anderson and Hardaker (1979), notional technology can be evaluated by using intuition or formal analysis (e.g. modelling). Preliminary technology requires substantive evaluation techniques, including laboratory experiments and on-station field experiments. Developed technology requires evaluation under real-world conditions, for example, on-farm experiments and pilot projects. In general, evaluation becomes more costly as the technology becomes more developed. This is because the evaluation techniques in themselves become more costly (e.g. on-farm experiments are more costly than on-station experiments). Also, the more developed the technology the more location-specific it is. This raises the cost of evaluation by requiring that evaluation be done in many locations. If the direct cost of evaluation is kept down by restricting the number of locations, the opportunity cost of neglecting other locations will be high. Moreover, given that farmers' circumstances are continually changing, the adaptation of technology is an on-going process. The implication is that too much fine-tuning of technologies by researchers before assessing their acceptability to farmers is inappropriate. Technologies should be evaluated from a farming systems perspective when they are at the notional or preliminary stage and thus still potentially applicable across a wide range of farmer circumstances. Promising 'prototypes' can then be selected for development with farmers in various locations.

With regard to soil conservation technologies, there is a widespread perception that appropriate practices have been known for decades and that it is only a matter of providing the right incentives for smallholders in developing countries to adopt them (Biot et al. 1995). However, this is to ignore the changes in recommended soil conservation practice which have occurred in recent decades. In particular, there has been a trend away from the implementation of engineering works designed to manage surface run-off on a catchment basis (e.g. the US and Australian model of graded channels and grassed waterways) towards the utilisation of a combination of contour-based biological and physical measures designed as far as possible to retain run-off within individual farmers' fields, while at the same time providing short-term production benefits (Hudson 1992, 1995; Norman and Douglas 1994). The new approach involves a change in emphasis from erosion control as an end in itself to improved soil and water management for crop and livestock production, or 'land husbandry' (Hudson 1992; Shaxson et al., 1997). The potential role of agroforestry measures, such as contour hedgerow intercropping, within this new approach to soil conservation has been given special prominence (Kang and Wilson 1987; Young 1989).

While it is true that there are many technologies which can be utilised in new-style soil conservation projects for smallholders (e.g. Sheng 1989), in most cases they have only been systematically tested on moderately sloping land, and even then not for the full range of farmers' circumstances. Hudson maintains that 'our understanding of the physical processes of soil erosion on steep lands is limited' and that 'we have not devoted sufficient attention to developing technology to improve production and limit erosion on steep or marginal land' (1992, pp.87,113). For example, while hedgerow intercropping may be applicable on gentle to moderate slopes, it has only speculative potential on steep slopes (Young 1989; Hudson 1992, p.102). While recent research in the Philippines and elsewhere has extended our knowledge of the physical processes of soil erosion on steep lands, particularly with regard to the role of overland flow (Coughlan and Rose 1997), Hudson's point about the tentative nature of available technologies remains valid.

Scherr and Muller also observe that 'most agroforestry technologies that are currently available are 'prototypes', that is, specific 'best bets' whose designs are based on available information within and/or outside the project area, which are generally not validated locally. These may be introduced on a pilot basis with intensive monitoring and farmer input for validation and adaptation to local conditions' (1990, p.263). Similarly, Craswell and Pushparajah argue that 'the use of agroforestry systems to stabilise hillsides in Southeast Asia would seem to have wide application.... However, more on-farm research is needed to evaluate these technologies and identify key factors determining the rates of farmer adoption, which have been disappointingly slow in many areas' (1991, p.96). With regard to the Philippines, Garrity et al. conclude: 'The experience of the past 15 years with alley cropping and contour hedgerows suggests that appropriate solutions must be uniquely tailored to diverse soil and environmental conditions, farm sizes and labour availabilities, markets, and farmer objectives' (1992, p.23). They add that 'there has yet been little attempt to clarify the appropriate hedgerow technologies for the range of specific local physical and institutional settings' (1992, p.23).

Given the preliminary nature of much of the technology designed for upland farmers, development projects in upland areas have selected 'best bet' or 'prototype' technologies for implementation. Scherr and Muller (1990, 1991) reviewed 108 agroforestry projects worldwide. They remark that 'in most cases, agroforestry technologies promoted in development projects are disseminated to farmers without formal verification of their effectiveness in meeting project or farmer objectives. This is due to the lack of applied and adaptive research results, and the time pressures of the typical project life cycle' (1991, p.236). As a consequence, many projects have incorporated technology assessment procedures in order to improve their extension recommendations during the course of the project, though 'technology evaluation by projects is mostly limited to biological aspects and to variables that are conventionally assessed in agriculture and forestry research [e.g. tree survival and growth]' (Scherr and Muller 1990, p.267).

There is thus considerable scope for conducting technology/evaluation research on both ongoing and completed development projects, to examine the fate of new technologies under farmers' conditions. Raintree (1987) and Scherr and Muller (1990, 1991) provide methodological guidelines for such research. Scherr and Muller suggest that 'projects and researchers work much more closely together in agroforestry research and development. Projects can play valuable roles in generating hypotheses to be tested by researchers and also in identifying needed methods which can be developed through research' (1990, p.279). Raintree concludes a lengthy review of ICRAF's diagnosis and design procedures by observing: 'Ultimately, ... the theory and practice of agroforestry diagnosis and design must come to rest on the empirical foundation of a large body of case study results. At present, although there is a growing knowledge base on agroforestry techniques from research projects and from the study of existing agroforestry systems, there is still a paucity of published case study material' (1987, p.242).

Thus, in implementing conservation technologies in the Philippines, both farmers and the upland development agencies which seek to assist them are still largely involved in a process of trial and error. Notwithstanding the confident assertions of project documents, there can be no firm technological recommendations nor unambiguous prediction of impacts. In these circumstances, we should expect considerable development of project technologies in the process of implementing them on farmers' land. There is a need to analyse and evaluate these farmer and project 'experiments' in order to improve the process of technology (re)design. This was the strategy adopted in Project 1992/011.

Technology Adoption

The preceding discussion implies that the rate and extent of adoption of a new technology by farmers should be taken as prima facie evidence of its appropriateness (at least at the farm level). As Garrity et al. (1998) emphasise, technologies cannot be considered appropriate (that is, the technical problem cannot be considered 'solved') if farmers are not able to adopt them. Hence 'adoptability' becomes a key criterion in technology evaluation. There is a long tradition of socioeconomic research into the factors affecting the diffusion and adoption of agricultural technology (Jones 1967; Feder et al. 1985; Lindner 1987; Anderson 1994; Rogers 1995). Nevertheless, much of this research has undergone a critical re-examination in recent years.

In Lindner's (1987) view, the essence of the technology adoption process is that it involves the progressive acquisition of information (learning) about the technology in question, and a sequence of risky decisions (in that uncertainty exists about whether the decision-maker will be made better or worse off by adopting the technology). As the decision-maker learns more about the technology, either by experience or observation, his/her decision to adopt or not is periodically reviewed. From this perspective, the factors affecting adoption of a given technology are those which influence the decision-maker's state of knowledge about the available options and his/her evaluation of that knowledge in terms of utility maximisation. As Parton argues, however, there remains a need to identify and analyse the many observable socioeconomic factors which affect the decision-maker's subjective utility as 'it is these underlying influences which are the targets of policy intervention and extension efforts' (1992, p.113).

The view of adoption as a process of learning and decision-making leads naturally to the delineation of stages of adoption (Lindner et al. 1982; Sinden and King 1990; Rogers 1995). Anderson (1993) emphasises the need to examine the steps in adoption decision-making in order to determine appropriate points of intervention, so as to achieve higher payoffs to research and better outcomes for farmers. He distinguishes three stages: establishing a mind-set for change (influenced, for example, by input suppliers, extension services, orchestrated field tours and farm visits); learning the particularities of the technology (e.g. by observing neighbours, pilot testing, seeking other people's experience and views); and implementing the new technology (including, for example, planning for adjustments, arranging credit, and adopting some elements in a package).

Implementation itself, however, can involve several sub-stages which may need to be distinguished. In the case of agroforestry technology such as hedgerow intercropping, three levels of adoption can be identified: willingness to test the technology on-farm; willingness to maintain and manage the technology; and extension of the technology to other pieces of land, or re-establishment at the end of its life-cycle (Scherr and Muller 1991). Frequently, adoption in the first sense, usually within the context of a development project, is taken as evidence of adoption in the second or third senses. Strictly speaking, however, adoption means 'the integration of a new concept, activity or input as part of the pattern of normal practice.... It implies repeated usage over time, and adaptation to farm specific requirements' (Scherr and Muller 1991, p.244). Thus, as noted above, new technology is almost invariably adapted or 'reinvented' in the process of implementing it on-farm.

The conventional adoption framework explains the adoption decision and its timing (early or late) primarily in terms of the decision-maker's perceptions and inherent characteristics, with 'innovators' at one extreme and laggards' at the other (Rogers 1995). However, farmer decision-making is generally more complex than this implies. As Scherr (1995) emphasises, farmers have multiple objectives (including food security, adequate cash income, a secure asset or resource base, social security) and select 'livelihood strategies' to pursue these objectives with the resources available to them (see also Ellis 1997). Both the objectives and the available resources vary between farmers and change over the life-cycle of the farm household (e.g. some farmers at some times may rely on off-farm work as a major source of livelihood, restricting their capacity to invest in labour-intensive conservation measures). Thus farmers in the same environment may have different objectives and livelihood strategies, and so respond differently to a given conservation technology. Hence Biot et al. suggest that 'different behaviour [with respect to soil conservation] may be as much a function of different opportunities and constraints as of different perceptions' (1995, p.24).

The adoption framework further simplifies the analysis of the adoption decision by its implicit assumption of an individual 'decision-maker'. Within the farm household, the ability to make decisions regarding resource use and technology varies according to age, gender, and other categories, and actual decisions can depend on a complex bargaining process among household members (Ellis 1993, ch. 9; Jackson 1995; Biot et al. 1995). Beyond the household, group processes and the ability to harness them can play a crucial role in adoption decisions, particularly with regard to conservation practices (Chamala and Mortiss 1990; Chamala and Keith 1995; Frank and Chamala 1992; Pretty and Shah 1994). Moreover, decisions about new technology are frequently prompted by an intervention of some sort, typically in the form of a project. As Long and Van der Ploeg argue, such interventions involve a variety of social actors, with diverse histories and agendas, from both within and beyond rural communities. Hence a project intervention needs to be recognised as part of 'an ongoing, socially-constructed and negotiated process, not simply the execution of an already-specified plan of action with expected outcomes' (1989, p.228).

These considerations lead us to expect a range of responses to the promotion of a soil conservation technology, not merely a clear-cut decision to adopt or not. Differences between the environment in which the technology was developed and the environment of the 'target' community will prompt farmers to adapt the technology in the process of adopting it. Differences within a given community in farmers' goals and circumstances, hence livelihood strategies, and the complexity of intra-household, group, and project interactions and decision-making, will result in a variety of adoption/adaptation behaviours, which should be investigated on their own terms and not pre-judged by labelling them as 'poor adoption' or 'non-adoption'.

More generally, the above discussion reinforces the need to move beyond the conventional or 'transfer-of-technology' approach, or even 'farming systems research' with its increased emphasis on farmers' perspectives, to 'participatory technology development', in which researchers and farmers collaborate at all stages of the technology development process (Scoones and Thompson 1994; Okali et al. 1994). While the benefits of pursuing yet another new methodology should not be taken for granted (Biggs and Smith 1995), participatory technology development does have the potential to incorporate directly the complexity and dynamic nature of farmers' goals and circumstances in the on-going evaluation of technology options, resulting in a genuinely adaptive research process (Fujisaka 1993).

Research Hypotheses

Based on the above considerations, a number of hypotheses were developed to guide the research in this project. The general or underlying hypothesis was that upland farmers are intentionally rational in their choice of technology. As previously stated, this means that they choose technology in order to further their goals, subject to the constraints imposed by resource availability and environmental conditions. Hence 'adoptability' can be taken as the primary criterion for evaluating new soil conservation technologies. Specific hypotheses flowing from this proposition included the following:

- Upland farming systems are evolving or intensifying in response to the growing population pressure on the land, and this evolution includes the adoption of measures to reduce soil erosion in situations where soil erosion is perceived as a problem. As a concomitant, farmers' response to introduced soil conservation technology will be a function of the stage of evolution or degree of intensification of the farming system.
- Upland farming systems are also evolving in response to changing commercial opportunities as urban markets grow and rural infrastructure is developed, increasing effective demand for both farm products and rural labour. Hence farmers' response to soil conservation measures will also be a function of the degree of commercialisation of the farming system.
- The rate of evolution or adaptation of upland farming systems is constrained by the limited availability of new technological components (cropping systems, tree species, management practices, etc.) which are suited to local conditions.
- The rate of evolution or adaptation is also constrained by elements in the socioeconomic environment, including community management structures, land tenure arrangements, credit facilities, input supply, transportation and marketing infrastructure, and extension services.
- The rate of adoption of soil conservation technologies will be increased by genuine farmer participation, at both household and community levels, in the design and adaptation of the technologies and the planning of upland development projects intended to promote them.

These hypotheses provided a focus for the case studies and bioeconomic modelling work described in subsequent chapters.

Chapter 3

Agricultural Land Degradation in the Philippine Uplands: an Overview

R.A. Cramb

SOIL EROSION has been seen as a major environmental problem in poor countries since the colonial era, and governments, colonial and post-colonial, have implemented numerous programs and policies to promote soil conservation technologies among farmers. However, the long-term impact of these programs worldwide has been singularly disappointing. Blaikie remarks that 'while techniques within pilot projects have enjoyed some success, their extension and implementation over wide enough areas and numbers of people to have an appreciable effect in reducing erosion and improving food production have almost universally met with slow progress or failure' (1985, p. 4). Similarly, Pretty and Shah conclude: 'By all performance measures, conventional SWC [soil and water conservation] programmes have been remarkable failures. Little has changed this century.... Few farmers benefit, structures rarely persist, and inadequate implementation by outside technical teams causes erosion rather than prevents it' (1994, p.18).

The explanations for this widespread failure vary. Pretty and Shah emphasise three factors which have undermined success, namely 'the high cost of project packages, the selection of inappropriate technologies, and the lack of incentives for farmers to maintain conserving measures and practices' (1994, pp.11,12). At the same time they point to 'a growing number of mostly small-scale programmes that are sufficiently successful to suggest the need for application on a much wider scale.... These have adopted flexible, inter-disciplinary and long-term approaches that build upon local knowledge and skills, reinforce local social organisation, doing so through the active participation of rural people' (1994, p.18). That is, they see a need to move from what has been variously referred to as a 'classic', 'paternalist', or 'transfer-of-technology' approach to a 'populist', 'participatory', or 'farmer-first' approach (Chambers et al. 1989; Biot et al. 1995).

While agreeing with the desirability of such a farmer-oriented approach at the local level, Blaikie draws attention to more fundamental constraints, namely, 'that the causes of soil erosion may be outside the afflicted area altogether; that the state is not neutral and cannot necessarily solve soil erosion problems rationally or impartially;

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and that there are always winners and losers in erosion and conservation' (1985, p.5). Thus successful small-scale or pilot projects 'which do not test the implementing capacity of government institutions nor involve themselves in large-scale politically sensitive issues' are typically not replicable on a scale which matters (1985, p.4). To be realistic, therefore, it is necessary to examine the problem of soil erosion and land degradation at various levels, from the local to the international.

The role of this chapter is, at the outset, to place the problem of soil erosion and land degradation in the Philippine uplands in a broader context than that of specific farming systems or technologies. The chapter begins with a brief discussion of the approach used to contextualise the problem of soil erosion, then examines in turn some of the important links in a 'chain of explanation', including the pattern of land use, demographic change, the economic environment, the agrarian structure, and the institutions involved in upland development and conservation. The chapter concludes with a summing up and a brief assessment of the prospects for change.

The Political Ecology Framework

Blaikie and Brookfield outline a framework for multi-level and interdisciplinary analysis of land degradation which they term 'regional political ecology', combining the concerns of ecology with those of a 'broadly defined political economy' (1987, p.17). This framework, which has been further developed and applied by Blaikie (1989, 1994, 1995), relies on 'progressive contextualisation or 'nested scales of analysis' to place the local-level manifestations of land degradation within a wider political economy context:

> [E]ssentially the approach follows a chain of explanation. It starts with the land managers and their direct relations with the land (crop rotations, fuelwood use, stocking densities, capital investments and so on). Then the next link concerns their relations with each other, other land users, and groups in the wider society who affect them in any way, which in turn determines land management. The state and the world economy constitute the last links in the chain (Blaikie and Brookfield 1987, p.27).

These various levels can be conveniently if crudely grouped into micro (farmers and fields), meso (communities and catchments), and macro (governments and global institutions). Blaikie and Brookfield (1987) tend to highlight the downward direction of causation, from macro- to micro-levels, such that the wider political economy is conceived as exogenous to the choices and actions of land managers (e.g. see their decision-making model on page 70). However, subsequent work gives greater emphasis to the importance of interaction between levels, with action at the micro- and meso-levels, for example, capable of mediating or modifying macro-level interventions or constraints (Black 1990; Long 1992; Biot et al. 1995; Leach et al. 1997).

The links in a chain of explanation are not only between levels of analysis, but across an array of social and environmental processes at any one level. In this respect, the regional political ecology approach places considerable emphasis on the multi-faceted nature of 'marginality' in framing explanations of land degradation. Blaikie and Brookfield (1987) distinguish three interrelated concepts of marginality: ecological, economic and politico-economic. A process of politico-economic marginalisation (say through urban bias in development policies (Lipton 1977)), may push land users to extend the economic margin of cultivation (beyond which it is not profitable to apply further inputs to the land, including conservation inputs (Barlowe 1986)), resulting in the use of ecologically marginal land (such as upland soils which are highly sensitive to disturbance and low in resilience (Stocking 1995)), thereby precipitating or accelerating land degradation (though the three forms of marginality do not necessarily coincide in this way). Black (1990) considers that the concept of politico-economic marginalisation as used by Blaikie and Brookfield (1987) is ambiguous, being attributed variously to incorporation in and exclusion from global economic processes. He presents evidence to show that it is exclusion or isolation from wider economic opportunities which marginalises poor farmers in upland areas, whereas integration (e.g. through non-farm wage employment) can enhance their ability to manage their land. This, however, is an empirical issue with quite region-specific, and perhaps household-specific outcomes (e.g. Windle and Cramb 1997; Ellis 1997).

Blaikie and Brookfield comment that 'the knack in explanation must lie in the ability to grasp a few strategic variables that both relate closely together in a causal manner, and which are relatively sensitive to change. In that way the most promising policy variables and paths of social change can be identified' (1987, p.48). However, they have been criticised for lack of theoretical rigour, such that 'their conception of political economy appears woolly ... and dispersed [hence] ... their chains of explanation seem incapable of explaining how factors become causes' (Peet and Watts 1993, p.239). Similarly, Black views them as opening 'a Pandora's box of possible processes and outcomes' (1990, p.45). However, this seems to be expecting too much of what is essentially a framework for analysis rather than a comprehensive model in its own right. New theoretical tools can be utilised within this framework. For example, the concept of 'environmental entitlements' developed by Leach et al. (1997) helps trace the interaction between human agency and institutional structure at various levels. Likewise, the concept of 'development coalitions' elucidates the way in which social actors form complex alliances, again across various levels, which can direct the path of technical and institutional change (Biggs and Smith 1995, 1998). The framework also provides a useful guide for further case studies, through which theoretical generalisations and policy approaches can be tested and refined. Given the complexity and uncertainty surrounding the phenomenon of land degradation, and the tendency to base policies on simplified, uni-causal explanations, the more open and eclectic approach followed by Blaikie and Brookfield (1987) is to be preferred.

It is the argument of this chapter that a regional political ecology approach is particularly helpful in understanding the problem of soil erosion and conservation in the Philippine uplands, and is necessary to contextualise the specific issues relating to the adaptation and adoption of conservation farming technologies which were the focus of Project 1992/011. Subsequent sections develop some of the links in a chain of explanation, beginning with the landscape itself and the land use practices which have given rise to accelerated soil erosion and land degradation. It will be obvious that the focus of the discussion, as of Project 1992/011 itself, is on small-scale agriculture in the uplands rather than other sources of land degradation, notably logging, extensive grazing, and plantations. The scale of analysis is also largely confined to the macro-level, to keep the discussion manageable, hence relations among land users at the local level, including gender relations, are not considered, except in relation to land tenure. Micro- and meso-level processes will be addressed more directly in other chapters in this volume.

Landscapes, Land Use and Land Degradation

While the Philippines is often associated with irrigated rice cultivation using 'green revolution' technology in extensive floodplains, steep upland areas with slopes of 18% or more account for 15 million ha or just over half the total land area (Cruz and Zosa-Feranil 1988). Soils are relatively favourable for agriculture but vary considerably; in upland areas, acidic, infertile soils predominate (Garrity et al. 1993). The Philippines experiences a humid, tropical climate, but the complex physiography, combined with the effects of the monsoons, and of cyclones in the northern half of the country, result in considerable local variation in the amount and seasonal distribution of rainfall. The combination of steep slopes and high rainfall, frequently concentrated in intense rainfall events, creates the potential for serious soil erosion, particularly where the land is cleared and the soil disturbed through cultivation (World Bank 1989). The varied nature of the environment ensures that strategies for containing soil erosion are highly location-specific.

There are three broad land use zones in the uplands: permanent agricultural land, grassland and forest land (Garrity et al. 1993). Agricultural activities of varying intensities occur in all three zones. The permanent agricultural land is predominantly found on the lower slopes closest to the lowlands and to roads. With increasing elevation and remoteness, grasslands come to dominate. The remaining forested areas occur at the highest elevations and on the steepest slopes. At the same time as the grasslands are advancing into the forested zone, permanent agricultural land is expanding into the grasslands, such that both forest land and grasslands are declining in total area while land under permanent agriculture is increasing.

While most of the uplands were forested in 1950 (and are still anachronistically classified as 'public forest land'), rapid deforestation had reduced forest cover in the Philippines from 50–60% of the total land area in 1950 to around 20%, or 6–7 million ha, by the 1980s (World Bank 1989; Kummer 1992). Old-growth dipterocarp forests, the most valuable, had declined to under 3 million ha by the early 1980s, compared with 10 million ha in the mid-1950s (World Bank 1989). Estimates of the annual rate of deforestation during the 1980s range from 150,000 ha (Kummer 1992) to 320,000 ha (World Bank 1996). Hence 'less than half the uplands remains under any significant level of tree cover' (World Bank 1989, p.10). The primary cause of deforestation has been logging, legal and illegal. Though clear-felling has not generally been practised, logging operations have converted primary forest to degraded secondary forest, opened up the forest to farmers practising shifting cultivation, and rendered the forests susceptible to fire. The combined effects of logging, shifting cultivation, and uncontrolled fires have led to the conversion of forest to grassland (Brosius 1990; Coloma 1990; Kummer 1992). As well as its impact on forest cover, 'commercial logging is a major contributing factor to land degradation and soil erosion', mainly due to access roads and skid trails (World Bank 1989, p.19).

The total area of grassland in the Philippines probably now exceeds the area of forest. The area of pure grassland is almost 2 million ha, with another 10 million ha of extensive cultivation mixed with grassland and scrub (Sajise and Ganapin 1991). The grasslands are commonly used for low-productivity, extensive grazing. Annual burning to provide livestock with fresh growth helps to maintain a grassland climax and contributes to the spread of fires in remaining forest land (Coloma 1990). Overstocking during the period of regrowth after burning is said to result in severe soil erosion (World Bank 1989). Small-scale farming in the grasslands using draught animals is increasing as landless migrants move in. As shifting cultivation systems are progressively intensified the zone of permanent agriculture advances into the grassland (Kummer 1992; Garrity et al. 1993; Garrity et al. 1997).

Cultivated land accounts for about 11 million ha or 38% of the total land area of the Philippines (Garrity et al. 1993). In the 1980s the total cultivated area increased by about 230,000 ha per year, a rate of over 2%. Most of this expansion occurred in the uplands, primarily through the conversion of grassland and logged-over forest to cropping (Kummer 1992). The cultivated area in the uplands is around 4 million ha; the rapid extension of this cultivated area is a direct result of the growth of the upland population, both through natural increase and in-migration. Upland agriculture occurs at altitudes of 500–2,000 metres above sea level and on slopes of 20–45% (Cruz and Zosa-Feranil 1988). Farming systems in the uplands are primarily oriented towards subsistence production and include extensive shifting cultivation, as practised traditionally by upland communities; intensive shifting cultivation; permanent cultivation; home gardens; grazing; and any combination of these. The crops grown include annuals, primarily maize, upland rice, and various root crops, and tree crops, such as coconut and fruit trees. Over time there has been a tendency towards intensification of land use, with long-fallow shifting cultivation systems evolving into permanent upland cultivation (Kummer 1992; Garrity et al. 1993). This intensification process has increased the risk of soil erosion and land degradation. While there are many examples of the development of indigenous technology to help conserve soil productivity under more intensive cultivation, the rate of expansion and intensification in the uplands is widely thought to have exacerbated the problem of soil erosion (World Bank 1989; Garrity et al. 1993).

The problems of measuring the extent of soil erosion and land degradation, and the on-site and off-site impacts, particularly in developing countries such as the Philippines, are well known (Stocking 1987; 1995). Hence it is not surprising that a major World Bank review of natural resource management issues in the Philippines found very little firm evidence regarding the extent of soil erosion: 'The evidence ranges from informed speculation to extrapolations from limited empirical studies, and does not inspire too much confidence' (1989, p.25). Nevertheless, the report concludes that 'land is likely to be prone to soil erosion in a country where more than one half is over 18% in slope, and mostly mountain forest land with thin topsoil layers; rainfall is heavy and seasonally concentrated, and typhoons are frequent; and where logging, shifting cultivation, and grazing have removed a large proportion of protective cover. These facts — rather than actual surveys — account for the alarming statistics on the areal extent of badly eroded land which are sometimes recited in the Philippines' (1989, p.25). The report estimated that short-fallow plough cultivation on steep slopes results in erosion rates of 300–400 t/ha/year, and that similar rates occur on grasslands which are burned regularly and overgrazed. Similarly, in another important review, Garrity et al. conclude: 'The high relief, the relatively high levels of precipitation, and the frequent extreme concentration of rainfall in short periods because of typhoons contribute to serious soil erosion problems' (1993, p.551).

Field observations and modelling work in Project 1992/011 tend to confirm this overall picture, though they suggest that the World Bank estimates of erosion rates under cropping are probably too high (see Nelson and Cramb, this volume) and also underscore the wide regional variation in the severity of the problem (hence the need to be wary of blanket prescriptions). In terms of the sensitivity-resilience matrix proposed by Blaikie and Brookfield (1987), a large proportion of the uplands is highly sensitive to degradation once opened up for continuous or short-fallow cultivation (as evidenced by the rapid erosion at a study site of relatively recent settlement at Ned in Southern Mindanao), and not very resilient once the usually thin layer of topsoil has been removed and the land begins to 'grow rocks' (as evidenced by the difficulty and cost of rehabilitating a long-degraded study site at Tabayag in Cebu).

Population Pressure on Upland Resources

Blaikie and Brookfield critically examine the notion that population pressure on resources (PPR) in developing countries inevitably causes land degradation. They argue that '... PPR can be seen both as creating a need to exploit resources in environmentally sensitive areas in such a way as to expose them to damage, and also as providing the means of a labour-intensive management system which seeks to contain the consequences. There is no reason, even on *prima facie* grounds, why both cannot be true' (1987, p.32). Hence merely citing evidence of population growth in rural areas is not in itself an explanation of land degradation. Nevertheless, the magnitude of demographic change in the Philippines makes it necessary to include this variable in any explanatory framework.

The population of the Philippines was 70 million in 1995 and still growing rapidly (2.5% for 1990–95, the highest population growth rate in Southeast Asia) (Asian Development Bank 1996). The population density is over 220 persons per square km, also the highest in Southeast Asia (apart from Singapore). There has been considerable internal migration in the postwar period, to Metro Manila and adjacent provinces on the one hand, and to the uplands, particularly in Mindanao, on the other. The upland population was estimated to be 18 million in the mid-1980s (hence it is probably now more than 20 million), of which 8.5 million (about half) were residing on public forest lands (Cruz and Zosa-Feranil 1988). About 6 million, or one third of the total, belonged to 'cultural minorities' (non-hispanicised indigenous groups) occupying their 'ancestral lands'; two thirds were lowland farmers who had migrated into the uplands in recent decades. The growth of the upland population continues to be rapid. Serna describes the upland population as the 'poorest of the poor' and attributes their poverty to 'low farm productivity, limited access to support services, unavailability of alternative employment opportunities, and very limited access to basic social services' (1990, p.104).

There is certainly evidence for the position of Blaikie and Brookfield (1987) that population growth can cut both ways. Project 1992/011 found that adoption of conservation measures such as hedgerow intercropping was most difficult to achieve in provinces such as Palawan with a relatively low population density, while the most widespread adoption occurred in the densely populated Cebu province, where there is some evidence of environmental recovery (Kummer et al. 1994). Where the land/labour ratio is high and rotational farming is still possible, there is little incentive to adopt permanent conservation measures, whether physical or vegetative. Conversely, the loss of farm population due to off-farm employment opportunities can threaten existing conservation structures, such as the magnificent rice terraces at Banaue, because of the lack of labour to maintain them.

Nevertheless, the evidence appears overwhelming that the rate of population growth in the uplands and, perhaps as important, the degree of population movement between provinces and farming zones, has made it difficult for most farmers to adapt their practices sufficiently rapidly to forestall serious land degradation. Hence population pressure on land resources is a major proximate cause of soil erosion. This is not to suggest that population policy alone can remove the pressure on resources (quite apart from the difficulties associated with this issue in a conservative, largely Catholic country, with a politically powerful church leadership). The 'chain of explanation' must link the growth and movement of population to the issue of rural poverty, leading to an analysis of economic and agrarian structure.

Economic Structure and Performance

Around 1950 the Philippines had the highest GDP per capita in Asia after Japan and Malaysia. However, a policy of import-substituting, capital-intensive industrialisation resulted in slow growth, high levels of unemployment and poverty, and adverse conditions for small farmers and rural dwellers (Balisacan 1996). The highly regulated economy also created the potential for major corruption; under Marcos, the dispensing of economic privileges to select groups close to the ruling elite was rampant. Short-sighted policies and continued dependence on volatile external finance has created a crisis-prone economy with a low rate of capital accumulation (Montes and Lim 1996). While there has been a shift towards labour-intensive exports (electronics, garments) since the 1970s and to heavy industry since the 1980s, according to Balisacan the essential structure of the Philippine economy is 'still Latin American rather than Asian: extremely high import content of manufactured exports, inefficient and highly capital-intensive manufacturing sheltered behind high tariff walls, and the absorption of the growing labour force in subsistence agriculture and marginal service sector employment' (1996, p.421). Many workers also seek employment overseas and their remittances keep the current account deficit from growing even larger (Asian Development Bank 1997).

The ironic result of such policies is that the country is still largely agricultural and rural in the 1990s. Agriculture still accounted for 22% of GDP in 1994 and 46% of employment in 1990; industry's share of GDP in 1994 was 33% — where it has been for a decade or more — but it accounted for only 15% of employment (World Bank 1996). Moreover, growth in labour-intensive manufactured exports is slowing as low-wage competitors such as Vietnam enter the scene (Asian Development Bank 1997). Hence the rapidly growing population is still largely dependent on the land.

Population pressure on upland resources is thus as much a function of the lack of urban employment opportunities as the growth of population per se.

Agricultural policy has added some specific distortions to the biases created by the overall macroeconomic framework. Maize has been the only agricultural commodity to have received consistent trade protection in real terms since the 1970s (David 1996; Nelson and Cramb, this volume). For other agricultural commodities, trade protection has been insufficient to offset the negative protection brought about by consistent overvaluation of the peso (at least until the 1997 currency crisis). Protection of maize was designed to promote domestic self-sufficiency in the production of livestock feeds for the pork and poultry industries. It has contributed to a dramatic expansion of maize production in steep upland areas, most of which erode rapidly when subjected to conventional maize cultivation techniques (monocropping, continuous cultivation, repeated ploughing, stubble burning). Removing trade protection could thus be an effective soil conservation strategy, by reducing incentives to produce maize relative to less erosive crops, particularly tree crops. The modelling study reported by Nelson and Cramb (this volume) found that removal of protection for maize would render it uneconomic as a cash crop in relatively remote upland areas. Yield-increasing technical change in maize production is also likely to reduce soil erosion, by inducing a reduction in the price of maize and in the area cultivated (Jayasuriya 1991; Coxhead and Jayasuriya 1994; Coxhead and Shively 1995).

Agrarian Structure

Land ownership in the Philippines is highly concentrated, again reflecting what might be termed a Latin American structure. Very small semi-subsistence farms coexist with large estates and plantations, the latter controlled by a landed elite whose origins lie in the feudal institutions of the Spanish era. The average farm size in 1980 was 2.9 ha; only 3.4% of farms were of more than 10 ha but these accounted for 26.0% of total farm area (Balisacan 1996). In addition, 34% of farms were tenant-operated in 1980, rising to 50% in 1990 (Montes and Lim 1996). The incidence of landlessness, defined to include landless agricultural labourers, is even greater; according to Garrity et al. (1993, p.556), landlessness and near-landlessness in rural areas is as high as 75%. Land ownership is not only concentrated in terms of area, but large landowners (private and corporate) also monopolise the most favourable lands, such as the Central Luzon plain, the sugar-producing island of Negros, and the rolling uplands of Mindanao. Thus the agrarian structure has combined with rapid population growth and the unfavourable economic environment to push landless and impoverished rural dwellers into the marginal uplands.

Successive programs of land reform have not been effective in changing the agrarian structure. Under Marcos, land reform was restricted to tenanted rice and corn lands and was used mainly to discomfit his opponents in Central Luzon. The Comprehensive Agrarian Reform Program (CARP) introduced under Aquino in 1987 is much more ambitious (arguably overambitious) in its goals but has made slow progress due to political, administrative and fiscal constraints. Hence landlessness and tenancy have continued to grow. In Balisacan's view, 'a major land redistribution... is not likely to be forthcoming, given the strong resistance by the landed elite, the fiscal constraints facing the government, and the magnitude of increased landlessness relative to the extent of productive areas available for redistribution' (1996, p.569).

While landlessness in the lowlands has contributed to land degradation by inducing migration to the uplands, the lack of secure tenure for upland farmers is frequently cited as a reason for them to neglect conservation measures. Approximately two-thirds of the uplands are designated as 'public forest land', in the ownership of the state (as opposed to 'alienable and disposable land', capable of private ownership). These lands are officially administered by the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR), which in the past has viewed the so-called 'forest occupants' as 'squatters'. However, the official position is a good example of what Bromley (1985) terms 'the myth of management'. In practice, much of the public forest land is owned and managed by tens of thousands of smallholders under varying tenurial arrangements. Cultural minorities occupy their ancestral domains under traditional land tenure systems which combine private and common property rights (Russell 1986; Lynch 1986); for example, among the Ikalahan of Nueva Vizcaya in northern Luzon, land is controlled by a community council which allocates plots for the use of individual families according to need (Rice, pers. comm., June 1998). Project 1992/011 also found that comparatively recent immigrants to the uplands recognise de facto land ownership rights within their own communities, such that an active land market usually operates, including renting (mainly share-cropping), mortgaging and sale of land. This can give rise to marked economic differentiation among upland households within a relatively short period, including the re-emergence of a class of tenant farmers. Evidence from the case studies suggests that it is tenancy which is the major disincentive to adoption of conservation measures such as contour hedgerows, rather than the supposed insecurity of tenure arising from 'squatting' on public land.

It is now officially recognised that much of the uplands are no longer defensible as 'forest lands', hence the policing approach of the Forest Management Bureau's predecessor in the Marcos era (the infamous Bureau of Forest Development) has given way to a 'social forestry' approach in the form of the Integrated Social Forestry (ISF) Program (Gerrits 1996). A central plank of this program is the issuance of Certificate of Stewardship Contracts (CSCs) to ISF 'beneficiaries' (Escueta n.d.). These are 25-year leases, renewable for a further 25 years, which are inheritable but not transferable, hence not 'bankable'. Notionally the leases are conditional on adopting loosely defined 'agroforestry' practices such as planting fruit trees, however in many instances they are issued in anticipation of such practices being implemented so that ISF staff can meet their annual targets.

Fieldwork in Project 1992/011 indicates a variable response to CSCs on the part of upland farmers (see also Escueta n.d.). They are often resisted by claimants of ancestral lands as being a considerably weaker set of property rights than those they feel they already possess (though Communal Forest Stewardship Agreements have been accepted by well-organised tribal groups, such as the Ikalahan, because they effectively recognise their right to manage their territory according to their own customs). CSCs may also be resisted by migrant farmers who would prefer to have their land reclassified as Alienable and Disposable, with full titles issued. The evidence suggests that CSCs are only really valued where expropriation by the state or powerful local interests is feared. In general, however, they are not very effective as instruments to induce the genuine adoption of conservation practices.

It has been suggested that CSCs should be transformed into an intermediate form of land tenure, capable of upgrading to full title after say 10 years of acceptable use according to some well-defined criteria (World Bank 1989). These titles would be transferable but for agricultural use only (perhaps achieved through the introduction of local government land use zoning schemes) and subject to requirements of sustainable farming practices. However, this would imply the reclassification of vast areas of public forest land, removing them from the control of the DENR and the FMB.

Upland Development Institutions

Three large government departments have a stake in upland development and conservation: the Department of Environment and Natural Resources (DENR), the Department of Agriculture (DA), and the Department of Agrarian Reform (DAR). There is considerable overlap between their roles, yet none is particularly well equipped to assist upland farmers with soil conservation (World Bank 1989).

As described above, the DENR, through the Forest Management Bureau, has jurisdiction over a vast area of the uplands classified as Public Forest Lands, accounting for over half the land area of the Philippines. The predecessor of the DENR in the Marcos era was widely perceived to be a corrupt regulator, supposedly protecting the public forest land from the people who lived there and used it. Many upland farmers remember its less than helpful approach in the past and have been reluctant to get involved in its current programs as a result. Its transformation in the past decade into a facilitator of 'integrated social forestry' has been slow and difficult (Gerrits 1996). The ISF Program has been hampered by an acute lack of resources to train and support the number and calibre of field staff required for such a demanding role. While the ISF Manual pays lip-service to the ideals of participation and empowerment, in practice a top-down, transfer-of-technology approach is often used, with a good measure of 'coercion and control'. Additionally, the persistent view that, as these are public *forest* lands, the land users should be planting trees, has skewed the choice of conservation technologies in favour of 'agroforestry', notably the Sloping Agricultural Land Technology (SALT) package involving contour hedgerows of shrub legumes, whereas in many settings and for many upland farmers (especially resource-poor, tenant farmers) other practices appear to be better adapted, such as natural or planted grass strips (Fujisaka 1989; Garrity 1991; Garrity et al. 1998; Nelson and Cramb, this volume). Hence, notwithstanding dedicated work on the part of some ISF field staff and some important localised success stories (Garcia et al. 1996), the ISF program has not been adequate to the task of promoting sustainable *agricultural* development in the uplands.

The DA obviously has a mandate to pursue agricultural research and extension but historically has confined its attention to lowland agriculture with a commodity focus. While it has a formal role in servicing upland farmers occupying alienable and disposable lands, it too is poorly equipped, both in attitude and resources, for this role. The few hillylands research stations of the DA are required to serve a vast area, but conduct research of little technical or economic relevance to poor upland farmers (e.g. one such station used a large tractor for cultivation and had demonstration hedgerows of shrub legumes in which only weeds could be found). Extension staff are also poorly trained for upland work, many of them lacking even a basic knowledge of soil erosion and conservation (John Bee, pers. comm. 1995).

The DAR has the huge task of implementing the Comprehensive Agrarian Reform Program. This entails direct involvement with upland farmers in the case of uplands classified as alienable and disposable. In addition, more than half the area to be covered by CARP is public land. In this case beneficiaries come under DENR's ISF program and are issued with CSCs, not titles, as discussed above. The DAR itself has no capability to provide technical or other assistance to farmers to whom leases or titles are issued but is responsible for coordinating the provision of support services by DA, DENR, and other agencies such as the Land Bank of the Philippines.

Under the new Constitution, all three agencies are undergoing a process of decentralisation and devolution of functions to local authorities. Unfortunately, this has often weakened agricultural extension capability in the uplands as municipal governments may not have the inclination or resources to employ adequate extension staff. On the other hand, it may have created an opportunity to integrate farm-level services (given that municipal authorities are less concerned with demarcation disputes between the line agencies) and to tailor them to local needs rather than implementing blanket, nation-wide extension packages as at present. However, to capitalise on this opportunity, local authorities will need increased revenue and technical support.

The constraints facing the main government agencies have opened an opportunity for non-government organisations (NGOs), particularly in the post-Marcos era, though many worked courageously under adverse conditions during the period of martial law. There have been numerous upland conservation projects organised by NGOs, and a few, such as the Mindanao Baptist Rural Life Centre (MBRLC) (the developers of the SALT package) and the Mag-uugmad Foundation Incorporated (MFI) in Cebu, have justifiably gained national and international recognition for their work. However, most NGOs lack the technical skills or resources to provide the kind of adaptive research and extension services needed in the uplands, and resort to the same SALT package as the government agencies, regardless of the circumstances of the farmers they are serving. Some are also hampered by an ideological commitment to 'organic' farming when one of the main short-term benefits of adopting conservation techniques is the increased effectiveness of chemical fertiliser use. Moreover, even the more successful NGOs are finding they have limited capacity for expansion, without losing their strength at the grassroots level. Given the current legitimacy of populist approaches to development in the Philippines and elsewhere (Edwards and Hulme 1996), government agencies and international donors are keen to involve NGOs in their projects, but the few really competent NGOs are in danger of being swamped.

This raises the issue of a role for aid agencies. Blaikie (1985, p.62) has highlighted the contradictions between the characteristics of foreign aid projects and the requirements for successful soil conservation programs, particularly the need for a long-term, adaptive approach with diffuse, diverse, and often unquantifiable outputs. The Project 1992/011 case studies, many of which dealt with aid projects, confirm this view, notwithstanding the almost universal espousal of populist or participatory principles in project documents. The most effective aid is long-term program support for government and non-government agencies. Given the constitutional commitment to devolution, it may be feasible to develop a long-term aid package to strengthen the role of local or regional government to administer land in the uplands (e.g. land titling, land use planning, land taxation) and to provide the needed research and extension services for upland farmers and farmer organisations. Montes and Lim (1996) certainly see a potential boost to environmental investment from donors whose priorities currently favour local-level (especially NGO) initiatives. However, this would clearly threaten important interests within the state, notably the DENR, DA and DAR, and may simply entail 'devolution of the locus of corruption' (World Bank 1989, p.58).

Conclusion

Agricultural land degradation in the Philippine uplands is clearly a major environmental and development issue. The problems of fine-tuning technical solutions to soil erosion, the primary focus of Project 1992/011, appear to be dwarfed by larger problems of regional political ecology. Pursuing a chain of explanation indicates that soil erosion is caused by an interlocking of several key elements: landscapes of high sensitivity and low resilience, subjected to pressure from a rapidly increasing and highly mobile upland population, itself under pressure from a legacy of poverty-inducing economic policies and agrarian structures, and ill-served by poorly resourced and focused development agencies. Thus upland farmers are living ‘at the margin’ in all three senses identified by Blaikie and Brookfield (1987). They have been marginalised by politico-economic structures and processes, hence pressured to extend the economic margin of cultivation into what is, in most cases, ecologically marginal land for agriculture.

The obstacles to the promotion of soil conservation in the uplands are thus formidable. An effective long-term program would arguably require a major shift in land policy (e.g. reclassifying a considerable area of public forest land which is already used for agriculture, issuing conditional titles to upland farmers, and increasing the role of local or regional government in land use planning) and a major investment in adaptive *agricultural* research and extension for the uplands (cutting across existing government line agencies, integrated at the local government level, and giving much greater emphasis to farmers’ participation in the adaptation of conservation technologies). Local NGOs have an important role in the latter but cannot be expected to carry the burden of a nation-wide research and extension effort.

Without this kind of program it is likely that land degradation and poverty in the uplands will continue to escalate, yet such a program is clearly beyond the present financial resources of the Philippine government and would in any case face opposition from various interests. However, focusing only on top-down constraints to soil conservation in the uplands is to ignore the interaction between micro-, meso- and macro-level processes, attracting Black’s (1990) criticism that the political economy of land degradation is treated as entirely exogenous to land management at the local level. In fact, there is evidence for the potential effectiveness of what Biggs and Smith (1995, 1998) refer to as coalition building, in this case involving groups of innovative farmers, local NGOs and NGO networks concerned with equitable management of environmental resources, progressive local government officials, academics and scientists at various universities and colleges, development professionals within and outside government, and international agencies keen to channel funding to the local level for environmental initiatives (Broad 1993; Montes and Lim 1996; White and Tiongco 1997, pp.154–158). Indeed, it has arguably been due to the policy influence of this coalition or network that Sajise and Ganapin were able to write that 'the need for sustainable upland development ... is foremost in the national agenda' (1991, p.31), a statement confirmed more recently in Philippine Agenda 21 (Philippine Council for Sustainable Development 1997). It will be important, however, for such a coalition to move beyond a focus on *project* methodologies and technological packages (such as SALT) to an agreed understanding of the requirements for an effective national *program* of upland development and conservation. The Philippines Strategy for Improved Watershed Resources Management (DENR 1998) provides a sound conceptual basis for such a program.

Chapter 4

Profiles of the Case Study Sites

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In Chapter 2 it was argued that upland farmers are rational in their choice of technology, hence the rate and extent of adoption of a new technology can be taken as prima facie evidence of its appropriateness. It was suggested that farmers' responses to introduced soil conservation technologies will be influenced by a number of factors, including the availability of new technological components (cropping systems, tree species, management practices, etc.) which are suited to local biophysical conditions; the stage of evolution of the farming system, notably the degree of intensification and commercialisation; elements in the socioeconomic environment, including land tenure, credit and input supply, and marketing infrastructure; and the extent of farmer participation in the design, adaptation and promotion of the technologies. It was concluded that there is considerable scope for conducting technology-evaluation research on both on-going and completed development projects, to examine the fate of new technologies under a range of farmers' conditions.

Hence to evaluate the adoptability of the soil conservation technologies being promoted in the Philippines, a case study approach was used in Project 1992/011. This involved identifying upland development projects which had introduced new soil conservation technologies to farmers, and using various survey techniques to assess farmers' responses to these technologies. This chapter outlines the procedures used in the case studies and provides profiles of the case study sites and projects. Subsequent chapters elaborate on the promotion, adoption and adaptation of recommended technologies at these sites.

Site Selection and Survey Methods

Nine case study sites were selected — seven for detailed investigation involving several visits by the research team, and two (Halang and Guba) for less detailed study (Table 4.1 and Figure 1.1). The following guidelines were used in selecting the case study sites:

Table 4.1. Case study sites, projects, technologies and data sources.

Study site (village, municipality)	Province, region	Project/organisation	Main technologies promoted	Sources of data				
				Rapid appraisal	Survey respondents			Case studies
					A	N	C	
Domang, Kasibu	Nueva Vizcaya, Cagayan Valley	Integrated Social Forestry Program, Department of Environment and Natural Resources (DENR)	Contour hedgerows	✓	–	–	–	10
Halang, Jalajala	Rizal, Southern Tagalog	ACIAR PN 9220, QDPI/SEARCA	Various cropping patterns tested in on-farm research trials	✓	–	–	–	–
Guba, Cebu City	Cebu, Central Visayas	Cebu Soil & Water Conservation Program, Mag-uugmad Foundation Inc. (MFI)	Contour hedgerows, bunds, and canals	✓	–	–	–	–
Tabayag, Argao	Cebu, Central Visayas	Cebu Soil & Water Conservation Program, MFI	Bench terraces, rock walls, contour hedgerows	✓	50	28	25	–
Magdungao, Passi	Iloilo, Western Visayas	Magdungao Agroforestry Project, DENR	Contour hedgerows, bunds and canals	✓	60	12	22	–
Salogon, Brooke's Point	Palawan, Southern Tagalog	Upland Stabilisation Project, DENR	Bench terraces Contour hedgerows	✓	52	44	24	–
Managok, Malaybalay	Bukidnon, Northern Mindanao	MUSUAN Project, Central Mindanao University	Contour hedgerows	✓	47	57	–	–
Pananag, Bansalan	Davao del Sur, Southern Mindanao	Mindanao Baptist Rural Life Centre (MBRLC)	Contour hedgerows (Sloping Agricultural Land Technology)	✓	49	24	–	–
Ned, Lake Sebu	South Cotabato, Southern Mindanao	Ned Agro-Industrial Development Project, SEARCA; ACIAR PN 9220, QDPI/SEARCA	Contour hedgerows (and various experimental cropping patterns)	✓	–	–	–	27

Key: A = adopters; N = non-adopters; C = control group

- The sites should represent important agroecological zones in the uplands.
- The population in each site should be predominantly resource-poor, semi-subsistence farmers, practising a farming system which is of widespread importance in the uplands and which is associated with serious soil erosion.
- Within or between sites there should be both indigenous and immigrant upland farmers, to capture the differences in knowledge, skills and incentives for conservation between these two categories.
- Within or between sites there should be a range of tenure types, e.g. 25-year leaseholds, customary tenure, and illegal occupancy, to capture the effects of security of tenure on investment in conservation technology.
- Within or between sites there should be varying degrees of population pressure, hence varying degrees of intensification, from traditional shifting cultivation to permanent cropping.
- Within or between sites there should be varying degrees of access to market centres, hence varying degrees of commercialisation of the farming system (including both inputs and outputs).
- Within each site there should have been a major attempt to introduce some form of soil conservation technology (e.g. Sloping Agricultural Land Technology or SALT).
- There should be local organisations willing to collaborate in the case studies.

The research methods involved a combination of reconnaissance or ‘rapid rural appraisal’ methods and a questionnaire survey of a sample of farmers from within the project area. In two sites (Domang and Ned) the survey was replaced by detailed household case studies (10 households in Domang and 27 households in Ned) and in another two sites (Halang and Guba) only a reconnaissance survey was undertaken (Table 4.1).

The reconnaissance methods included: a review of existing municipal and village documents; direct observation; semi-structured 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. The survey typically involved a single, hour-long interview in the respondent’s home, with husband and wife both present, supple-

Table 4.2. Biophysical profile of study sites.

Study Site (village, municipality)	Province, region	Climate				Soils	Elevation (m above sea level)	Dominant slopes (%)	Erosion status
		Type	Rainfall (mm/year)	Dry months (< 100 mm)	Typhoons				
Domang, Kasibu	Nueva Vizcaya, Cagayan Valley	III	2,400	Dec–Mar	Frequent	Acidic clay-loam	50–1,000	30–50	Moderate to severe
Halang, Jalajala	Rizal, Southern Tagalog	I	2,200	Dec–Apr	Frequent	Acidic loamy-sand to clay-loam	15–320	25–45	Moderate to severe
Guba, Cebu City	Cebu, Central Visayas	III/IV	1,700	Feb–Apr	Occasional	Neutral–acidic heavy clay-loam	200–600	10–50	Slight to severe
Tabayag, Argao	Cebu, Central Visayas	III	1,500	Jan–May	Occasional	Alkaline clay-loam	250–700	30–50	Severe to very severe
Magdungao, Passi	Iloilo, Western Visayas	III	1,800	Jan–Apr	Occasional	Neutral–acidic clay	50–300	5–50	Moderate to severe
Salogon, Brooke's Point	Palawan, Southern Tagalog	III	1,600	Jan–Apr	–	Neutral–acidic clay-loam	100–1,000	5–60	Slight to moderate
Managok, Malaybalay	Bukidnon, N. Mindanao	III/IV	2,500	Feb–Apr	–	Acidic clay	400–1,000	5–70	Moderate to severe
Pananag, Bansalan	Davao del Sur, S. Mindanao	III	2,500	Jan–Apr	–	Acidic clay-loam	500–1,000	10–50+	Slight to severe
Ned, Lake Sebu	South Cotabato, S. Mindanao	IV	2,200	Nil	–	Neutral–acidic sandy loam (clay B horizon)	700–1,200	12–40	

Key: Climate types are based on the Modified Corona System used in the Philippines: Type I – pronounced wet and dry seasons; Type III – no pronounced wet season, dry season 1–3 months; Type IV – no pronounced wet or dry seasons.
Soils are classed as acidic, pH <5.5; neutral–acidic, pH 5.5–7; or alkaline, pH>7.

Table 4.3. Socioeconomic profile of study sites.

Study Site (village, municipality)	Province, Region	Population density (persons/ km^2)	Cultural groups	Migrants (%)	Proportion of public land (%)	Dominant form of title	Mean farm size (ha)	Incidence of tenancy (%)	Access to market town
Domang, Kasibu	Nueva Vizcaya, Cagayan Valley	50	Ifugao Igorot Bontoc Ilocano	80	100	CSC	3.8	0	Moderate
Halang, Jalajala	Rizal, Southern Tagalog	100	Batangueno	100	0	CLOA	2.6	100	Good
Guba, Cebu City	Cebu, Central Visayas	240	Cebuano	0	10	TCT	1.0	30	Good
Tabayag, Argao	Cebu, Central Visayas	150	Cebuano	0	30	Tax declaration	1.7	2	Moderate
Magdungao, Passi	Iloilo, Western Visayas	130	Ilongo	0	40	CSC	2.6	37% of plots	Moderate
Salogon, Brooke's Point	Palawan, Southern Tagalog	70	Pala'wan	0	80	CSC	2.8 +	3	Poor
Managok, Malaybalay	Bukidnon, N. Mindanao	100	Visayan Ilocano Tala'andig Manobo	75	6	No formal title	2.9	30	Moderate
Pananag, Bansalan	Davao del Sur, S. Mindanao	140	Bagobo Visayan	40	100	No formal title	2.9	15	Good
Ned, Lake Sebu	South Cotabato, S. Mindanao	26	Visayan T'boli	95	24	CLOA	3.7	30	Poor

Key: TCT, Transfer Certificate of Title; CSC, Certificate of Stewardship Contract; CLOA, Certificate of Land Ownership Award.

mented in some cases with farm inspection. In total, 531 farm households were interviewed (including the 37 household case studies).

Rapid rural appraisal methods, particularly those of a participatory nature, are frequently portrayed as being inherently superior to formal surveys (Chambers 1983, 1997). The experience in Project 1992/011 suggests that both kinds of method have their strengths and weaknesses and need to be viewed as complementary rather than competing approaches. In brief, though the two kinds of methods overlapped and thus reinforced each other, rapid appraisal methods were particularly useful for gaining an overview of the characteristics, current status, and trends in the local environment and farming system, and a factual account of project interventions, while the formal household survey was most helpful in documenting, quantifying, and correlating the range of farmers' circumstances and responses, and pursuing specific, possibly sensitive questions about project implementation in more detail.

The biophysical and socioeconomic characteristics of the case study sites are summarised in Tables 4.2 and 4.3 and described more fully below. Table 4.4 uses a 3x3 classification to locate the sites in terms of two key socioeconomic variables — population density and market access. Population densities are classified as low (< 100 persons per sq. km), medium (100–150 persons per sq. km), and high (>150 persons per sq. km). Market access is classified as poor, moderate and good based on a composite index which takes into account the mode, frequency and cost of transporting produce to the nearest urban market, as well as the size of the market.

Table 4.4. Classification of study sites by population density and market access.

Population density (persons/km^2)	Market access		
	Poor	Moderate	Good
LOW (<100)	Ned, Salogon	Domang	–
MEDIUM (100–150)	–	Magdungao, Managok, Pananag	Halang
HIGH (>150)	–	Argao	Guba

Site Profiles

Domang

Domang is a sub-village (*sitio*) of Barangay Nantawacan, located in Kasibu Municipality in the northeast of the province of Nueva Vizcaya in northern Luzon. Rainfall in the uplands of Nueva Vizcaya averages about 2,400 mm and occurs throughout the year, with a somewhat drier period between December and March (i.e. a Type III climate). Regular typhoons result in intense rainfall events. Sitio Domang occupies about 200 ha on a ridge descending from Mt Gusing (1,455 m), at elevations ranging from 50 to 1,000 m asl. The topography is heavily dissected and gently to steeply sloping, with dominant slopes between 30% and 50%. Soils are predominantly acidic clay-loams and erosion is moderate to severe.

The Domang area is Public Forest Land and was logged commercially from the early 1950s until 1985. Ifugao and other migrants from the Central Cordillera began arriving from the early 1970s, practising shifting cultivation of upland rice. There was conflict between settlers and the former Bureau of Forest Development in the 1970s but now most occupants hold Certificate of Stewardship Contracts from the DENR. The population density is relatively low at around 50 persons per sq. km, hence the mean farm size is close to 4 ha and tenancy as such is non-existent. Domang is only moderately accessible, requiring a journey on foot or carabao of up to an hour to reach a roadhead where jeepneys can provide transport to market towns. Market access has improved since the 1980s and the farming system now includes both subsistence and commercial crops — rain-fed bunded rice on terraced land, upland rice, maize, a variety of vegetable and field crops (beans, tomato, ginger, taro, etc.), and banana and other fruit crops.

An Integrated Social Forestry (ISF) Project of the DENR operated at Domang 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% of the Domang population. Hedgerows were being maintained but there was no expansion onto additional land. The alleys were being used for maize, upland rice, and a range of commercial vegetable 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 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.

Halang

Halang is an upland *sitio* of Barangay Bayugo, located in the municipality of Jalajala in Rizal Province in southern Luzon. The *sitio* is at the southern end of the Jalajala Peninsula which juts into Laguna de Bay. The climate is classified as Type I; rainfall averages 2,200 mm but is concentrated in the wet season from June to November when typhoons are common. Halang occupies an area of 250 ha of rolling to steep, moderately dissected terrain, between 15 and 320 m asl. Dominant slopes are between 25% and 45%. Soils are acidic loamy-sands to clay-loams and appear to be moderately to severely eroded.

Halang lands are owned by three large landowners but were progressively occupied by migrants from Batangas Province in the south of Luzon, beginning in the late 1950s. Though technically tenants, the occupants assert de facto ownership; the lands are in the process of being distributed to the occupants by the Department of Agrarian Reform (DAR). The population density is around 100 persons per sq. km and the mean farm size is 2.6 ha. Access to markets is relatively good, with a short, steep, unsealed road leading down to the narrow plain skirting the peninsula, from where the road journey to Manila takes around three hours. The farming system involves the production of upland rice and vegetables for subsistence, and taro, maize, peanuts and fruit (especially mangoes and bananas) for sale. Livestock production (cattle and pigs) is also an important source of income, and charcoal is produced from fallow vegetation.

There has not been a major upland project in Halang itself. The Social Forestry Program of the UPLB College of Forestry, funded by the Ford Foundation, was implemented in a neighbouring *barangay* from 1982 to 1987. The MERALCO Foundation conducted training in SALT in 1990 and implemented a seedling dispersal program in Barangay Bayugo. The Integrated Jalajala Rural Development Project was implemented by the Department of Agrarian Reform in the 1990s but concentrated mainly on irrigation and road development. The main reason for including Halang as a study site was that SEARCA and the Queensland Department of Primary Industries conducted an ACIAR-funded farming systems development project in the *sitio* from 1994 to 1998. Farmers in Halang have adopted various conservation practices from these and other sources, including the planting of bananas and napier grass in strips across a plot. However, contour hedgerows and terraces were not in evidence.

Guba

Guba is an upland *barangay* within the municipality of Cebu City in the Province of Cebu in the Central Visayas. The climate is transitional between Type III (seasonally dry) and Type IV (continuously wet); rainfall averages 1,700 mm with a short dry season from February to April. The area is occasionally influenced by typhoons. Barangay Guba occupies 1,098 ha of rolling to very steep terrain, with dominant slopes of 10% to 50% at elevations of 200 to 600 m. Soils are neutral to acidic heavy clay-loams with slight to severe erodibility and susceptibility to waterlogging.

Guba is an area of long settlement with a high population density of around 240 persons per sq. km. As with other parts of rural Cebu, it has been a source of out-migration to urban areas and to the southern Philippines. Most of the land is privately owned but there is a high incidence of tenancy (around 30%). Average farm size is about one hectare. The *barangay* is only 25 km from the centre of Cebu City and is well-linked to the city and to surrounding *barangays* by several unsealed, all-weather roads. The farming system has been dominated by the cultivation of maize for subsistence and perennials (bananas and mangoes) and livestock for sale. In recent years vegetable production has became a major source of cash, along with seasonal production of flowers.

At Guba, a World Neighbours project (which eventually gave rise to a farmer organisation, the Mag-uugmad Foundation Inc. (MFI) 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 1,000 farm-households in 10 villages spread over 78 sq. km. This represented perhaps 30% 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.

Tabayag

Barangay Tabayag is located in Argao Municipality in the southern part of Cebu Province. Rainfall averages 1,500 mm and follows a Type III distribution, with a pronounced wet season and a dry season which extends from January to May. The *barangay* occupies about 500 ha in the upper part of a sub-catchment of the Argao River at elevations of 250 to 700 m asl. The terrain is gently sloping in the lower catchment, becoming steeply sloping at higher elevations; dominant slopes are 30 to 50%. The soils are alkaline clay-loams which have been very severely eroded.

Tabayag is a long-settled *barangay* with a population density of around 150 persons per sq. km. About 30% of the area is classified as Public Forest Land but most of this is farmed by de facto landowners who pay land tax to the municipal government; many of these now hold Certificate of Stewardship Contracts. The average farm size is 1.7 ha; the incidence of tenancy is very low. The *barangay* is 14 km by dry-weather road from Argao, which is 67 km (a three-hour drive) south of Cebu City, providing moderate access to urban markets. The farming system is focused on the production of maize for subsistence. Most households also have home gardens and raise livestock, especially pigs, for sale. Some have coconut holdings and some now produce vegetables for sale in Cebu City.

Tabayag is another World Neighbours-MFI project site. The project 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% 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.

Magdungao

Barangay Magdungao is located in the north of Passi Municipality in Iloilo Province on the island of Panay in the Western Visayas. Rainfall averages 1,800 mm distributed in a Type III pattern, with a dry period from January to April. The *barangay* occupies 1,200 ha of rolling to steep terrain at 50 to 300 m asl; slopes vary from 5% to 50%. Soils are predominantly neutral-acidic clays and are moderately to severely eroded.

The residents of Magdungao are Ilongo; those occupying the upper regions of the *barangay* had moved to the area over time from the adjacent lowlands. The population density is 130 persons per sq. km. The *barangay* lands include Alienable and Disposable Land (much of which was a large estate which is now being distributed to the occupants under the Comprehensive Agrarian Reform Program) and Public Forest Land. Both categories of land are cultivated by smallholders as the de facto owners. Farm size averages 2.6 ha and around a third of farm land is tenanted. Farmers in the upland areas of the *barangay* have only moderate access to markets; produce is transported on carabao-drawn sledges to the roadhead, a one- to two-hour trip. From there trucks and jeepneys can be used to reach Passi. The farming system is quite diversified, including the production of rain-fed, bunded rice and upland rice for subsistence, and maize and vegetables for sale; perennial crops include coffee, fruit and timber trees; most households also have draught carabao, pigs and chickens.

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% of the potential adopters within the village. By the time of the survey in 1995 the level of adoption was still around 80%, though many adopters had not maintained their contour bunds. A significant proportion (28%) 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.

Salogon

Barangay Salogon is located in Brooke's Point Municipality which is 192 km south of Puerto Princesa, the capital of Palawan Province. The climate is Type III, with an annual rainfall of 1,600 mm which peaks in November-December, followed by a short dry period from January to April. Salogon occupies 3,457 ha of predominantly mountainous terrain at elevations of up to 1,000 m asl. Slopes range from 5% to 60%. Soils are mainly neutral-acidic clay-loams and show slight to moderate erosion. Much of the land in the interior of the *barangay* is under secondary forest or scrub.

The indigenous Pala'wan (or Palawano) comprise half the population of the *barangay* and almost all of the upland population; immigrants from Luzon and the Visayas make up the remainder, and mainly occupy the lowlands. The population density is around 70 persons per sq. km. The upland areas, though part of the ancestral domain of the Pala'wan, are classified as Public Forest Land; some households hold Certificate of Stewardship Contracts. Average farm size is 2.8 ha but households in more remote parts of the *barangay* have additional land under bush fallow. Tenancy is almost non-existent. Access to markets is poor; residents of the more remote sections of the *barangay* headload produce along narrow footpaths; those closer to the lowlands use buffalo-drawn sledges to reach the main coastal road south of Brooke's Point. The farming system was traditionally based on the shifting cultivation of upland rice. It has evolved towards short-fallow or even annual cultivation of upland rice, glutinous maize and root crops for subsistence, and of maize for sale. Perennials include fruit and cashew trees, and there is some collection of forest produce for sale.

At Salogon, the government's Upland Stabilisation 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% of the sample were classified as adopters on the basis that they had implemented contour hedgerows or bench terraces on part (mostly 10–50%) of their farms. In many cases, however, the technologies were not being maintained, confirming the view of a key informant that only 5–10% of the land development existing at the end of the project was still in evidence.

Managok

Barangay Managok is located in Malaybalay Municipality in the centre of Bukidnon Province in Northern Mindanao. The climate is transitional between Types III and IV, with an annual rainfall of 2,500 mm which is fairly evenly distributed throughout the year, apart from a relatively dry period from December to March. The *barangay* occupies 1,872 ha at elevations ranging from 400 to 1,000 m asl. The area encompasses a wide plain lying between two ranges of hilly to mountainous terrain with slopes of 10% to 70%. The soils are predominantly acidic clays showing moderate to severe erosion.

The population density of the upland *sitios* of Managok is around 100 persons per sq. km. The population comprises *dumagat* or immigrant groups (75%) and *lumad* or indigenous groups, namely the Tala'andig and Manobo (25%). Most of the land is Alienable and Disposable, though in the uplands farmers typically have no formal title; 30% of farmers are share-tenants or mortgagees. Farm size averages 2.9 ha. Farmers have moderate access to markets; the Managok township is 14 km by gravel road from the main north-south highway through Bukidnon, and 24 km from Malaybalay, the provincial capital. Side roads from this gravel road link provide access to upland *sitios*, and farmers use carabao and horses to transport produce to the road. The farming system is based on two crops of maize per year, which is both the staple crop and the main source of cash income. In addition, farmers cultivate vegetables, field crops and tubers, perennial cash crops, and fruit and forest trees. Livestock are raised for draught, transport and sale.

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

Pananag

Pananag is a *sitio* of Barangay Managa in Bansalan Municipality in the province of Davao del Sur in Southern Mindanao. The climate is Type III, with annual rainfall of 2,500 mm and a dry season from January to April. Pananag occupies an area of 300 ha straddling a ridge descending from Mt Apo (2,953 m), at elevations of 500 to 1,000 m asl. Along the ridgeline the terrain is rolling to hilly but quickly becomes steep to very steep as one descends to the Miral River to the west. Hence slopes range from 10% to 50% or more. Soils are acidic clay-loams and show slight to severe erosion.

The residents of Pananag are indigenous Bagobo and immigrant Visayans. The population density is 140 persons per sq. km. The entire area of the *sitio* lies within Mt Apo National Park, created in 1992. Farmers have no formal title to their land, but under the zonal approach to park management they are allowed to continue cultivation. Farm size averages 2.9 ha; 15% of farmers are share-tenants. Access to markets is relatively good; a former logging road passes through the *sitio*, linking it to Bansalan 9 km away. The farming system is based on two crops of maize, which is both a subsistence and a cash crop. Tubers, vegetables and field crops are also cultivated for subsistence and sale. Coconut and coffee are the most common perennials. Most households have a range of livestock, with pigs the major source of cash.

The conservation farming project at Pananag was more drawn out than in most other cases studied. 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% 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%. There had been some diffusion to relatives in a neighbouring village.

Ned

Barangay Ned is located in the western portion of Lake Sebu Municipality in the province of South Cotabato in Southern Mindanao. The annual rainfall is 2,200 mm, evenly distributed throughout the year (a Type IV pattern). The *barangay* occupies an extensive area (22,700 ha) of rolling to mountainous topography at elevations of 700 to 1,200 m asl. Dominant slopes are 12% to 40%. The soils are neutral-acidic sandy-loams with a clay B horizon and are highly susceptible to erosion.

In 1980 the population was around 1,600, comprising mainly the indigenous T'boli. By 1995 this number had grown to over 11,000 due to the in-migration of mainly Ilonggo settlers from elsewhere in Mindanao. The population density remains low at 26 persons per sq. km, though it is higher in the more accessible *sitio*. The *barangay* is a settlement area administered by the Department of Agrarian Reform; 76% of the land is Alienable and Disposable and settlers hold Certificate of Land Ownership Awards. The standard DAR allotment is 3 ha but some households have acquired more land and others have forfeited their land through mortgaging and sale; the incidence of share tenancy is high at 30%. Access to markets is poor; the *barangay* is about 100 km from Koronadal and 35 km from the national highway at Isulan. The main route is a narrow, unsurfaced former logging road which becomes impassable after heavy rain. The farming system involves the cultivation of upland rice and maize, rice being the main staple and maize the main cash crop.

DAR contracted SEARCA to implement the Ned Agro-Industrial Development Project (NAIDP) from 1993 to 1997. This was based in Sitio Kibang in the northern part of the *barangay*. The project had various components, including the promotion of SALT through training of farmer-trainers at MBRLC and the formation of work groups of 5–10 farmers to establish hedgerows and undertake other tasks. Twenty-eight work groups were organised, of which 21 were active at the time of the survey. In addition, SEARCA and QDPI undertook a farming systems development project (ACIAR PN 9220) in the Kibang area, involving on-farm trials with 10 farmer-cooperators. These included various forms of hedgerow and the trialling of high-value horticultural crops.

Conclusion

The site profiles reflect the great diversity of biophysical and socioeconomic circumstances facing upland farmers in the Philippines. When consideration is also given to the diversity between farm households within each site it becomes clear that blanket recommendations for conservation farming in the uplands are unlikely to be appropriate. However, project interventions have tended to focus on a narrow range of soil conservation technologies, notably contour hedgerows (especially SALT) and, to a lesser extent, bench terraces (sometimes with rock walls). Subsequent chapters examine the ways in which these technologies were promoted and implemented in each site and the responses of farmers as they experimented with the technologies.

Chapter 5

Characteristics and Implementation of Soil Conservation Technologies in the Case Study Sites

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THIS CHAPTER examines the characteristics, implementation and field-level impacts of soil conservation technologies in the case study sites. In particular, it explores the relationship between implementation and adaptation of the recommended technologies. The first section provides a brief description of the technologies promoted. The second section describes the implementation and adaptation of these technologies, focusing on contour hedgerow intercropping, the main technology promoted and adopted. The third section considers the field-level impacts of implementing and adapting hedgerow intercropping. A final section draws some general conclusions about the process of technology development for soil conservation in the uplands.

Conservation Technologies Promoted by the Upland Development Projects

Overview

Most projects promoted a large repertoire of soil conservation technologies rather than attempting to match technologies to site characteristics. Recommended technologies included physical barriers (i.e. contour bunds, contour rockwalls, bench terracing), vegetative barriers (i.e. contour hedgerows), various supplementary physical structures (i.e. drainage canals, contour canals, check dams, soil traps) and agronomic/fertility management measures (i.e. crop rotation, multiple cropping, manuring, fertiliser use, composting). In practice, however, most emphasis was placed on hedgerow intercropping, often in association with other measures. Table 5.1 summarises the characteristics of the recommended technologies and indicates where the specific technologies were promoted. The following sections briefly describe the various technologies and methods of establishment. (For more detailed accounts of these and other conservation technologies see, e.g. Hudson 1992, 1995; PCARRD 1990; Sheng 1989; and Young 1989.)

Physical and Vegetative Barriers

Contour lines

In most of the conservation technologies promoted, the identification of contour lines was the first step, as the conservation structures were to be established along the contour. To do this, an A-frame (a simple level made from local materials) was recommended. The use of the A-frame requires two people, one manipulating the A-frame and one marking the identified point within the contour. Contour lines are identified at regular intervals down the slope, spacing being determined by the slope of the land.

Contour bunds

Contour bunds are embankments (risers or humps) of stones, grasses, or compacted soil (or combinations of all these materials) which are constructed along the contour and serve to slow run-off and trap eroded soil, leading to the progressive formation of terraces. Establishment of contour bunds involves ploughing or digging along identified contour lines, the loosened soil then being used to form the bund. Removal of the soil from the contour line also creates a contour canal, which helps to reduce overland flow, increase infiltration, and divert excess water.

In the projects studied, hedgerows were typically planted on top of the bunds to reinforce them, as well as providing a source of biomass for green manuring and/or forage in a cut-and-carry system for penned livestock. Various hedgerow species were used, including grasses (Guinea grass *(Pennisetum maximum*), Napier grass (*Pennisetum purpureum*) and leguminous shrubs (*Leucaena leucocephala*, *Leucaena diversifolia*, *Gliricidia sepium*, *Flemingia macrophylla*, *Desmodium rensonii*, *Calliandra* spp., *Desmanthus* sp.).

Bench terracing

There are several forms of bench terracing, including backward-sloping, forward-sloping, or level bench terraces. Terraces are constructed using the cut-and-fill method. Two contour lines with a vertical distance of not more than 1.5 m are marked using an A-frame. The midline between the two contour lines is marked by stakes. Using hand tools or a plough, soil from above the midline is removed (cut) and placed below the midline (fill). The process is continued until the areas above and below the midline are level. The walls of the bench terraces may need to be supported, e.g. by planting with grasses or building rock walls.

Table 5.1. Characteristics, advantages, and disadvantages of soil conservation technologies promoted in the case study villages.

Type of technology	Basic idea	Characteristics	Advantages	Disadvantages	Site where promoted
Contour bunds	• Minimise erosion by reducing runoff and trapping sediment Increase infiltration and drain excess runoff • Hedgerows to reinforce bunds • Mulching and green manuring with hedgerow trimmings	• Simultaneous construction of contour bunds and canals • Hedgerows on bunds Spacing of bunds determined by slope • Spreading hedgerow trimmings on soil • Maintaining bunds with soil deposited in canals	• Immediate erosion control • Reduces erosion and run-off • Increases crop yields due to reduced erosion and increased soil fertility • Eventual increase in farm income	• Laborious to establish and maintain • Reduction of plantable area • Shading effects	• Magdungao, Iloilo • Guba, Cebu
Contour rock walls	• Rid farm of rocks and facilitate cultivation • Minimise soil erosion by reducing runoff and trapping sediment at base of rock walls	• Construction of 0.5–1 m rock walls on contour • Spacing of rock-walls determined by slope • Walls stabilised by grasses, shrubs or trees	• More permanent structure • Facilitates cultivation • Immediate erosion control • Minimal maintenance	• Difficult to establish • Limited by abundance of rocks • Labour-intensive	• Tabayag, Cebu
Bench terracing	• Reduce run-off and erosion by reducing slope to level or nearly level	• Construction of terraces using cut-and-fill method • Topsoil replaced on newly constructed terraces	• Immediate erosion control • Ease of cultivation	• Difficult to establish • Labour-intensive • Limited by topsoil depth	• Salogon, Palawan

Table 5.1. (cont'd) Characteristics, advantages, and disadvantages of soil conservation technologies promoted in the case study

Type of technology	Basic idea	Characteristics	Advantages	Disadvantages	Site where promoted
Hedgerow intercropping	• Minimise erosion by reducing runoff, trapping sediment, and forming terraces • Protect soil and improve soil fertility by mulching and green manuring with hedgerow trimmings	• Planting closely-spaced double hedgerows on contour • Range of hedgerow species (leguminous shrubs, grasses) • Spacing of hedgerows determined by slope • Annual and perennial crops grown in alleys • Regular trimming of hedgerows, trimmings spread over alley	• Reduces soil erosion and run-off • Crop yield increase due to reduced soil erosion and increased soil fertility • Increase in income • Adaptable to range of upland conditions	• Delay before impacts occur • Reduction of plantable area • Possibility of competition with crops • Less effective on steeper slopes	• Tabayag, Cebu • Pananag, Davao del Sur • Managok, Bukidnon • Salogon, Palawan • Magdungaoi, Iloilo • Domang, Nueva Vizcaya • Ned, South Cotabato

Contour rock walls

Contour rock walls are constructed by collecting the rocks lying on or near the soil surface and using them to construct a 0.5–1 m high rock wall running along the contour, sometimes in association with bench terraces. Contour rock walls are constructed at regular intervals down the slope, the spacing being calculated in relation to the steepness of the slope. In the projects studied (notably, at Argao in Cebu), spacing of rock walls was initially determined by a technique whereby the farmer descended the slope until his shoulder was level with the base of the previous rock wall (as determined by sighting along his outstretched arm). This was modified because the technique resulted in high rock walls which collapsed easily. Hence a spacing of 1–2 m on steep slopes and 2.5–3 m on more gentle slopes was recommended by project staff. Walls were supposedly stabilized by planting grasses, shrubs or trees along their base, these plants being a source of green manure and/or forage, as with hedgerows.

Hedgerow intercropping

Hedgerow intercropping is an agroforestry technique which, in its conventional form, involves the cultivation of annual crops between contoured hedgerows of perennial shrub or tree species, usually legumes (Kang and Wilson 1987; Young 1989). In the Philippines this has become the most widely promoted conservation technology, particularly a local variant of hedgerow intercropping known as Sloping Agricultural Land Technology (SALT) which was developed at the Mindanao Baptist Rural Life Centre in Bansalan, Davao del Sur (MBRLC n.d.; Watson and Laquihon 1986). There are four variants of SALT, all designed around a labour input of 1.5 person-days per day and minimal use of tillage and purchased inputs. Organisations concerned with upland development, including those involved in the case study projects, have focused on the extension of SALT I and, to some extent, SALT II.

Sloping Agricultural Land Technology (SALT I) is a contour hedgerow intercropping system designed for moderately sloping fields. Double hedgerows of closely planted (i.e. a spacing of 5 cm within the row and 50 cm between rows), nitrogen-fixing shrubs or trees are established on the contour at 3-5 m intervals (giving an overall density of 60,000–100,000 plants per ha). Alley width is dictated by field slope, with narrower alleys on steeper slopes. Initially *Leucaena leucocephala* hedgerows were promoted. However in 1986 a plague of the psyllid, *Heteropsylla cubana*, decimated existing hedgerows, prompting diversification in hedgerow species. Mixed-species hedgerows comprising *Leucaena leucocephala, Leucaena diversifolia, Desmodium rensonii, Flemingia macrophylla* and *Gliricidia sepium* are now utilised.

Once established, hedgerows are trimmed up to twelve times a year at knee- to waist-height, the trimmings being used as a mulch and green manure in the alleys.

Every third alley is planted to perennial crops such as coffee, cacao, citrus and other fruit trees. Other alleys are planted alternately to cereals (maize, upland rice, sorghum), other crops (sweet potato, melon, pineapple, castor bean) and legumes (soybean, mungbean, peanut). Crops are grown in rotation to minimise pest problems and maintain soil fertility. Zero or minimum tillage is used on the alleys. Over time, terraces develop, with hedgerows acting as the anchor for each terrace. When using a 3.8 m spacing, fully established hedgerows, perennial crops, and annuals occupy 27%, 30%, and 43% of the total land area, respectively. Where possible, tree species for timber and firewood (e.g. mahogany, teak, casuarinas, sesbania) are planted on the boundary of the farm, while a forested area is developed at the top of the farm.

Simple Agro-Livestock Technology (SALT II) was developed in 1987. It is a 0.5 ha goat-based agroforestry scheme in which 20% of a farmer's land is used for forestry, 40% is used for agriculture (in the form of SALT I), and 40% is cultivated with leguminous, nitrogen-fixing tree and shrub species which are used as a source of forage for livestock. SALT I is established on the upper half of the farm with three-quarters of the area ultimately devoted to perennial cash crops and one-quarter devoted to annual crops. The lower portion of the farm is cultivated with several species of palatable, proteinaceous, fast-coppicing and high-yielding forage crops, e.g. *Desmodium rensonii, Flemingia macrophylla, Gliricidia sepium*, Napier grass (*Pennisetum purpureum*) and other grasses, which serve as a source of forage for livestock while the area as a whole acts as a sink for any erosion stemming from the annually cultivated area. A goat barn is located at the boundary of the food and forage crop gardens. A cut-and-carry system brings forage to the goats and returns manure to the annually cropped fields. Goats are bred, with saleable products including milk and goat meat.

Supplementary Physical, Agronomic and Soil Fertility Measures

A range of supplementary physical soil conservation structures were also promoted, including contour canals, drainage canals, check dams, soil traps, and water catchments. These technologies were usually implemented in association with the physical and vegetative soil conservation structures already mentioned. Contour canals were usually promoted in association with contour bunds or contour hedgerows. As noted, contour canals slow the flow of water, thereby increasing infiltration and soil moisture, and may also be used to drain excess water from a field. The latter function requires construction of a drainage canal, built down one side of a farmer’s field to collect and remove diverted water from the field. Drainage canals can also perform this function in association with contour bunds and hedgerows. Soil traps are pits in a gully or drainage canal used to slow run-off and trap eroded soil before it leaves the farm. Check dams are physical or vegetative barriers placed in drainage canals and eroded gullies to slow run-off, prevent erosion, and trap eroded soil before it leaves the farm.

In most case study sites, agronomic measures and soil fertility management technologies were also promoted in association with the physical and vegetative soil conservation technologies. These included crop rotation, multiple cropping, green manuring, fertiliser management, and various methods of composting (trench composting, double digging, basket composting, compost piling, and soil reconstitution).

Adoption and Adaptation of Hedgerow Intercropping

Technologies involving a combination of physical and vegetative barriers were the most widely and intensively promoted. Most of these were primarily concerned with reducing soil erosion by slowing run-off and thereby increasing infiltration, rather than diverting run-off through coordinated drainage structures. Specifically, at all but one of the sites (Argao), the project promoted contour hedgerow intercropping (with or without contour bunds) as the main soil conservation technology, and even at Argao hedgerows were an important component. Hence this is the technology addressed in the remainder of the paper.

Implementation of Hedgerow Intercropping

Adopters generally established one plot of the hedgerow intercropping system on one parcel of their land. Typically, this plot represented a sizeable proportion (40–100%) of the parcel. Implementation and management of the hedgerow system generally differed from that followed in research trials and promoted by extension systems. Thus there was much variation in choice of hedgerow species (although most were legumes), spacing between hedgerows, the use of single- or double-row hedgerows, and spacing between plants within the hedgerow. Management of the hedgerows was reduced relative to recommended practice, as reflected in the limited frequency of trimming (2–4 times per year) and the lack of in-fill planting where gaps occurred. Hedgerow trimmings were generally left on the field or used as forage for livestock. When left on the field they were commonly placed at the base of the hedgerows rather than being spread and/or incorporated in the alleys as mulch or green manure. Most farmers cultivated only maize in the alleys. While this represented the major share of the farm-household's total maize production, most households continued to produce some maize on open-cultivated fields without soil conservation measures.

In some sites (notably Magdungao in Iloilo, which became something of a model for the DENR's Integrated Social Forestry projects), the recommended conservation technology consisted of contour bunds with hedgerows planted on top of the bunds to help stabilise them. Typically, spacing of plants on the bunds was considerably wider than for a 'pure' hedgerow system. Contour bunds need to be maintained by regularly digging out eroded soil deposited in the contour canals and using this to re-build the bunds. However, at Magdungao, while continuous ploughing resulted in the terracing of the alleys, poor initial construction of the contour bunds and lack of maintenance resulted in their eventual disappearance, leaving only the hedgerows. Given the wide planting distance, the hedgerows on their own were unable to check soil erosion.

In general, adaptation of the recommended contour hedgerow system involved: (a) reduced hedgerow density due to wider alleys, single rather than double hedgerows, and lower planting density within hedgerows; (b) reduced trimming frequency; (c) lack of or infrequent mulching of the alleys with hedgerow trimmings; (d) substitution of recommended hedgerow species with alternatives; (e) incorporating additional components in hedgerows or using them for other purposes; and (f) changing the cropping pattern (Figure 5.1).[1]

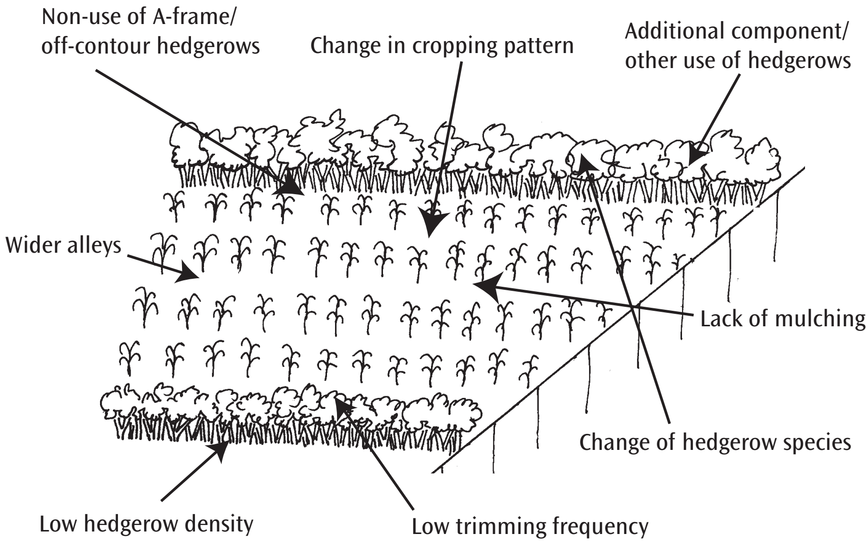

Figure 5.1. General adaptations of hedgerow intercropping.

[1] The MBRLC has also documented various modifications or adaptations of the SALT system when adopted by farmers. These include: (a) failure to use the A-frame to identify contour lines; (b) wider hedgerow spacing than recommended; (c) use of single- rather than double-row hedgerows and/or using lower planting density within the hedgerow; (d) reduced trimming frequency; (e) lack of or infrequent mulching with hedgerow trimmings (or return of animal manure); (f) failure to practise crop rotation; (f) monocropping in the alleys; and (g) a shifting system whereby the SALT plot is rested after a number of croppings but re-cultivated after a period of fallow.

Farmers' Rationale for Adaptation of Hedgerow Intercropping

Farmers' opinions regarding factors limiting wider adoption of hedgerow intercropping provide some insights into the rationale for adaptations made (Table 5.2). Most adopters perceived that hedgerow intercropping was not difficult to learn and that the necessary planting materials were easy to get and not unduly expensive. These perceptions no doubt reflected the assistance given by the project in terms of training and planting materials and did not necessarily apply to non-project farmers. The perceptions may also have been due to the adaptations made. For example, at Managok in Bukidnon the adopters at first found difficulty in securing planting materials for the recommended species (*Flemingia macrophylla*, *Desmodium rensonii*) but not the alternative species they used, namely wild sunflower *(Tithonia diversifolia*) which was abundantly available. However, adopters were more likely to agree that hedgerows required too much work, both for establishment and maintenance, that hedgerows took up too much land, and that hedgerows took too long to bring benefits.

Figure 5.2 outlines, and the following discussion elaborates on the factors underlying each of the adaptations to hedgerow intercropping made by farmers in the case study sites.[2]

(a) *Technical difficulty*. The time and difficulty involved in pegging out contour lines using an A-frame led some farmers to estimate the contour by eye or to plant in a straight line across the slope, resulting in hedgerows which were off the contour.

(b) *Small landholding*. In the standard SALT package, contour hedgerows occupy 27% of the land area, even more on steeper slopes. Farmers with limited land often established hedgerows at wider intervals than recommended and/or with only a single row, to minimise reduction of the cultivable area.

(c) *Labour constraint*. The high labour requirements for establishing and maintaining hedgerows, particularly on steeper slopes, led farmers to make adaptations such as wider alleys, single hedgerows, wider within-row spacing, lower trimming frequency, lack of mulching, and replacement of shrub legumes with grasses or natural vegetation.

(d) *Planting materials*. The availability and the characteristics of hedgerow planting materials influenced the choice of hedgerow species. Most of the recommended hedgerow species were not indigenous and hence had to be procured by farmers or provided by the project. Limited supply of these planting materials sometimes resulted in the use of alternative species, the planting of single-row hedgerows, wider alleys, and wider within-row spacing. Likewise, the lack of

[2] For other experiences with hedgerow intercropping in the Philippines, see Fujisaka (1989a, 1989b, 1991, 1993); Garrity (1991); Garrity et al. (1993); Kent (1985); Laquihon (1989); Londhe et al. (1989); Stark (1993); Tacio (1993); Watson and Laquihon (1986).

planting materials for recommended new crops limited the adoption of crop rotation within the alleys as specified in the SALT system.

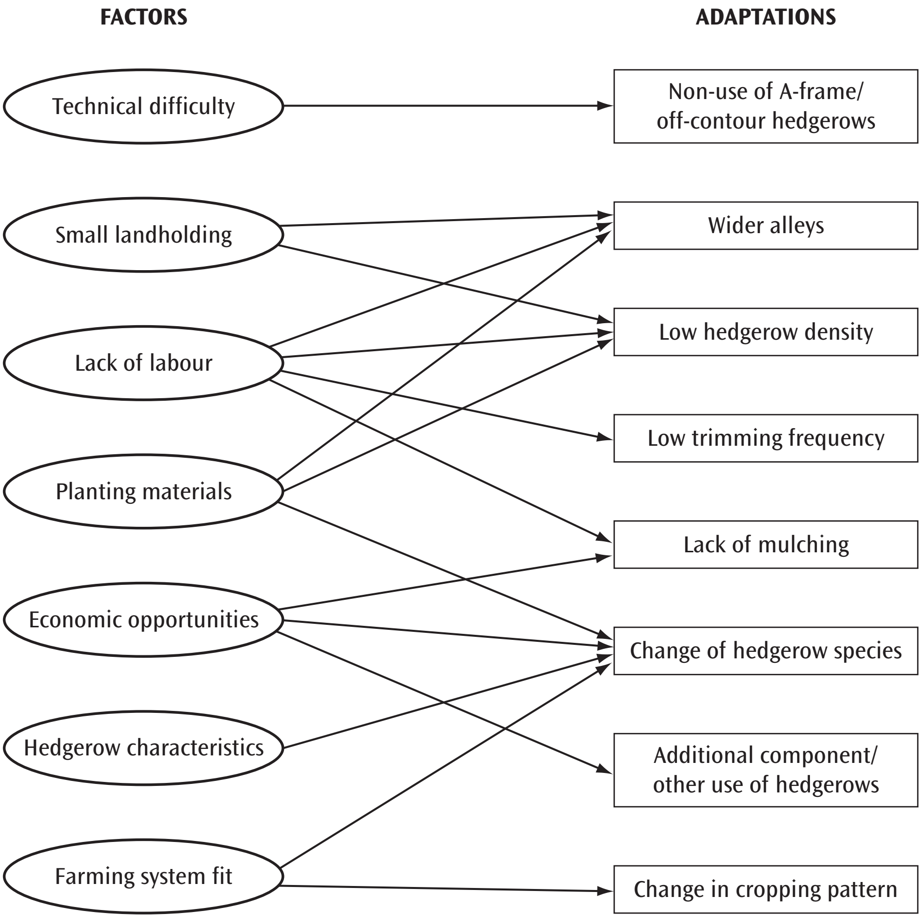

Figure 5.2. Factors affecting adaptations of hedgerow intercropping.

(e) *Market opportunities*. Farmers frequently attributed lack of adoption of contour hedgerows to the lack of immediate economic benefits. Consequently, many farmers added components to the hedgerow system from which saleable by-products could be derived and/or changed the relative importance of the system components to emphasise outputs with higher income generating potential. These adaptations were, of course, dependent on local markets. Examples included using hedgerow trimmings as livestock feed rather than as mulch, thereby improving livestock productivity and sales; delayed trimming of hedgerows so that they produced seed, which could be sold to other farmers or development agencies; fallowing hedgerow plots, then cutting the overgrown hedgerows to produce firewood or charcoal for sale; replacement of leguminous hedgerows species with species of market value, e.g. perennial food crops such as pigeon pea, cassava, and banana; and use of hedgerows for intensive commercial systems, e.g. high-input vegetable production. These adaptations suggest that the high labour requirements of hedgerows and the loss of cultivable land can be traded off against increased cash income.

(f) *Hedgerow characteristics*. Some of the recommended hedgerow species had undesirable side-effects. For example, *Leucaena* hedgerows on acid soils did not grow well, competing with crops in the alleys and failing to produce substantial biomass for green manuring. Napier grass often proliferated into the alleys, creating a weed problem. Such problems prompted farmers to change the hedgerow species or to remove the hedgerows altogether.

(g) Existing farming system. In many cases, adaptations of the contour hedgerows resulted from the need to fit better with the existing farming system. In Pananag, Davao del Sur, *Flemingia macrophylla* and *Desmodium rensonii* hedgerows proved better adapted to the short-fallow system practised in the area; the fallow period allowed the hedgerows to seed, giving the farmers the opportunity to harvest and sell the seed. However, *Gliricidia sepium* hedgerows in a short-fallow system in Domang, Nueva Vizcaya, rendered cultivation difficult as the *Gliricidia* developed big roots and encroached into the alleys during the fallow period, subsequently obstructing cultivation.

Field-Level Impacts of Hedgerow Intercropping

Most of the farmer adaptations of the recommended hedgerow intercropping system appeared to be at the expense of soil conservation and crop productivity (Figure 5.3), though some may have been beneficial (e.g. off-contour hedgerows may have helped to divert excess run-off in some situations). In general, failure to use A-frames, wider alleys, single-row hedgerows, wider distance between plants within the row, lower trimming frequency, lack of mulching, use of trimmings as livestock fodder, alternative hedgerow species, increasing the number and changing the balance of competitive uses for hedgerow biomass, and lack of crop rotation all tended to reduce the soil conserving and fertility improving characteristics built into the recommended hedgerow intercropping system. Nevertheless, while modified hedgerow systems may have been sub-optimal with regard to soil conservation, in most cases they still had a significant positive conservation effect. In addition, of course, the adaptations frequently had positive effects at the whole-farm level, e.g. by reducing labour requirements and increasing cash income. The adaptations can thus be seen as attempts by farmers to trade-off the soil conservation objective with other objectives of the farm-household.

At each site, most adopters felt that soil erosion had decreased and soil fertility and soil moisture had increased since establishing hedgerows, though this perception was less marked at Salogon in Palawan, where hedgerows had not been maintained (Tables 5.3, 5.4, 5.5). Decreasing soil erosion was primarily attributed to the direct effect of conservation measures and to increases in soil organic matter resulting from the application of hedgerow trimmings and/or the return of animal manure to the alleys. However, fertility effects were confounded with changes in fertiliser use, as discussed below.

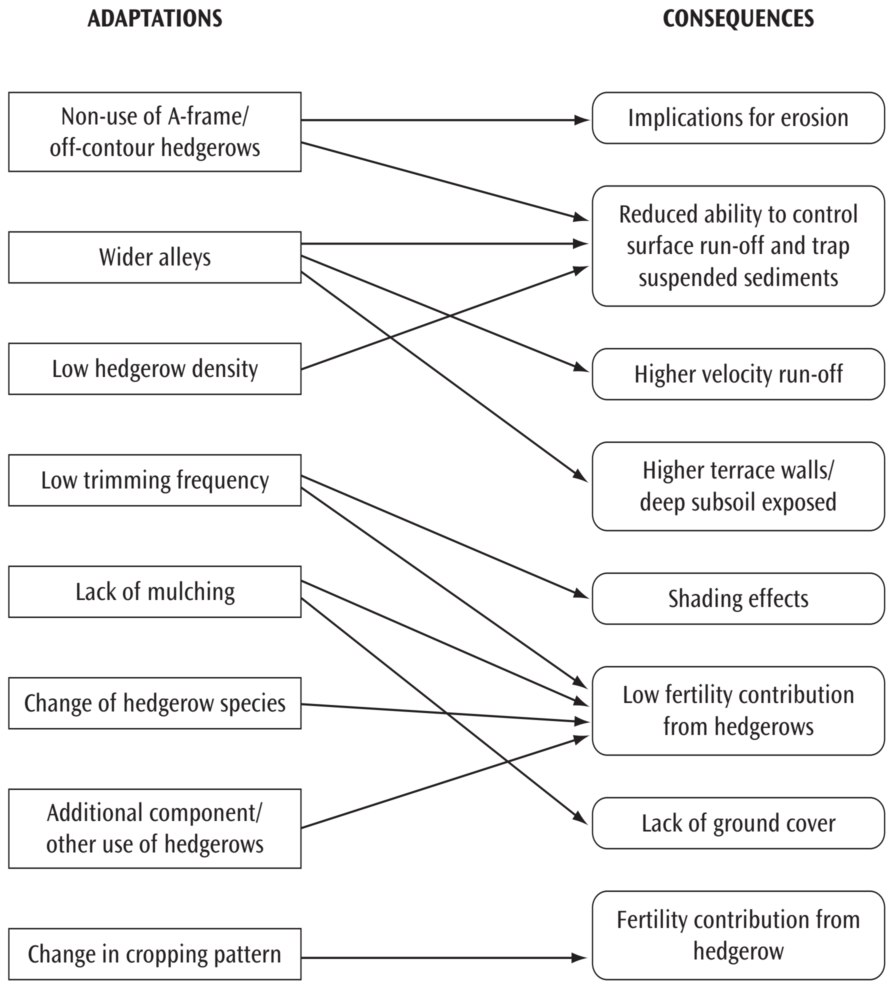

Figure 5.3. Consequences of adaptations to hedgerow intercropping.

Table 5.2. Response of adopters at four sites to suggested factors responsible for non-adoption of contour hedgerows.

Suggested characteristic of hedgerows	Pananag (%)		Managok (%)		Salogon (%)		Magdungao (dominant view)	
	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree
Difficult to learn	2	96	9	89	–	–		✓
Cost of materials too high	28	69	4	94	19	75		✓
Materials hard to get	2	96	6	91	15	35		✓
Too much work to establish	28	69	51	49	81	13	✓	✓
Too much work to maintain	20	76	47	51	65	27	✓	✓
Use too much land	28	67	64	34	36	52	✓	✓
May not get benefits	0	89	0	98	–	–	–	–
Too long to get benefits	16	80	30	64	58	21	✓	✓

Note: Percentages of respondents who did not know or had no response are omitted.

Table 5.3. Perceptions of farmers at five sites regarding trends in soil erosion in the farm since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	–	–	–	0	98	0
Pananag	–	–	–	2	90	3
Managok	68	19	9	0	98	2
Salogon	25	23	36	23	62	12
Magdungao	42	17	42	10	90	0

Note: Percentages of respondents who did not know or had no response are omitted.

In the field, control of soil erosion was manifested in the gradual formation of terraces. In sites where ploughing of the alleys occurred, terrace formation was relatively rapid. Generally, terraces were perceived favourably as they were more easily and rapidly cultivated than sloping lands, particularly on very steep slopes, where the physics of ploughing across the slope necessitated ploughing in one direction only. However, at Domang in Nueva Vizcaya there was evidence that acid subsoils had been exposed at the top of the alleys and crop productivity was declining. At Magdungao in Iloilo, poor hedgerow establishment procedures and ploughing too close to the terrace walls led to collapse of the terraces. In addition, some farmers abandoned hedgerows once terraces had been formed. In some locations, terraces proved to be stable and this action had no detrimental effects, while in others this led to the collapse of the terraces.

In a number of sites the effects of hedgerow intercropping on weeds, pests and diseases were also investigated. Responses varied considerably (Table 5.6). With regard to weeds, farmers in some sites (notably Managok in Bukidnon) indicated a decrease in the weed problem because of shading by hedgerows and mulching with hedgerow trimmings. However, at other sites, the hedgerows themselves became a weed problem, e.g. Napier grass was considered to be too vigorous and *Desmodium rensonii* flowered and seeded prolifically. A similar response was obtained with regard to pests and diseases. In some sites hedgerows were considered to be a haven for rats and snakes. In Cebu, *Gliricidia sepium* was found to be a host for a hairy caterpillar which caused severe itchiness if touched while trimming the hedgerows and also caused death of livestock if ingested when hedgerow trimmings were used as forage.

With the exception of Salogon in Palawan, most adopters perceived an increase in maize (and, where cultivated, upland rice) yields, while most non-adopters perceived stagnant or declining yields over the same period (Table 5.7). Comparison of reported maize yields with and without conservation measures indicated significantly higher yields at Tabayag, Pananag, and Salogon, but not elsewhere (Table 5.8).

While adaptation of hedgerows could explain reduced yield benefits in these other locations, the lack of a consistent yield response does agree with research findings that hedgerows may have positive, neutral or negative yield effects, and that there may be long delays in securing yield benefits. Experimental work at the MBRLC in Kinuskusan, Davao del Sur, indicates that even where management is ‘optimal’ it is only in the fifth year that higher maize yields in SALT compensate for the area lost to hedgerows. (See also Nelson and Cramb, this volume)

Where adopters averaged higher yields, this was partly associated with higher rates of fertiliser use, both inorganic and organic. However, the interaction between fertiliser use and adoption of hedgerows was complex. There was evidence that adoption of hedgerows and the associated reduction in run-off and erosion led to

Table 5.4. Perceptions of farmers at five sites regarding trends in soil fertility in the farm since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	46	29	21	90	0	6
Pananag	0	88	4	90	4	6
Managok	4	77	18	74	2	21
Salogon	9	67	18	21	48	27
Magdungao	50	33	17	83	13	3

Note: Percentages of respondents who did not know or had no response are omitted.

Table 5.5. Perceptions of farmers at five sites regarding trends in soil moisture in the farm since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	29	39	18	86	0	6
Pananag	4	92	0	88	6	6
Managok	11	46	37	74	2	17
Salogon	16	75	18	6	60	10
Magdungao	8	75	17	82	15	2

Note: Percentages of respondents who did not know or had no response are omitted.

Table 5.6. Perceptions of farmers at five sites regarding trends in weeds in the farm since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	–	–	–	–	–	–
Pananag	42	33	21	14	78	8
Managok	35	23	39	19	26	55
Salogon	7	70	11	13	63	15
Magdungao	75	17	8	32	28	30

Note: Percentages of respondents who did not know or had no response are omitted.

Table 5.7. Perceptions of farmers at five sites regarding trends in yield of maize or upland rice since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	32	21	43	92	0	4
Pananag	0	79	4	59	8	16
Managok	11	53	23	68	2	19
Salogon	16	64	27	4	58	10
Magdungao	42	33	17	53	15	17

Note: Percentages of respondents who did not know or had no response are omitted.

increased retention and effectiveness of applied fertilisers. At Pananag in Davao del Sur, for example, fertilised SALT farms yielded significantly more than unfertilised SALT farms, while non-SALT farms had yields similar to those of unfertilised SALT farms, irrespective of whether inorganic fertilisers were applied. That is, on non-SALT farms, crops did not appear to respond to inorganic fertiliser applications. This suggests that, in general, adopters of hedgerows applied more fertiliser than non-adopters because the returns to fertiliser application had been improved.

Yet adopters generally reported a decreasing trend in the use of inorganic fertilisers, while most non-adopters reported unchanged or increasing inorganic fertiliser use (Table 5.9). It may have been that adopters used higher rates of fertiliser to begin with and, though now able to reduce fertiliser use on their hedgerow plots because of the increased effectiveness of fertiliser applied, still used more on average than non-adopters. At Tabayag, however, adopters were replacing inorganic fertiliser with organic fertiliser supplied by the farmers' organisation, hence overall use of fertilisers was not declining.

Overall, it can be said that the improved effectiveness of fertilisers on hedgerow plots encouraged some farmers, with low initial levels of fertiliser use, to apply more fertiliser, and others, with higher initial levels, to apply less. Hence it appears that a combination of conservation measures and fertiliser effects accounted for the improvement in yields. It seems unlikely, however, that higher yields and/or reduced fertiliser use were due to any great extent to nutrients supplied by the hedgerows themselves, given the low frequency of hedgerow trimming, the competitive uses of hedgerow trimmings, and the limited return of animal manure to maize farms.

Figure 5.4 provides an integrated interpretation of the evidence regarding the plot- or field-level impacts of hedgerow intercropping for an upland maize enterprise. The adoption of hedgerows was seen to reduce the rate of run-off and soil erosion, thus directly affecting soil fertility (by slowing the loss of nutrients in eroded topsoil) as well as increasing soil moisture (by increasing infiltration). The formation of terraced alleys directly increased the ease of cultivation. Importantly, reduced run-off and erosion also increased the retention and hence the effectiveness of applying both organic and inorganic fertilisers. In some cases this led to a reduction in fertiliser applied, whereas in others more fertiliser was applied (the different response being due to interaction with other factors, such as the initial level of fertiliser application). Where hedgerow trimmings were applied as green manure and mulch to the cultivated alleys, this not only helped reduce erosion but was seen to increase the organic matter content of the soil, affecting both soil fertility and the soil's moisture-holding capacity. The combined effect of these changes on soil productivity was seen in increased maize yields. In turn, higher yields eventually more than offset the loss of cultivated land to hedgerows and thus contributed to higher food availability or higher cash income.

Table 5.8. Estimated maize yields (kg/ha) with and without conservation measures at five sites.

Site	Mean yield with conservation measures (kg/ha)	Mean yield without conservation measures (kg/ha)	Significance of difference in mean yields
Tabayag	863	649	*
Pananag			
1st cropping	985	719	*
2nd cropping	824	439	*
3rd cropping	888	457	ns
Managok			
1st cropping	1,178	1,246	ns
2nd cropping	1,509	1,345	ns
Salogon			
1st cropping	1,604	1,154	**
2nd cropping	1,102	799	*
Magdungao			
1st cropping	1,910	1,569	ns
2nd cropping	1,593	1,443	ns

Note: ** = significant at 5% level; * = significant at 10% level; ns = not significant at 10% level.

Table 5.9. Perceptions of farmers at five sites regarding trends in inorganic fertiliser use since conservation project.

Site	% Non-Adopters			% Adopters		
	Increase	Decrease	Same	Increase	Decrease	Same
Tabayag	32	7	61	22	44	30
Pananag	8	0	29	0	49	10
Managok	49	4	14	2	31	40
Salogon	18	0	61	42	12	27
Magdungao	75	0	25	23	60	12

Note: Percentages of respondents who did not know or had no response are omitted.

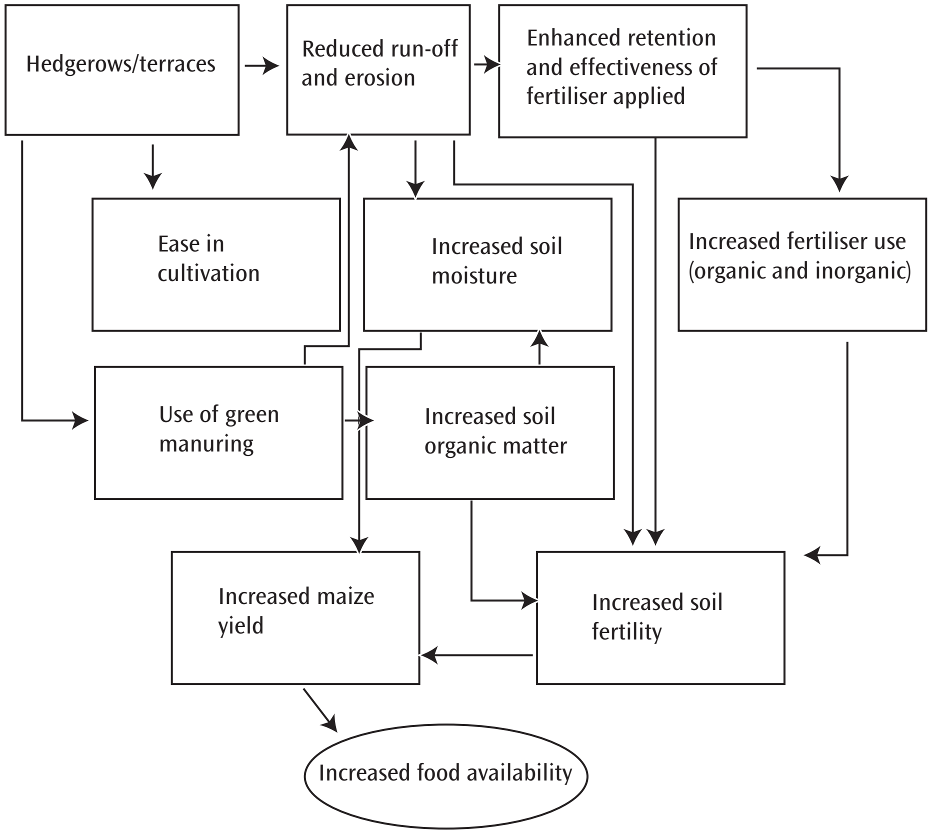

Figure 5.4. Plot level model of hedgerow intercropping impacts.

Conclusion

Many soil conservation technologies were promoted in the case study sites, all within the general category of contour-based measures, but most emphasis was placed on hedgerow intercropping, with SALT as the model or prototype. This analysis of farmer implementation of hedgerow intercropping indicates that (a) the technology has the potential to reduce soil erosion and increase crop productivity, (b) it has a narrower recommendation domain than often assumed, (c) there are limitations to the adoptability of the full hedgerow intercropping model, and (d) farmers adapt the technology to suit their goals and circumstances.

Hedgerow intercropping is suited to particular recommendation domains but is not broadly applicable to the Philippine uplands. A farming systems approach to upland development which emphasises conservation farming and views hedgerow intercropping as one component of this approach may be more successful (e.g. Norman and Douglas 1994). Implementation of hedgerow intercropping, particularly the full SALT package, should never have become an end-point for soil conservation efforts or a benchmark for project evaluation. The limited applicability of hedgerow intercropping indicates that extension agencies should offer a suite of soil conservation technologies, focusing on those which are suited to a particular environment. Extension workers need to have a better understanding of the range of technologies and farmer circumstances so as to help match the two. Farmers also need a better understanding of the technological options so that they are more likely to incorporate effective conservation measures on a sustainable basis. In Hudson's words, 'there is a need for adaptive on-farm research on conservation farming. What is required is a more multi-disciplinary approach than usually exists in conventional agricultural research. The need is not for new wonder crops, or breeding new varieties, but putting together existing knowledge, including traditional indigenous methods, into farming systems that meet local needs and fit in with local conditions' (1992, p.114).

Unfortunately, deviations from project recommendations with regard to hedgerow intercropping were sometimes seen merely as 'poor implementation and management' rather than on-farm experiments to adapt the technology. Though farmer adaptations of the contour hedgerow system may have reduced its effectiveness as a soil conservation measure, the adapted technology nevertheless appeared to make a significant contribution to the conservation objective, while fitting in with other objectives of the farm-household, such as the need to reduce labour costs and to maintain or increase food production and income in the short-term. In addition, these adaptations indicate ways in which the adoptability and effectiveness of hedgerow intercropping can be improved. While farmers are clearly capable of modifying a technology package to fit their goals and circumstances, the adaptive process is in many cases path-dependent, that is, it is influenced by the characteristics of the initial package and the mode of promotion. For example, if a project promotes hedgerows of a particular shrub legume, most adopters will initially implement this form of the technology and only subsequently modify their choice of hedgerow species (e.g. switching to a less vigorous grass), perhaps involving considerable cost, both in wasted effort and delayed benefits. By devising variants of the basic hedgerow intercropping model to suit specific sets of goals and circumstances, it should be possible to offer alternative starting points and step-wise sequences for on-farm adaptation, thereby increasing the overall efficiency of the adaptation process.

Chapter 6

Adoption of Soil Conservation Technologies in the Case Study Sites

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THIS CHAPTER summarises the project's findings regarding the farm-level factors associated with the adoption of recommended soil conservation technologies within seven of the case-study sites, that is, excluding Halang and Ned, where the development and promotion of new technologies had only recently begun. The focus of the chapter 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 chapters in this volume, or, in the case of catchment or regional impacts, were beyond the scope of this project. The aim of this chapter is simply to analyse *who* adopted and what were the consequences *for them*.

As discussed in Chapter 2, the very concept 'adopter' (and its converse, 'non-adopter') is problematic. However, the use of these categories here 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 (for convenience, termed 'adopters') implemented the soil conservation technologies which were being promoted, and others (termed 'non-adopters') 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 'adoption process' in each study site began with the commencement of a project which sought, among other things, to promote conservation technologies. 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. At Salogon (possibly an extreme case), the project seemed to take inordinate responsibility for on-farm implementation of the technologies, at times hiring outsiders to establish terraces and hedgerows, hence some farmers were catapulted from the awareness stage of the adoption-decision process to the implementation stage, largely bypassing the evaluation and trial stages (Rogers 1995). The high rate of discontinuance at this site was a logical consequence of this project strategy. 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.

In the analysis which follows, the *attributes* of the adopters were primarily examined in relation to the attributes of non-adopters within the project site (i.e. farmers who were exposed to the conservation project but chose not to implement the technologies), while the *consequences* of adoption were assessed where possible by reference to 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). Individual and group perceptions of changes over time were used to supplement these cross-sectional comparisons. The meaning of 'adopters' obviously varies somewhat from site to site, but in general the term refers to farmers who at some point implemented contour hedgerows and/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. However, in many cases (even in Guba, the site of the most widespread and long-term implementation), confirmation of adoption through extension and re-establishment had not always occurred and a process of discontinuance may have been underway.

Attributes of Adopters

In this section, three broad sets of farmer attributes affecting adoption are considered: the personal attributes of the principal decision-maker; his/her perceptions, both of the problems of erosion and of the recommended technologies; and the attributes of the farm, including physical and economic attributes (Table 6.1). 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; Garcia, this volume) 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

Personal attributes of the household head were hypothesised 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 developmental cycle and management has passed to a younger person.

Table 6.1. Summary of farm household attributes associated with adoption of soil conservation measures in the case study sites.

Attributes	Association with adoption	Comments
Personal attributes		
Age	–/0	Only at Tabayag where rock walls were built
Education	+/0	Only at Tabayag where rock walls were built
Female household head	–/0	Only at Tabayag where rock walls were built
Household size	–/0	Only at Tabayag where rock walls were built
Minority cultural group	+/0	Only at Pananag where Bagobo were targeted
Religion	0	No difference between religious groups
Migrant	0	No difference between migrants and locals
Personality	?	Some farmers attributed non-adoption to 'laziness' or 'conservatism'
Perceptions		
Awareness of soil erosion	0	Most farmers aware of erosion processes
Erosion seen as a problem	+	Adopters more likely to rank erosion highly as a problem
Awareness of technologies	0	Non-adopters mostly aware of hedgerows
Awareness of how to implement technologies	+	Non-adopters less aware of techniques such as A-frame or hedgerow establishment
Positive perception of technologies	+	Non-adopters more likely to see problems e.g. too much work, too long to get benefits, loss of land, reduction in crop yields
Farm attributes		
Farm size	+	Adopters had larger farms at some sites only
Farm location	+	Adoption more likely on plots closer to homestead and roads
Field size and orientation	+	Adoption more likely on larger fields oriented down slope
Slope	+	Adoption more likely on steeper slopes
Complexity of terrain	–	Adoption less likely on highly broken terrain
Ownership of a lowland field	0	No association with adoption where upland farming dominant
Land classified as Public Forest Land	+/0	In Salogon and Domang, dependence on public land gave incentive to adopt in order to obtain CSC

Key: + positive association with adoption
0 no association with adoption
– negative association with adoption
? no data

Table 6.1. (cont'd) Summary of farm household attributes associated with adoption of soil conservation measures in the case study sites.

Attributes	Association with adoption	Comments
Tenant/mortgagee	–/0/+	Tenancy and mortgaging discouraged adoption at many sites but not at Guba
Labour supply	0	Not a factor in itself; related to cash flow constraint
Cash income/capital	+	Adoption more likely with higher cash income and working capital
Credit	+/0	Adopters sometimes had access to project credit

Key: + positive association with adoption
0 no association with adoption
– negative association with adoption
? no data

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) 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% of non-adopters but only 6% of adopters were in this category. In commenting on the technologies promoted at this site (particularly rock walls), 25% 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 developmental 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%) than Cebuano (52%), 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%) was above the average (67%), Catholic households also had a high adoption rate (77%).

In many cases farmers had migrated to the village from elsewhere in the municipality or from further afield. In Managok, for example, over 75% 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% of adopters and 42% of non-adopters attributed non-adoption to 'laziness'. Similarly, in Tabayag 38% of adopters and 21% 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%) 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 the conflict with the Bureau of Forest Development during the Marcos era, mentioned in Chapter 4. They remained on the fringes of the community and were semi-derisively labelled *pilosopo* (translated as recalcitrants or 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% of non-adopters recognised that soil erosion was occurring on their farms, but 61% 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% of adopters a primary motivation for adoption of terraces, rock walls or hedgerows was ‘to control soil erosion’, and 98% perceived that soil erosion had decreased since adoption.

In Pananag, 90% of adopters were aware of soil erosion on their farms before adoption, and 84% indicated that they adopted hedgerows to control erosion. Most non-adopters perceived that erosion was occurring ‘rapidly’ (63%) or ‘moderately’ (25%). However, when both groups were asked to list their major farming problems, 37% of adopters listed soil fertility and erosion, compared with only 4% 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% of their parcels. This was most commonly perceived as rill and gully formation, but sheet erosion and loss of fertility were also recognised. In this case, 26% of adopters and 33% 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% of farmers in this category reported using other erosion control measures on 26% 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 Salogon, awareness of erosion processes was reasonably high; most farmers recognised 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 his or her 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 Magdungao 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% of adopters and 50% 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% of adopters were aware of the technology, only 57% of non-adopters reported awareness. At the same site, 92% of adopters were aware of contour ploughing but only 36% 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 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% of adopters and 34% 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 that the benefits took too long to accrue.

At Magdungao, adopters and non-adopters shared similar perceptions regarding the need for contour hedgerows and the ease of learning how to implement them. Non-adopters were more likely to agree that hedgerows required too much work, used too much land, harboured weeds, pests and diseases, 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 Managok, 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 minimising 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. 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 7 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%, 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% of non-adopters, but only 12% 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 10 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%) fields at some distance from the homestead, and a larger (1 ha), steeper (30–50%) 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 area 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 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 could 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 hypothesised that access to a lowland field would reduce the incentive for adoption of conservation measures on the upland area. However, in Managok 30% of adopters had access to a field on the adjacent plain (used for bunded rice production), compared to 23% of non-adopters. Adopters had somewhat larger lowland fields and accordingly produced and sold more rice. In Magdungao 73% of adopters and 83% 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 before 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 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 Stabilisation Project (USP). In this case, 32% of non-adopters had one or more parcels of A&D Land, compared with only 17% of adopters. Of parcels classified as A&D Land, only 13% were reported to have conservation measures (terraces or hedgerows), whereas 39% 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) to 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% of non-adopters had some A&D Land, compared with only 52% 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% of non-adopters were tenants, compared with only 4% 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% of adopters and 42% of non-adopters who gave a response agreed that not owning the land gave no incentive to adopt.

In Managok, 39% of non-adopters were tenants, compared with 19% of adopters. In this case 46% of adopters and 48% 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%) 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 utilising 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% of non-adopters held land by mortgage, compared with 1% 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 metres of rock wall one metre 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', 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 fertiliser, 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 fertiliser from traders, with the crop as security. The duration of the loan was one crop season or about 4 months, and the implicit interest rate was high (e.g. averaging 96% 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 fertiliser 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 likely 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 P5,500, compared with P1,900 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 P7,200. 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 P9,700, the difference 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.

Figure 6.1 summarises the observed relationships between labour supply, cash income, working capital, and adoption of soil conservation measures. A household with productive on-farm cash-earning activities had higher cash income and more time and working capital to invest in conservation activities, notwithstanding a general shortage of rural credit. In time, these conservation activities could have enhanced the cash-earning activities, as indicated by the dashed line. On the other hand, a household with limited farm cash income had to devote a significant proportion of its labour supply to off-farm wage work merely to survive, hence had too little time or capital to devote to soil conservation.

In many cases the distribution of cash income among adopters was skewed to the right, and for Pananag it was clearly bi-modal. This indicates that the category 'adopters' included a smaller sub-group 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. 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, p.104).

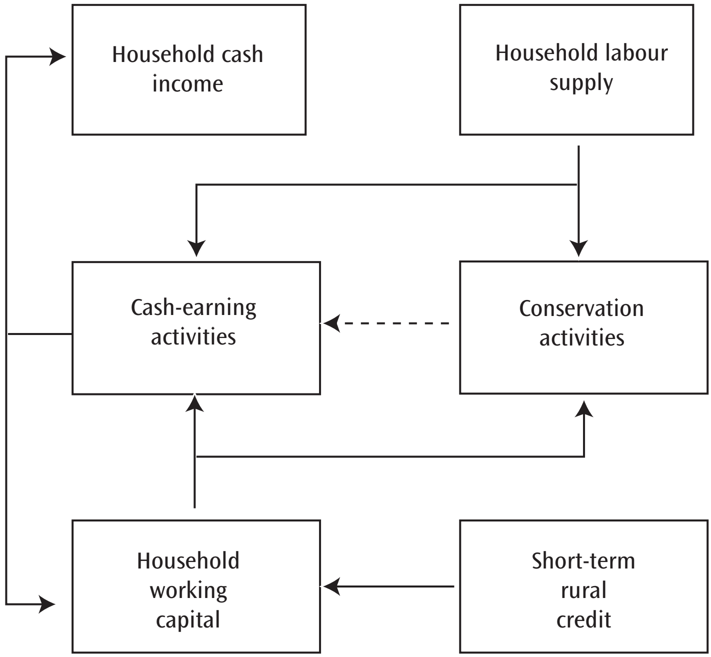

Figure 6.1. Relationships between labour, working capital, cash income and investment in soil conservation.

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: those relating to the operation of the farming system (labour use, input use, the balance of farming activities); and those relating to the outputs of the farming system (household food supplies and farm cash income) (Table 6.2).

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.

Table 6.2. Summary of farm-level impacts associated with adoption of soil conservation measures at the case study sites.

Impact	Association with adoption	Comments
Impact on inputs and activities		
Labour for establishment	+	Peak load for hedgerow establishment; off-season work for establishing terraces/rock walls
Labour for crop and farm maintenance	+/–	Net increase for hedgerows; net decrease for terraces/rock walls
Women's work	+/–	As for crop and farm maintenance in general
Fertiliser	+/–	Increased effectiveness of applied fertiliser led most farmers to decrease inputs; animal and green manure substituted for purchased fertiliser in some cases
Vegetable production	+/0	Adopters in some sites increased commercial vegetable production on hedgerow and terraced plots
Tree crop production	0	Increased tree planting by adopters and non-adopters
Livestock production	+/0	Goat production associated with hedgerows in Tabayag and Pananag, not elsewhere
Impact on outputs		
Food supplies	+/0	Maize yield and output higher for adopters in Tabayag, Pananag and Magdungao, partly due to greater use of hybrid maize
Farm cash income	+/0	Adopters had higher cash income in most sites, partly due to other factors

Key: + positive association with adoption
0 no association with adoption
– negative association with adoption

The complexity of the impacts of adoption is illustrated in Figure 6.2, which traces some of the key field- and farm-level impacts of the adoption of hedgerows and rock-wall terraces as perceived and reported by farmers in Tabayag. In this site the project also promoted goat production and provided a supply of organic fertiliser and credit for fertiliser purchase. The project intervention points are shown in the bold boxes. The main outputs of the farming system, household food supplies and cash income, are shown in the shaded boxes.

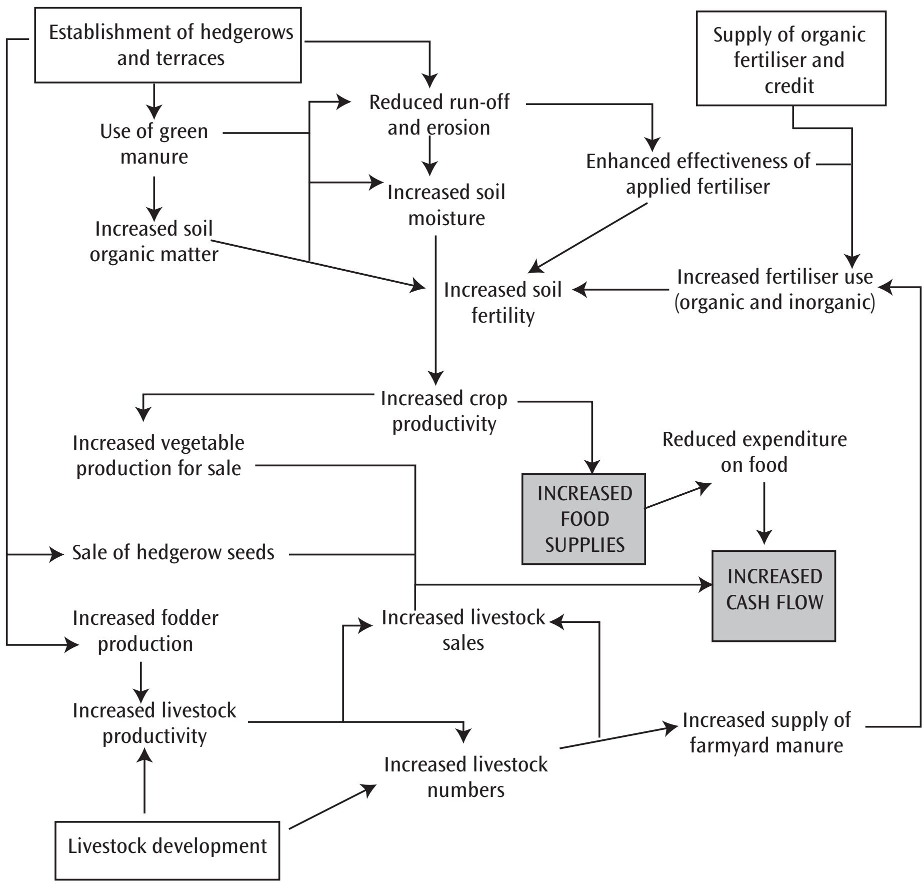

Figure 6.2. Flowchart showing perceived impacts on food supplies and cash flow of conservation farming project in Tabayag, Argao, Cebu. Boxes represent project intervention points in the farming system. Shaded boxes represent the two principal outputs or objectives of the farming system.

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 fertiliser application (the use of organic fertiliser 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.

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% 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% 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 fertiliser. In Tabayag, farmers maintained or decreased their use of inorganic fertiliser but in many cases increased their use of organic fertiliser. 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 fertiliser to the farmers' organisation and the provision of credit for purchase of fertiliser.

In Pananag, farmers reported decreased use of purchased fertiliser, again because of the increased effectiveness of the fertiliser 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 fertiliser because of higher soil fertility attributable to soil conservation measures and green manuring. Non-adopters, in contrast, reported increasing use of inorganic fertiliser (perhaps partly reflecting a need to offset losses due to erosion and partly a catching up with the available seed-fertiliser technology for maize production). Likewise in Magdungao, adopters generally reported a decrease in the use of inorganic fertiliser and non-adopters an increase.

However, in Salogon half the adopters reported an increase in fertiliser 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%) 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 at these sites. At Magdungao there was a trend towards expansion of commercial vegetable 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 supply. 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% more than both non-adopters and control group farmers. This was mainly due to greater use of and response to fertiliser on the terraced fields; there was no difference in cropped area. Hence 28% of adopters were self-sufficient in maize, compared with 11% of non-adopters and 8% 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% of adopters said their maize production had increased, compared with 32% of non-adopters and 36% of the control group.

In Pananag, SALT maize farms averaged 2,140 kg per year whereas non-SALT maize farms averaged 840 kg. The difference was due to greater cultivated area and higher yields on SALT farms (the latter primarily due to increased fertiliser use and effectiveness). As to trends, 63% of adopters said output of maize had increased, and 59% 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 fertiliser, not hedgerows. Thus while 68% of adopters said maize yield and output had increased, compared with only 10% of non-adopters (indeed, 53% of non-adopters said yield had decreased), this probably reflected greater adoption of seed-fertiliser technology which occurred concurrently with the adoption of hedgerows. For 1993, 66% of adopters and 32% 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 fertiliser. This appeared to be the major effect of the project at this site, rather than changes in conservation practices.

In Magdungao, 43% of adopters said 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% of adopters said farm cash income had increased. Yet, as noted, adopters averaged P5,500, non-adopters P1,900, and the control group P4,700, 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 utilisation 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 P7,200 (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% 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 — P5,400 per ha for adopters and P4,200 per ha 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 ha was P4,800 for adopters and P4,200 for non-adopters) and the greater uptake of seed-fertiliser technology noted above. Hence, 70% of adopters said farm cash income had increased, compared with 9% of non-adopters (54% 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 P6,100, that of non-adopters, P5,000, and that of the control group, P1,700. As explained above, this was because of the greater use of seed-fertiliser 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 (cf. Sumberg and Okali 1997, pp. 133–142) 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 highly dependent on the specific context. 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 sub-group 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, emphasising 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 fertiliser 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 fertiliser. 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 stabilised their sloping land and so were willing to invest more in seed-fertiliser 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 longer-term consequences of conservation technology for food crop yields and production requires a modelling approach, such as reported by Nelson and Cramb in this volume.

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 (consistent with the findings of the bioeconomic analysis reported by Nelson and Cramb in this volume), 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). Moreover, as shown by Garcia et al. (in this volume), even those who adopted the technologies found it necessary to modify them in various ways. Thus the main 'constraint to adoption' may be the 'transfer-of-technology' approach itself, which unduly privileges the technology being promoted and tends to denigrate farmers' experiments as 'poor adoption' or 'non-adoption', rather than the rational pursuit of diverse livelihood strategies. A wider range of more profitable and less demanding conservation technologies is needed, promoted more flexibly and with greater ongoing support for farmers in their efforts to experiment with improved farming systems.

Chapter 7

Approaches to the Promotion of Soil Conservation in the Case Study Sites

R.V. Gerrits, R.A. Cramb, J.N.M. Garcia, and G.C. Saguiguit

THIS CHAPTER examines the role of the delivery organisation in promoting soil conservation in the study sites. Although the research project did not have the specific objective of investigating the delivery organisations, the analysis of farmer responses to recommended technologies between sites indicated that delivery organisations and their extension methods were important variables in explaining farmers' adoption behaviour. Hence the need to evaluate the role of the delivery organisation in promoting adoption. This evaluation was primarily based upon information obtained during rapid rural appraisal exercises (see Chapter 4), with data being collected from project documents, extension agents, key informants, and project participants. Farmer responses to the formal surveys conducted at every site also contributed to the following descriptive analysis.

The first section characterises the delivery organisations operating in the upland case study sites. The second section describes the extension methods utilised by the delivery organisations. By relating farmer comprehension and adoption of recommended soil conservation technologies to extension methods, generalisations regarding more effective extension methods are made. The final section reviews the role of delivery organisations in promoting sustainable upland development and draws conclusions about how to promote sustainable land resource management in the Philippine uplands.

The Delivery Organisations Promoting Soil Conservation in the Case Study Sites

The sources of upland development (including soil conservation) interventions can be characterised by delivery mechanism (i.e. government/non-government and program/project), funding sources (self, national, or international) and duration. Table 7.1 presents a summary of these characteristics for the six delivery organisations studied.

Table 7.1. Profile of delivery organisations promoting soil conservation in the case study sites.

Study site (village, municipality)	Province, region	Delivery organisation	Delivery mechanism		Funding
			Govt/NGO	Program/project	
Domang, Kasibu	Nueva Vizcaya, Cagayan Valley	Integrated Social Forestry Program	Govt DENR	Program	Govt
Salogon, Brooke's Point	Palawan, Southern Tagalog	Upland Stabilisation Project, Palawan Integrated Area Development Program	Govt DENR	Project	Govt, ADB, EEC
Magdungao, Passi	Iloilo, Western Visayas	Magdungao Agroforestry Project, Rainfed Resources Development Project	Govt DENR	Project	Govt, USAID
Tabayag, Argao	Cebu, Central Visayas	Cebu Soil and Water Conservation Program, Mag-uugmad Foundation Inc.	NGO	Program	Ford Foundation, World Neighbours, NGO
Guba, Cebu City	Cebu, Central Visayas	Cebu Soil and Water Conservation Program, Mag-uugmad Foundation Inc.	NGO	Program	Ford Foundation, World Neighbours, NGO
Managok, Malaybalay	Bukidnon, Northern Mindanao	MUSUAN, Central Mindanao and Xavier Universities	Govt University	Project	Ford Foundation
Pananag, Bansalan	Davao del Sur, Southern Mindanao	Mindanao Baptist Rural Life Centre	NGO	Program	Baptist Church (USA and Philippines), NGO

At the government level the Department of Environment and Natural Resources (DENR) has jurisdiction over all lands with a slope of 18% or more, including mountainous land above 600 m. The DENR approach to agricultural land use in the uplands has evolved over time. Initially the Bureau of Forest Development (BFD) characterised upland farmers as ‘squatters’ and utilised a heavy handed, top-down, regulatory approach to ‘control’ land use. In the 1980s the DENR developed the bottom-up, participatory Integrated Social Forestry Program (ISFP) to promote sustainable land use in the uplands. Throughout the Philippines the legacy of the BFD approach has hindered implementation of the ISFP. However inadequate resources (i.e. funding, personnel) have presented a more fundamental constraint to ISFP activities.

Other government agencies involved in upland development are the Department of Agrarian Reform (DAR) and the Department of Agriculture (DA). DAR has become involved in upland development through its redistribution of land to smallholders. While participants are issued with specific leases (i.e. Certificates of Land Transfer), they are required to follow ISFP initiatives. Finally the DA has a limited role in the Philippine uplands. Nonetheless, where ‘lowland’ farmers cultivate sloping lands, the DA promotes hedgerow intercropping. The inclusion of the ISF project in Domang, Nueva Vizcaya, as one of the case study sites allowed study of the major government program addressing land degradation in the uplands.

Most non-government and project-specific interventions in the uplands were linked to some or all components of the ISFP by virtue of the latter’s jurisdiction over the uplands. Accordingly, to varying degrees, ISFP regulations regarding issuance of Certificate of Stewardship Contracts (CSCs) and implementation of resource conservation initiatives had to be adhered to. Specifically, in most of the study sites the ISFP was present before project entry. While allocation of CSCs may have occurred during this period, generally the initial ISFP presence was characterised by a marked lack of activity.

The Mindanao Baptist Rural Life Centre (MBRLC) in Davao del Sur and the Mag-uugmad Foundation Incorporated (MFI) in Cebu are non-government organisations implementing upland development programs. The MBRLC and the MFI are the largest, most successful, and hence best-known NGOs working in upland development in the Philippines. Both have been active in upland development for over two decades. In addition to having well-established upland development programs, they both have well-established training centres supporting national (and international) training needs. Project 1992/011 studied one MBRLC site (i.e. Pananag) and two MFI sites (i.e. Tabayag and Guba).

Several past upland development projects with a substantial focus on soil conservation were also studied. These include: (a) the Ford Foundation-funded Mindanao Upland Stabilisation and Utilisation Through Proper Agroforestry Networking

(MUSUAN) Program implemented in Bukidnon between 1986 and 1992 by staff of the Central Mindanao University; (b) the Philippine government and USAID-funded Rainfed Resources Development Project (RRDP) implemented between 1982 and 1991; and (c) the Upland Stabilisation Program (USP), a component of the Palawan Integrated Area Development Program (PIADP) that received funding from the Philippine government, an ADB loan, and an EEC grant. Both the RRDP and the USP utilised the resources of relevant government departments.

The distinction between programs and projects is difficult to maintain in practice. Organisations with upland development programs implemented site-specific interventions following a specified implementation cycle and timetable. Typically completion of the cycle was associated with a total withdrawal from the site and no further program support. Nonetheless the distinction between programs and projects is important in the longer-term in that programs can apply the lessons derived from implementation at one site and thereby progressively build up a body of experience applicable to subsequent interventions. This is demonstrated by the evolution of implementation manuals and technology options by the ISFP, MBRLC and MFI. In contrast projects utilised much of their resources 'recreating the wheel.' Moreover, even though programs followed a project cycle at any one site, the possibility of follow-up was available.

Project funding was derived from the international and national level, while in a number of cases programs also generated their own revenue. Foreign funding occurred across the government/non-government, program/project categorisation. Foreign funds have been used to boost the line agency programs of the government, to provide ongoing operating funds for non-government organisations (NGOs), and to provide project-specific funding. National funds have been used to support line agency programs and bilateral aid programs such as the IADP in Palawan (of which the USP was one component) and the RRDP (of which the Magdungao Agroforestry Project was one component). Finally, both the MBRLC and MFI derived part of their funds from their activities (i.e. training, project implementation, supply of inputs). However, it should be noted that both organisations are dependent to a significant degree upon foreign funding. By comparison, locally funded NGOs are constrained in terms of funding and hence sustainability, scale, and impact.

The duration of the implementation cycle (and its component phases) and the terminology associated with the phases varied between the delivery organisations. This variation can be reduced to a common four-phase implementation cycle comprising: (a) pre-entry, (b) entry, (c) expansion, and (d) phase-out of targeted sites. Pre-entry refers to either the DENR ISFP presence and/or the organisation's presence before the intensive extension period resulting in the observed adoption phenomenon. For example, in the case of Pananag, the MBRLC initially utilised its (self-styled) 'shot-gun' extension approach before returning to the site several years later with its more systematic community- and household-based ‘impact area’ approach, implemented over a three- to five-year period. Entry involved introduction of the project and securing some adoption of recommended technologies. Expansion involved increasing farmer adoption across the site. Finally the phase-out stage involved planned withdrawal from the site, with handover to a local organisation. Details of the implementation cycle for the projects studied are provided in Table 7.2.

Generally, widespread adoption of recommended technologies occurred within a reasonably short and discrete period of time, this being associated with the intensive extension efforts (i.e. the entry and expansion phases) of the delivery organisation. The DENR ISFP site in Nueva Vizcaya is a case in point. Following inclusion in the ISFP and issuance of CSCs in 1985–86, the period between 1987–89 was characterised by few activities. In 1990 the site was declared to be a Model Site and assigned more resources (e.g. more funding, including a financial incentive for adoption, and a full-time extensionist) and specified adoption targets. Needless to say most farm development occurred in the period 1990–91, before devolution and the withdrawal of support in 1993. However, it is important to acknowledge that observed adoption is a result of a longer period of extension (even if there are variations in the intensity, duration and content) than is commonly recognised.

Extension Methods

The delivery organisations utilised different methods to secure farmer adoption of recommended technologies. Description and discussion of the extension methods is considered under the following headings: (a) extension and dissemination strategies; (b) extensionists; (c) entry to upland communities and targeting; (d) provision of training; (e) provision of assistance; and (f) provision of incentives.

Extension and Dissemination Strategies

All of the delivery organisations studied professed support of the development ethos that extension should be bottom-up and participatory and that recommended technologies should be economically viable, environmentally sound, and culturally and socially acceptable. However, despite the rhetoric, all organisations in practice used a ‘transfer of technology’ extension approach, focusing on the promotion and farmer adoption of specified soil conservation technologies (particularly hedgerow intercropping). In the field this was implemented through a variant of the ‘training and visit’ system, involving extension and training directed at key farmers.

Nonetheless delivery organisations differed in their efforts to: (a) facilitate farmer understanding of resource degradation and encourage farmers to include improved

Table 7.2. Project implementation cycle at the case study sites.

Study site (village, municipality)	Project cycle (years)					Comments
	Pre-entry	Entry	Expansion	Phase-out	Total	
Domang, Kasibu	–	0.5	6.5	4.0	11.0	Lengthy expansion phase associated with low activity levels while an ISFP site. When the site was selected as a Model ISFP site, the provision of increased resources saw rapid expansion of adoption over a two-year period.
Salogon, Brooke's Point	–	3.0	5.0	2.0	9.0	
Magdungao, Passi	6.0	1.5	3.5	2.0	13.0	Site included in ISFP in 1979; RRDP started in 1982 but field activities only started in 1985.
Tabayag, Argao	2.0	0.5	14	?	?	Difficult to assess duration as the project was not time-bound. While both MFI extension and the use of the training centre have declined, farmers continue to adopt the rock wall technology.
Guba, Cebu City	0.0	0.5	15	?	?	Difficult to assess duration as the project was not time-bound. The use of farmer-to-farmer extension systems resulted in a wave of extension across the community. Accordingly it is not clear when extension started and stopped in any one community or when MFI stopped intensive extension efforts, e.g. funding of farmer instructors.
Managok, Malaybalay	5.0	1.0	3.5	0.5	10.0	Issuance of CSCs by ISFP in 1983/84 before entry of MUSUAN in 1988 accounts for lengthy pre-entry phase.
Pananag, Bansalan	9.0	0.5	2.5	–	12.0	Proximity to MBRLC HQ in Bansalan assured regular visits and a long pre-entry period. Lack of a phase-out period due to entry of another project and concern with overlap.

land husbandry as a household goal, and (b) match technologies with household resources and the local farming system.

The MFI and MBRLC programs (and to a lesser extent the MUSUAN initiatives) stand out in terms of their efforts to facilitate farmer understanding of resource degradation and encourage farmers to include improved land husbandry as a household goal. The MFI utilised a six-step community development methodology devised by World Neighbours. Of relevance here are the first three steps: (a) start where the people are and plan with the village people to develop, implement, monitor and evaluate a flexible project plan; (b) discover the limiting factors (constraints to sustainable production); and (c) choose simple and appropriate technologies that fit the local situation.

MBRLC extension evolved from the 'shot-gun' approach to the more community-based 'impact area' approach. During the entry phase of the project the extensionist serves as a facilitator, promoting recognition and awareness of degradation and its effects, and helping the community to explore various methods of solving the problem. Recognition of the need for SALT leads to the establishment of small test plots that minimise consumption risk and labour use but allow farmers to experiment with the new technology. Following experimentation farmer evaluation was expected to lead to maintenance and expansion of the SALT on the farmers' fields.

In the MUSUAN project, participating farmers were asked to select a given technology package and subsequently conduct a SWOT (strengths, weaknesses, opportunities, and threats) analysis of the selected package. This is said to have developed a heightened awareness of the farm-household's need for the technology and the risks involved in its adoption.

Other projects entered upland sites and communities with a set definition of the problem (i.e. resource degradation and loss of crop productivity) and a limited range of solutions (i.e. soil conservation technologies). Hence they simply attempted to transfer technology packages to project participants. The most extreme examples of this were: (a) pre-entry establishment of soil conservation development targets by the ISFP in Domang, Nueva Vizcaya, and (b) the imposition of soil conservation technologies on short-fallow rotation systems in Palawan.

Overall the evidence suggests: (a) that emphasis should be given to approaches that enable the participants and the broader community to recognise the need for better land husbandry; and (b) that this requires the use of participatory approaches to include farmers and the absence of project-defined 'appropriate' technologies and measures of success, e.g. adoption of specific technologies.

In general, the delivery organisations did not actively seek to make recommended soil conservation technologies match household resources and the local farming system. The MBRLC is perhaps the exception, with extensionists recommending that farmers establish 0.1–0.25 ha Test SALT plots on their current season's maize fields.

The MBRLC believes that Test SALT plots demonstrate the utility of the technology and do not impose too much of a burden on household resources (i.e. land and labour) and production (i.e. loss of current season maize production). Other organisations (e.g. MFI, RRDP) dealt with the labour constraint (but not the production losses) by organising labour exchange groups. (These are discussed in the section dealing with the provision of assistance.)

Another example of adaptive and integrated technology usage derives from Tabayag. While promoting an integrated nutrient management system involving terrace development with rock walls and hedgerows (the latter providing either mulch for the terraces or fodder for livestock, with subsequent application of goat dung to the terraces), the MFI also promoted the use of (a) reduced quantities of inorganic fertiliser and (b) organic fertiliser (i.e. chicken manure). Such an integrated approach (i.e. conservation, reduced inorganic fertiliser application, and use of organic fertiliser) appeared to provide quick returns to investing in both the conservation measures and fertiliser usage.

Overall the constancy and frequency of farmer criticisms of hedgerow intercropping across sites (i.e. it takes too much land, it requires too much labour, it involves delayed returns to investment) demonstrates the need for in-situ adaptation of the system so as to better match farmer circumstances. Clearly extensionists need to be given the skills and a pool of technologies that allow them (and the community) to better match the technologies with household resources and the local farming system.

With regard to dissemination strategies, with the exception of the MFI, the delivery organisations targeted entire upland communities (defined by geographical, administrative and political boundaries) and concentrated resources on promoting adoption within the community. This involved professional or farmer extensionists working with individual households, groups, or the entire community. The outcome of this approach was a phenomenal degree of location specificity, with farmers in nearby communities indicating limited awareness of recommended technologies.

The MFI differed from other organisations by not limiting extension to specific upland communities and actively supporting farmer-to-farmer extension systems beyond the point of entry. In any one community the MFI utilised a group meeting to introduce the recommended technologies, organised labour exchange groups for training and implementation, and trained one or more of the new adopters to become extensionists. In this way, extension progressively moved away from the core project area. Hence the adoption phenomenon at the MFI Guba site. However, it is noteworthy that the MFI was not as successful at other sites. In Tabayag there was little evidence of widespread adoption, although this was attributed to the labour- and skill-intensive nature of the technology (i.e. rock walls) and MFI's limited capacity to provide follow-up extension and community organisation. Nonetheless, analysis of the MFI success in Guba illustrates (a) the utility of broader dissemination strategies (whether they involve household, group, or community level extension with professional or farmer extensionists), (b) the efficiency of farmer-to-farmer extension systems, and (c) the need for resources to support farmer extensionists. With regard to (c) it is clear that, while spontaneous farmer-to-farmer diffusion does occur, active use of farmer extensionists needs to be supported by resources.

Extensionists

Table 7.3 indicates the educational background and residence of project extensionists. The organisations studied used extensionists who were either (a) educated, with or without a rural background, and who may or may not have been resident at the project site for part or all of the project, or (b) local farmers regarded as successful adopters of the recommended technologies and who received training and wages to work as part-time extensionists. From the outset it should be noted that the use of farmer extensionists differs from the concept of spontaneous informal farmer-to-farmer extension. Farmer extensionists need to receive wages for their work with the understanding that active extension will cease when wages are no longer paid.

Evidence from various sites (e.g. Tabayag, Guba) suggests that farmer extensionists were more effective than professional extension agents. Farmer extensionists had a number of advantages. First, selected farmer extensionists were permanent residents of the community. Second, as a result of targeting, the first and more successful adopters were usually community leaders or respected community members. As extensionists they were able to take advantage of their reputation and existing community respect and rapport, i.e. they were widely known and likely to be listened to. Third, farmers within the one community were likely to share the same objectives and resource constraints. Given that the technology was appropriate to the environment and the community, successful adopters were able to articulate the rationale for adoption from the farmers' point-of-view, rather than from the project or 'soil conservation' points-of-view. This was a stronger argument for adoption. Fourth, given their understanding of the farming system and the biophysical and socioeconomic environment, they had a better understanding of farmers' opportunities and constraints, hence could recommend establishment procedures and adaptations that would better match the technology with the environment. Finally, having several farmer extensionists reinforced the potential of the technology and the extension message within the community and with other communities.

Note that many of the advantages of having farmer extensionists are contingent on the view that the farmer extensionists do not have a vested interest in securing farmer adoption, i.e. they do not become an arm of the project and its objectives. A negative example of this was evident in Managok, where lead farmers were paid for extension work once recommended technologies had been established on new participants' farms. Interviews with 'adopters' indicated that many were not actively involved in the decision to adopt and implement the technologies. Although farmer extensionists need to be paid a local salary, it is important that they do not receive a disproportionate gain for their activities so that the community continues to believe that they are working with the community's best interests in mind. In short, their credibility must not be compromised.

Finally, it should be noted that the argument for farmer extensionists does not negate the need for professional extensionists. Rather an extension system that utilises professional and farmer extensionists together is recommended. Such a system is likely to be more efficient in the use of scarce resources and more successful in achieving outcomes.

Entry and Targeting

Table 7.3 provides details of project entry and targeting methods used by the delivery organisations. Project entry and expansion relied upon identifying entry channels into the upland communities and developing positive relationships with key community members. The importance of this process was indicated by MBRLC estimates that at least eight to twelve months of building trust and establishing contacts were required before a project could start to focus on its objectives.

Generally project entry occurred through the DENR and local political channels. However the limitations of this approach were demonstrated in several locations where the *barangay* encompassed both lowland and upland areas and *barangay* officials resided in the lowlands (e.g. Bukidnon, Iloilo, Palawan). Typically these officials lacked a knowledge and appreciation of the upland environment and the necessary incentives to deal with issues affecting upland residents.

To overcome this shortcoming the MBRLC utilised the Baptist church as a point-of-entry into the community, although subsequent work was carried out on a community-wide basis and was not restricted to church members. While this had some negative outcomes in that the recommended technologies came to be seen as 'Baptist' technologies requiring adherence to Baptist beliefs, overall the MBRLC felt that its approach yielded substantial benefits. Clearly, while having an entry point into upland communities is advantageous, the lack of community organisations in the uplands means that most upland development projects are unable to utilise the MBRLC approach.

The MFI also avoided official political and bureaucratic channels during their expansion phase by utilising their farmer-to-farmer extension system. As discussed above, their success in disseminating and securing farmer adoption of recommended technologies is at least partly attributable to direct interaction between upland farmers such that the technologies spread from *sitio* to *sitio* and appeared to be 'of and for the people.'

Table 7.3. **Use of extensionists, targeting and training by delivery organisations operating in the case study sites.**

Study site (village, municipality)	Extensionists		Targeting			Training	
	Education	Residency	Entry	Target	Target	Location	Cross-farm visits
Domang, Kasibu	DENR ISFP extensionist	Non-resident	Political – *sitio*	Community leaders	Community and groups	Community hall and demonstration farm	Limited number of farmers
Salogon, Brooke's Point	DENR staff and project staff	Resident	Political – *sitio*	Community leaders	Community and groups	Training room and demonstration farm	-
Magdungao, Passi	DENR staff and project staff	Resident	Political – *barangay* and *sitio*	Community leaders	Community and groups	Training centre, demonstration farm, model farms and other farms	Key leaders and selected farmers to MFI, MBRLC, USP, and two sites in Luzon
Tabayag, Argao	Project and farmer instructors	Resident	Political – ISFP	Lead farmers and community members	Exchange labour groups	Farmers' fields	To demonstration farms in Tabayag and Guba
Guba, Cebu City	Project and farmer instructors	Resident	Political – ISFP	Lead farmers and community members	Exchange labour groups	Farmers' fields	To demonstration farm in Guba
Managok, Malaybalay	Project and lead farmer	Non-resident	Political – *barangay*	Community leaders	Community and households	Training room	Lead farmers taken to other MUSUAN site and to MBRLC and MFI
Pananag, Bansalan	Professional MBRLC extensionists	Non-resident	Church	Farmers	Community, groups and households	Community halls, farmers' households, and farmers' fields	Most farmers taken to MBRLC demonstration farm

Selection of participants in the entry phase involved targeting of *barangay* and *sitio* leaders and respected community members. Generally the use of political channels as entry points led to project cooperation with such leaders. While this tended to be successful in stable, harmonious communities (e.g. ISFP, Nueva Vizcaya), the case of the RRDP in Magdungao, Iloilo serves to illustrate why caution and perhaps other approaches might be useful. In Magdungao the community was divided into two opposing clans. The RRDP entered the site through the existing political channels and failed to account for the existing divisions within the community. These unacknowledged and unresolved divisions subsequently had negative effects on project implementation, especially with regard to cooperation, organisation and community building. In contrast, both the MUSUAN program and MFI overcame such potential difficulties by involving the community in selecting participants and/or farmer extensionists. Following specification of project- or community-defined criteria, the community was asked to select appropriate candidates. Hence the outcome belonged to the community and it was hoped that selected participants would feel some obligation to the community and consequently become 'better' participants.

Given the importance of initial success, it is clear that projects need to investigate community relations and identify appropriate community leaders, respected community members, and entry-phase participants to ensure true community participation. Nonetheless it would seem that conflict resolution skills would need to be part of the extensionist's responsibilities and repertoire.

Training

Training methods included instruction at the household-, group- or community-level, practical field-level demonstrations (either on the project's demonstration farm or farmers' fields), and cross-farm visits. Table 7.3 provides details regarding the targeting of training, the location of training, and the use of cross-farm visits. Generally all organisations used all of the methods, and ascertaining quantitative or qualitative differences in training was difficult. For example, with regard to training it was not possible to determine content, training style (i.e. instructive or participatory), size of group meetings, and frequency of group meetings. Nonetheless some general observations regarding training are provided below.

Regular household and field-level extension compared favourably with extension to groups at demonstration sites, in terms of farmer awareness, comprehension, willingness to adopt, and subsequent quality of adoption. In particular the MFI and RRDP's exchange labour groups provided the basis for sharing the workload and regular, field-level training, discussion and reinforcement of soil conservation.

Training typically focused on transferring technology and ensuring project success, rather than building capacity. For example the MBRC's ten-step SALT implementation method focused on transferring the knowledge and ability to establish and utilise contour hedgerows according to a standard set of specifications. Surveys indicated that farmers had a good understanding of project-recommended technical specifications and establishment methods for hedgerow development but were unable to explain the importance of contour cultivation, alley width, or within-row spacing in the hedgerow in relation to resource conservation. This lack of capacity has implications for expansion and further dissemination of the technologies.

Finally, cross-farm visits within and between communities appear to be accepted as standard practice for upland development projects. Cross-farm visits were an important element in stimulating farmer interest, generating confidence, and securing farmers' commitment to adopt the recommended technologies. Both extensionists and farmers viewed these experiences positively in that the visits allowed the farmers to see the system and substantiate its effects, and to talk with, and be reassured by, adopters who operated in similar environments to their own.

Assistance

As previously indicated, the delivery organisations implemented broad-based upland development projects bringing a range of benefits to the upland communities. Consequently all organisations provided participants with assistance across a range of sectors. Adoption of soil conservation was promoted by the provision of material assistance (e.g. planting materials and tools, sometimes in the form of starter packages) and the organisation of labour. Agroforestry development was further stimulated by the provision of a range of inputs (e.g. crop seed, fertiliser, livestock, and forest and fruit tree seedlings). Community development was encouraged by the organisation of cooperatives and the provision of credit. Table 7.4 outlines the delivery organisations' provision of assistance to the upland communities studied.

Organisations supporting farmer adoption of hedgerow intercropping supplied participants with tools and planting materials and organised labour to facilitate implementation. The emphasis on legume-based hedgerow intercropping required projects to supply planting material (seed or cuttings of various species) to adopters. Nonetheless planting materials were often in short supply. In some sites this led to poor quality implementation (i.e. Magdungao, Iloilo) while in others the shortage led to innovation, with wild sunflower hedges being established in Managok, Bukidnon, and hibiscus hedges being established in Domang, Nueva Vizcaya.

The organisation of labour sought to overcome the constraints to adoption imposed by the high establishment costs of the technology. Indeed farmers' comments about the high labour costs of establishment and maintenance of hedgerow intercropping demonstrate the potential utility of this activity. Four of the projects studied attempted some form of labour organisation and in the majority of cases these

Table 7.4. The provision of assistance by delivery organisations operating in the case study sites.

Study site (village, municipality)	Assistance									
	Planting materials	Tools	Labour	Crop seed	Fertiliser	Live-stock	Cash crops and forest & fruit trees	Credit	Association/Cooperative	Access Trail
Domang, Nueva Vizcaya	Provided (insufficient qty) and used locally available material	–	–	–	–	–	✓	–	Established and operational at time of survey	✓
Salogon, Brooke's Point	Provided	✓	✓	✓	–	✓	✓	–	Established and operated by project staff; ceased operation soon after project termination and departure of project staff	✓
Magdungao, Passi	Provided	–	✓	✓	–	✓	✓	–	Established and operational at time of survey but suffered from limited effectiveness	✓
Tabayag, Argao	Provided	✓	✓	–	–	✓	✓	Provision of seed, tools, and livestock in the form of credit within group	Established and operational at time of survey	–

Table 7.4. (cont'd) The provision of assistance by delivery organisations operating in the case study sites.

Study site (village, municipality)	Assistance									
	Planting materials	Tools	Labour	Crop seed	Fertiliser	Live-stock	Cash crops and forest & fruit trees	Credit	Association/Cooperative	Access Trail
Guba, Cebu City	Provided	✓	✓	–	–	✓	✓	Provision of seed, tools, and livestock in the form of credit within group	Established throughout extension area and operational at time of survey	–
Managok, Malaybalay	Used locally available material	–	–	✓	✓	–	✓	–	Established but ceased operation due to failure to settle loans	✓
Pananag, Bansalan	Provided	✓	–	–	–	✓	✓	–	Established and operational at time of survey	-

efforts were not particularly successful. The USP simply contracted labour to implement the technologies on 'participants' fields. More sustainable approaches centred on the organisation of labour exchange groups. They appeared to have worked well with the MFI in Tabayag (where rock walls were implemented) and in the hinterland of Cebu (where hedgerow intercropping was implemented). Rock wall construction in Tabayag required substantial and intensive inputs of labour. That exchange groups facilitated adoption is demonstrated by elderly farmers' comments that non-adoption was due to their inability to join labour exchange groups. These groups also formed the basis of sharing tools, draught animals, etc. In the RRDP in Iloilo the initial success of labour exchange groups in implementing labour intensive tasks petered out once these tasks had been completed. Finally, in the MUSUAN program in Bukidnon, labour exchange groups ceased operating after an initial learning period because of differences in farmers' work practices.

The evidence suggests that labour exchange groups are useful where several workers are needed to facilitate tasks, but are otherwise unnecessary. While it appears that traditional labour exchange systems can form the basis of labour exchange groups, the MFI experience suggests the need for a well-articulated, farmer-defined set of rules governing these exchanges. This appeared to be due to the larger farmer groups, the greater frequency with which the groups met and, relatedly, a greater tendency to substitute labourers, e.g. sending children. Larger groups are more likely to have a limited time span, as there is less to do once the labour intensive tasks are completed. However, greater emphasis on hedgerow maintenance might provide the basis for smaller groups to continue working together and simultaneously increase the sustainability of farmers' initial adoption.

The impact of other assistance promoting agroforestry and community development on the adoption of soil conservation is difficult to ascertain. A number of general observations are provided below.

Generally hedgerow intercropping was promoted as a multiple use and multiple benefit system, and various forms of assistance were provided to stimulate the development of such a system, e.g. livestock, fruit trees. Where they occurred, livestock dispersal programs relied on a limited number of breeding stock to supply participants with livestock and consequently supplies were below demand and usually much delayed. For farmers receiving and increasing their livestock holdings, inadequate fodder supplies meant that livestock and cropping alleys competed for hedgerow trimmings (unless animal manure was applied to cropped alleys).

While promotion of diversified and integrated systems might increase the incentives for farmers to adopt the system, multiple uses should be based upon complementary rather than competitive uses of system outputs. Alternatively a step-wise implementation methodology that allows sequential development of multiple uses might be preferred. In such a scenario farmers would (a) have recognised and secured the benefits from adoption of the primary technology, and (b) be aware of the trade-offs occurring when diversification and multiple uses involve competition for system outputs.

The potential to receive other benefits may have provided participants with the incentive to adopt soil conservation, this being particularly the case where the aid was, or appeared to be, conditional upon adoption.

As part of their phase-out, all organisations promoted the development of farmer associations and cooperatives. Although intended to serve as a focus for linking the community with other upland development initiatives (e.g. from other government departments), these bodies generally only served as marketing bodies and sources of credit. As such these bodies met with variable success. Farmers commonly utilised credit to purchase inputs such as fertiliser for their maize cropping. However, in some cases these bodies proved to be unsustainable because of farmers' failure to repay their loans (e.g. MUSUAN), or the failure of the delivery organisation to develop local management capacity (e.g. USP).

Incentives

Different types of incentives were utilised to promote adoption of soil conservation. Most prevalent were the direct incentives (i.e. land tenure security, financial benefits) that were conditional upon adoption of the technology. In addition, as suggested in the previous section, various forms of material assistance may also have served as incentives for participation. Less common were indirect incentives such as the creation of markets for products derived from adoption. Table 7.5 outlines the delivery organisations' use of incentives.

With the exception of the MBRLC Pananag site that is situated in a national park, all organisations held out the promise of land tenure security for their participants. In most cases such land tenure security was offered in the form of the DENR ISFP's Certificate of Stewardship Contracts (CSCs). (Note that other mechanisms such as the ISFP's Certificates of Community Forest Stewardship (CCFSs) and the Certificates of Land Transfer (CLTs) offered through the DAR's Comprehensive Agrarian Reform Program (CARP) were also available.)

The land tenure options offered by the ISFP promote adoption of soil conservation through regulation and incentive. The tenure instruments are regulatory in that they characterise upland farmers as stewards of public forest lands and thereby oblige farmers to conserve the land. Failure to meet these obligations could result in cancellation of the CSC, making upland cultivation illegal and punishable by law. The promise of tenure security was deemed to be an incentive because it is commonly believed that tenure security is a prerequisite for farmer investment in soil conservation technologies that have a long payback period. Hence the issuance of the tenure instruments was seen as carrying sufficient weight to influence farmers' behaviour. In

Table 7.5. The provision of incentives by delivery organisations operating in the case study sites.

Study site (village, municipality)	Incentives		
	Land tenure security	Financial	Market
Domang, Kasibu	CSCs provided at start of project	P6/m of hedgerow, rock wall or bench terrace established offered in 90–91. Insufficient funds prevented payment to late adopters	-
Salogon, Brooke's Point	CSCs provided at start of project	Substantial cash payments to labourers to implement conservation measures on 'adopters' farms	-
Magdungao, Passi	CSCs provided at start of project; those issued on A&D land subsequently cancelled	Monetary incentive (P6/m contour levees with hedgerows, P2/m of contour levees or hedgerows only) provided in 86–87; material incentives in 87	-
Tabayag, Argao	CSCs provided at start of project	–	MFI purchasing shrub legume seed
Guba, Cebu City	Not provided. Farmers were owners or tenants. DAR active in land re-distribution with issuance of CLTs	–	MFI purchasing shrub legume seed
Managok, Malaybalay	ISFP provided some CSCs before project. Project stimulated further issuance of CSCs. CSCs subsequently withdrawn because of CMU claims to the land	Between 89–91 DENR ISFP provided participants with monetary incentives for establishment of soil conservation measures (i.e. P6/m of double hedgerows, P2/m of single hedgerows). MUSUAN did not support such payment. Farmers reported signing for but not receiving payments	-
Pananag, Bansalan	Not provided. Area within Mt. Apo National Park	–	MBRLC purchasing shrub legume seed

addition extensionists could use the timing of the issuance of the documents in a 'carrot-and-stick' manner, whereby awarding the agreement was conditional upon the farmer having adopted soil conservation on his/her farm.

The efficacy of the land tenure instruments in encouraging better land husbandry depends upon the extent to which land tenure security influences farmers' land use practices and the extent to which these instruments convey such security to the upland farmer. These questions have been addressed elsewhere. In summary, (a) there is general agreement that land tenure security is an important variable influencing farmers' land use practices, and (b) the tenure instruments offered by government have both site- and farmer-specific effects in terms of providing incentives for adoption, leading to wide variation in their efficacy.

It must also be recognised that the efficacy of the ISFP land tenure instruments was undermined by the assignment of a CSC registration target to regional directors, leading to careless issuance of certificates (World Bank 1989) and limited incentives to cancel CSCs when farmers failed to meet their stewardship obligations. Implementation of the ISFP has seen the majority of the scarce resources available used in parcellary surveys and issuance of CSCs (Gibbs et al. 1990) although it was not clear that they delivered the anticipated outcomes. Finally (and relatedly) the ISFP did not have the resources, capability and incentive to enforce the conditions of the CSCs, and farmers were unlikely to respond to the threat of CSC cancellation.

The use of direct financial incentives was most evident in the ISFP. Between 1989 and 1991 the ISFP provided participating farmers with monetary compensation for labour expended in establishment of conservation technologies. The rationale for the subsidy was that farmer investment of labour (and other inputs) in developing conservation measures did not directly address the subsistence and cash income requirements of the household and that they should thus be compensated for this activity. Hence farmers received cash payments of (a) P6 per linear metre of any combination of vegetative and structural conservation measures (e.g. contour hedgerows with contour canals, contour rockwalls with hedgerows), and (b) P1.50 per linear metre of vegetative conservation measures implemented on their farms. Other examples in which financial incentives were provided include: (a) the MUSUAN program provided lead farmers with a cash incentive to recruit new adopters, with payment being conditional upon actual hedgerow establishment; (b) the USP provided funds to contract labourers to establish conservation measures on 'adopters' farms; and, (c) the RRDP provided food-for-work schemes to accomplish community projects.

There are good reasons justifying the provision of direct financial incentives. Douglas (1994) lists the following as grounds for such measures: (a) small-scale farmers are too poor to take any risk and usually have no resources to meet additional labour or capital costs; (b) many conservation measures involve a heavy labour investment and there is an opportunity cost associated with using family labour for conservation purposes; (c) soil conservation has off-site benefits, so if on-farm conservation is in the interests of the state (the wider society) then it is reasonable that the state should pay the whole or part of the cost; (d) a farmer's income may be reduced in the initial stages of conservation because (i) production is lost or delayed, (ii) additional labour is needed for construction, (iii) inputs, time and effort are needed to restore soil quality following disturbance and subsoil exposure, and (iv) some actual loss in production area is likely; and (v) financial or material incentives can be looked upon as a cost sharing between the project and the farmers.

However, the provision of direct financial incentives has been criticised in the literature for several reasons. First, direct incentives give farmers the belief that conservation is an activity that someone pays them to do. Hence the negative outcome that Douglas (1994) aptly summarises as 'when the payment stops, the conservation stops.' For example, in the case of the ISFP, evidence from various sites (including Domang, Nueva Vizcaya) suggests that highest rates of farmer adoption of conservation technologies coincided with the two years over which monetary incentives were provided for adoption and that virtually no expansion and new adoption occurred after this period. Second, payment based on quantifiable physical outputs (e.g. length of hedgerows established) creates incentives to maximise establishment at the cost of both quality and what is technically or economically optimal. Third, payment for establishment leaves open the question of who is responsible for maintenance; in general, it was found that in such cases adoption was not sustained. Fourth, once payments have been made for one activity, it is difficult to get farmers to work on the same and other activities on a voluntary basis. Fifth, in some cases extensionists appropriate some of the financial incentives as their own. There was support for each of these criticisms in the case studies.

Hence there are many potential negative outcomes from a policy of providing direct financial incentives. Perhaps the most important is that farmers who adopt conservation measures to secure the financial incentives generally do not integrate conservation farming into their farming system, and project success as measured by quantifiable adoption actually represents project failure. Douglas (1994) concludes that the challenge, and hence the measure of success, is to find and promote technologies which farmers voluntarily adopt.

Indirect incentives involve the creation of specific markets or facilitating linkages to markets from products stemming from adoption of soil conservation. While markets providing short-term returns address a common farmer criticism of soil conservation technologies, caution has to be exercised in creating temporary and competitive uses for the given technology and thereby affecting the long-term motivation for maintenance of the technology on farm. Two examples serve to illustrate this tension: (a) the creation of training centres and model farms, and (b) the purchase of hedgerow seed.

The relative success of most sites resulted in them becoming model sites for the region (and beyond) with subsequent development of training centres and programs. While involvement in training and cross-farm visits may have reinforced the initial adoption decision (that is, at least trialling and maintenance, if not expansion) amongst farmers, the activity also provided them with financial benefits. In some cases (e.g. the RRDP in Iloilo), the creation of a model site and training centre became the focus of the project.

The creation of markets for legume seed stimulated adoption in a number of areas, e.g. MFI sites in Tabayag and Guba, the MBRLC Pananag site, and various ISFP sites. However, in general, as hedgerow adoption became more widespread, the demand for seed decreased and the bottom dropped out of the market, with obvious consequences for farmers utilising hedgerows for this purpose.

Discussion

This evaluation of the role of delivery organisations in promoting farmer adoption of soil conservation has a number of limitations. First, evaluating extension was not an explicit objective of Project 1992/011. Rather it occurred after analysis of farmer responses to recommended technologies between sites showed that the delivery organisation and its extension methods were important variables in explaining farmer adoption behaviour. Accordingly most of the analysis relies on secondary data. Some concerns arise because farmer responses indicate that the documented extension methodology did not always match field practices. Second, post-project evaluation fails adequately to capture the human factor in extension. For example, how well trained and motivated were project staff? What were the relationships between project staff and participants? The human factor is critical in determining the success or failure of extension. Third, the evaluation compares and contrasts extension methods and practices across a range of sites that capture the diversity of the Philippine uplands. Accordingly doubts regarding the validity of cross-site comparisons of different methods and practices might be raised. For example, the success of MFI extension in Guba was not replicated at other sites where the same extension approach was utilised to promote different technologies. With these limitations in mind, is it possible to develop generalisations about ‘what works’? As demonstrated by the above analysis, the answer is a qualified ‘yes’.

No consideration has yet been given to whether the combination of the preferred extension practices discussed above will provide the best overall extension approach. Interestingly, when consideration is given to the extension approaches of the delivery organisations studied, the MBRLC, MFI, and (to a lesser extent) the MUSUAN project extension approaches are seen to be more effective than those of the other organisations studied. At one level this is attributable to the fact that these approaches incorporate more of the preferred extension methods and practices identified above. However the combination of extension methods and practices also reflects the overall project approach.

In describing project approaches to community forestry, Oltheten (1995) identifies two approaches, namely target- and process-oriented projects. Target-oriented projects are defined as mechanisms for the delivery of pre-defined packages of goods and services to specific target groups that typically use approaches that involve farmers participating in what the project wants to do. Process-oriented projects allow farmers to select activities on the basis of needs and local resources, provide technical support in the form of a menu of options, and involve farmers owning and taking responsibility for the activities. Pretty (1995, p.173) has developed a typology of participation ranging from passive participation (in classical top-down fashion) to self-mobilisation, where external agencies are no longer essential for action. Target-oriented projects rely on a mix of lower-order participation types (passive participation, participation in information giving, participation by consultation, participation for material incentives, and functional participation), while process-oriented projects tend to involve functional and interactive participation. While none of the delivery organisations can be described as wholly process-oriented, the MBRLC, MFI and, to a lesser extent, the MUSUAN project tended to be process-oriented interventions involving functional and interactive farmer participation. The other projects studied were more strongly target-oriented projects involving a mix of lower order modes of participation.

The breakdown of projects by type parallels the classification of projects according to delivery mechanism. Hence the process-oriented projects were implemented by NGOs and the target-oriented projects were implemented by government or as location-specific and time-bound interventions. Table 7.6 lists differences between government, non-government and project-specific interventions. Characterisation of the delivery organisation is not aimed at reinforcing stereotypes of government, non-government and project-specific interventions. Rather it suggests that the lack of a supportive environment precludes the development of process-oriented projects that involve interactive farmer participation and the use of preferred extension methods and practices. One conclusion is that more support needs to be channeled to NGOs promoting soil conservation in the Philippine uplands. However, given the extent of the uplands and the population dependent on these resources, more substantial impact will be achieved by encouraging a process-orientation in government institutions and programs focused on promoting upland development.

Table 7.6. Typical characteristics of government, non-government and project-specific interventions.

Type of intervention	Characteristics
Government	Low-to-medium levels of funding but, given nation-wide scope of program, interventions are limited by inadequate funding, personnel and other resources; medium-to-long term; scope for bottom-up, participatory, and flexible planning and implementation, but tend to be top-down; emphasis on visible and quantifiable output; scope for farmer evaluation but tend to be evaluated from within the bureaucracy
Non-government	Lower levels of funding; medium-to-long term; scope for bottom-up, participatory and flexible planning and implementation; emphasis on facilitation and capacity-building; evaluation from farmers' perspective
Project-specific	Higher levels of funding; short-to-medium term; top-down planning and implementation; emphasis on visible and quantifiable output; external evaluation, often using economic criteria

Conclusion

This discussion has highlighted the relative advantage of a number of extension methods and practices in promoting farmer adoption of soil conservation, notably the use of farmer-extensionists working with small groups of farmers. However, it is not argued that the most appropriate extension approach will automatically stem from use of these preferred methods and practices. Both the technology options and variations in the local biophysical, social, economic and political environment suggest the need for judicious use of the various methods and practices. The delivery organisations using the preferred extension methods and practices were characterised as process-oriented. The development of a process-orientation was seen to be dependent upon a supportive institutional environment. It was argued that the absence of an environment supporting the use of process-oriented extension methods and practices would preclude effective use of such an approach. Hence there is a need to strengthen the institutional environment for upland development activities, providing long-term, process-oriented support for both government and non-government extension projects and programs.

Chapter 8

Bioeconomic Modelling of Hedgerow Intercropping

R.A. Nelson and R.A. Cramb

LAND DEGRADATION in the Philippines is severe and widespread (Kummer 1992). World Bank (1989) cites soil erosion as the worst environmental problem in the Philippines. Total annual soil loss from the Philippines each year was estimated to be around 74.5 million tons by DENR (1992) and 80.6 million tons by Francisco (1994). Estimates of the land area affected by erosion in the Philippines have varied from 63% (PCARRD 1992) to 76.5% (FAO 1988, cited in VISCA 1991) of the country's total area. David (1988) estimated that the hydrology and productive capability of around one third of the total land area of the Philippines has been impaired by soil erosion. Thirteen of the 73 provinces have more than half their area moderately to severely eroded (Cabrido 1985; PCARRD 1992), including Batangas with 83%, La Union with 80% and Cebu with 76% (PCARRD 1992).

Although soil erosion is a natural process, it is greatly accelerated in the Philippine uplands by human activities. Most upland areas are steep, and intense rainfall on soils disturbed by intensive agriculture can produce high rates of soil loss and threaten the long-term sustainability of crop production. This has serious implications for the economic welfare of a growing upland population with few feasible livelihood alternatives. Slow and inequitable economic development has induced migration to the uplands where increasingly marginal land has been used for intensive cultivation. Addressing the causes of land degradation in the uplands at the policy level has proved to be a slow and ineffective strategy. Consequently, much of the effort expended to improve the economic welfare of upland communities has been directed towards improving the productivity of existing farming systems.

Hedgerow intercropping has emerged as a focus for soil conservation research and extension in the Philippine uplands. It has had appeal as a technical solution for erosion in the uplands because it can greatly reduce soil loss from annual cropping systems, improving the potential for sustained crop production. Hedgerow intercropping has been considered appropriate for extension into low-input upland farming systems because elements of the technology are present in some indigenous methods of farming steeplands in the Philippines, and the concepts involved are not unfamiliar to upland farmers. In addition, the costs of establishing and maintaining hedgerow intercropping are less than those of other soil conservation technologies with a similar capacity to reduce soil loss, such as bench terraces.

A large number of domestic and international organisations have committed considerable resources to promote hedgerow intercropping to farmers in the Philippine uplands. However, adoption of hedgerow intercropping has been sporadic and transient, rarely continuing once external support has been withdrawn. Adoption of hedgerow intercropping may have been constrained by a range of factors including limited access to credit, insecure land tenure or limited awareness of the link between erosion and declining crop production. While researchers and extensionists have tended to focus on controlling erosion, farmers are more likely to focus on the contribution of hedgerow intercropping to their economic welfare. Consequently, farmers may have rejected hedgerow intercropping because the economic returns are lower or more uncertain than those from existing methods of farming.

The objective of this chapter is to investigate the economic incentives for farmers in the Philippine uplands to adopt hedgerow intercropping relative to traditional open-field maize farming. The chapter summarises the results of multidisciplinary, bioeconomic research presented in Nelson et al. (1996a-g). Cost-benefit analysis is used to compare the economic viability of hedgerow intercropping, as it has been promoted to upland farmers, with the viability of traditional methods of open-field farming. The economic incentives revealed using cost-benefit analysis are interpreted in the context of the other constraints influencing adoption, and policy options with potential to influence adoption incentives.

The Economics of Soil Conservation

The Economic Nature of Soil

Soils are typically described as intermediate resources having characteristics of both non-renewable and renewable resources (Barlowe 1986, Sfeir-Younis and Dragun 1993, Thampapillai and Anderson 1994). However, the non-renewable, conservable flow components of soils dominate their characteristics as inputs to agricultural production because erosion reduces their future availability (Thampapillai and Anderson 1994). Farmers with a fixed endowment of soil can manipulate production over time using combinations of technologies with different implications for production and soil use (Walker 1982; Pagiola 1994) (Figure 8.1). Farming practices that erode the soil may cause yields to decline (path A in Figure 8.1), or farmers may have the option of switching to farming practices that conserve soil and reduce yield declines (path B in Figure 8.1). Conservation farming may reduce yields in the short term because of the crop area occupied by soil conservation structures, or because inputs that deplete the soil are reduced. The decision to introduce soil conservation is a dynamic one that can be made in any period, though delaying conservation may reduce the yields attainable from conservation farming in the future (path C in Figure 8.1). In some cases conservation farming and improved technology can improve yields, particularly on degraded soils (path D in Figure 8.1). From a farmer's perspective, optimum soil use occurs under the combination of farm practices returning the highest returns over time.

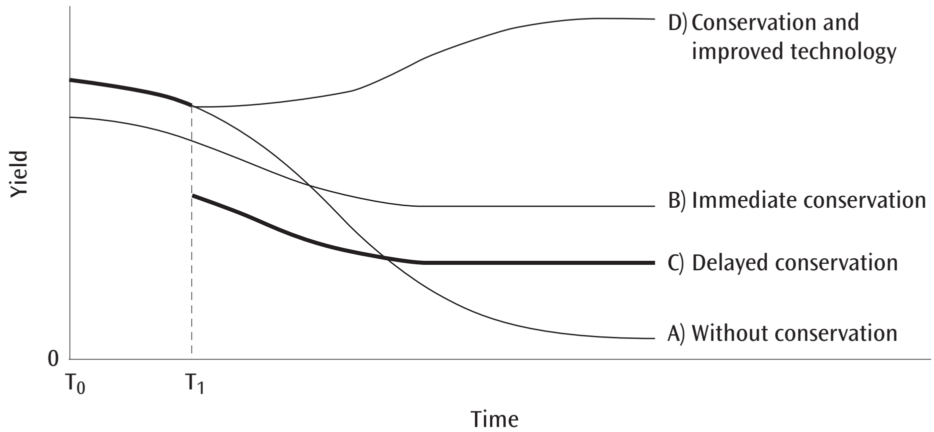

Figure 8.1. Alternative yield paths (adapted from Pagiola 1994).

Economic Analysis of Soil Conservation

To determine optimal soil use over time, detailed information on the costs of each farming method is required, as well as information on the productivity of each farming method at different levels of soil depletion. If these data are available, dynamic optimisation techniques such as optimal control theory and dynamic programming can be used to identify an optimal combination of farming methods and soil depletion over time (Pagiola 1994). Dynamic optimisation techniques involve specifying farmers' income maximisation decisions over time as mathematical functions, which are then solved subject to various constraints including land area, crop productivity and soil loss (Passmore 1992). However, lack of data has tended to restrict application of dynamic optimisation to abstract, stylised settings without empirical analysis to add to theoretical findings (Pagiola 1994).

Cost-Benefit Analysis of Soil Conservation

Cost-benefit analysis (CBA) can be used to compare the economic returns over time from alternative farming methods which have different implications for soil quality and production. Although pair-wise comparisons can be extended to a large number of alternative farming methods, CBA is a static technique comparing two or more farming methods at a specific moment in time, over discrete periods of time (Pagiola 1994). On its own, therefore, it does not provide a means for identifying optimal soil use over time. However, pair-wise comparison at the field level can shed light on the economic incentives for farmers to adopt conservation farming, which can then be interpreted in terms of farmers' other decision criteria and constraints to adoption. Cost-benefit analysis can be performed over different scales and from different perspectives. Adjusted prices and discount rates can be used to introduce a social perspective to the analysis, and a range of techniques have been developed to value the off-site impacts of soil erosion.

A net present value ranking provides a decision criterion for comparing the economic returns from alternative farming methods over time. However, farmers' decisions to adopt new farming practices are complex, and farmers are likely to apply a range of other decision criteria to meet numerous objectives subject to their production possibilities and constraints. It is widely recognised that farmers are cautious and risk averse, whether they live in developing or industrialised nations (Anderson and Thampapillai 1990). In low input farming systems, the adoption decisions of farmers operating close to the margin of economic survival may be heavily influenced by the possibility of negative returns in any year, even if expected net present value is positive in the long term. The relative risk of negative returns from alternative farming methods can be assessed by analysing the probability distribution of net returns resulting from uncertainty in prices, costs and yields.

The economic incentives to adopt new farming methods revealed by cost-benefit analyses need to be interpreted from the perspective of upland farmers, considering economic opportunities and constraints that are exogenous to each farming system (Pagiola 1994). For example, the decision to adopt or reject conservation farming depends critically on farmers' planning horizons. In many developing countries, the long-term benefits of conservation farming may be irrelevant to farmers whose planning horizons are limited by insecure land tenure. Access to credit to compensate for negative returns in establishment years may be essential for farmers' survival. However, high interest rates may make borrowing uneconomic relative to the rate at which returns from conservation farming are realised. Limited availability of labour may reduce the attractiveness of farming methods, however profitable, that increase the demand for labour at critical times during the cropping season.

Bioeconomic Analysis of Hedgerow Intercropping

In this chapter, cost-benefit analysis is used to compare the economic returns from traditional open-field farming and hedgerow intercropping of maize in the Philippine uplands. The analysis focuses on the field level returns to individual farmers considering, at a specific point in time, whether or not to adopt hedgerow intercropping or continue with open-field farming. No attempt is made to quantify the off-site benefits of soil conservation, though they may be significant, because they are unlikely to affect farmer adoption decisions. Although the residual resale value of land is not included in the analysis, a relatively long time horizon of 25 years is considered to capture most of the long-term returns to investments in soil conservation.

Key informant surveys were used to obtain production budgets from experienced maize farmers in two upland communities: Timugan, Laguna; and Claveria, Misamis Oriental. The two communities differ in their economic development, and their experience of hedgerow intercropping. In particular, employment and marketing opportunities in the two communities are influenced by the accessibility of urban centres. Timugan is a peri-urban upland community close to some of the most urbanised areas of the Philippines, with no prior adoption of hedgerow intercropping. Claveria is representative of relatively inaccessible upland communities, and various forms of hedgerow intercropping have been widely adopted. Production budgets for maize farming with and without hedgerow intercropping in the two communities were presented in Nelson et al. (1996b).

The Agricultural Production Simulator (APSIM) and Soil Changes Under Agroforestry (SCUAF) models were used to predict the effect of soil erosion on maize yields from open-field farming and hedgerow intercropping. APSIM is a cropping systems model that simulates the effect of erosion on the daily stocks of soil water and nitrogen available for plant uptake. Simulating soil physical and crop growth processes on a daily basis enables the model to capture some of the complex interaction between changing edaphic conditions, climate, management, and crop yields. It also enables APSIM to be parameterised and tested for new environments using intensive data collected over relatively few cropping seasons. An advantage of APSIM for application to maize farming in the Philippine uplands is that its developers have invested considerable effort into modelling maize in the tropics (Carberry and Abrecht 1991; Carberry et al. 1989; Abrecht and Carberry 1993; Carberry 1991; Muchow and Carberry 1989). Initial applications of the maize model within APSIM were promising, validating the model for tropical environments similar to those in the Philippine uplands (Carberry et al. 1994, 1996; Keating et al. 1992a,b).

The SCUAF model was chosen because of its capacity to simulate hedgerow intercropping in the humid tropics, and the ease with which it can be applied. SCUAF is a deterministic model designed to predict the effect of agroforestry systems on soils. A Modified Universal Soil Loss Equation (MUSLE) is used to predict erosion (FAO 1979). Erosion reduces the amount of nitrogen and carbon in a soil profile. The initial crop and hedgerow biomass production entered by the user are modified within the model in proportion to changes in soil nitrogen and carbon. SCUAF's default parameters for modelling carbon and nitrogen transformations in the soil are based on climate, texture, drainage, soil reaction and slope classes. The proportional reduction in crop yield resulting from changes in soil carbon and nitrogen is determined as part of the structure of the model and can be specified by the user.

APSIM and SCUAF were parameterised using data from comparative field trials of traditional open-field farming and hedgerow intercropping adjacent to the communities from which the economic data were collected. The farming methods simulated were based on the farming practices of farmers in the communities from which the economic data were obtained. This ensured that simulated maize yields reflected the returns to farmers from their investment of labour and material inputs in maize farming. Details of erosion/productivity modelling with APSIM and SCUAF are presented in Nelson et al. (1996a, c–f).

This chapter focuses on the key findings of the research, beginning with insights into the economic viability of leguminous shrub hedgerows, the form of the technology most commonly promoted to farmers in the Philippine uplands. The economic viability of hedgerows was compared with that of traditional continuous and fallow open-field maize farming on soils of differing erodibility, and in farming communities with different marketing opportunities. Leguminous shrub hedgerows were also compared to alternative forms of the technology including natural vegetation strips and grass strips. The effect of uncertainty in prices, costs and yields on expected returns was investigated by Nelson (1996), and is reviewed in this chapter. In addition, policy options with potential to influence farmers' planning horizons, discount rates, the price of maize, and share-tenancy were also investigated by Nelson et al. (1996a–g), and a summary of these earlier discussions is provided.

Leguminous Shrub Hedgerows

Soils of High Erodibility

Nelson et al. (1996e) parameterised the APSIM model to predict the long-term effect of erosion on maize production from hedgerow intercropping with leguminous shrub hedgerows and two types of open-field farming using data from experimental trials at Tranca, Laguna (Table 8.1). The trial of hedgerow intercropping at Tranca was established in 1988 in a collaborative research project funded by the Australian Centre for International Agricultural Research (ACIAR)[3]. Tranca is typical of upland areas with moderately fertile soils of relatively high erodibility. Estimates of labour and material inputs from farmers in Timugan, a farming community near Tranca, were used because agronomic conditions were similar. Costs and prices reported by farmers in

[3] Projects 1985/051 and 1992/001 of the Australian Centre for International Agricultural Research were conducted by the University of the Philippines, Los Baños, Griffith University and the Queensland Department of Primary Industries.

Claveria were used to analyse the economic viability of hedgerow intercropping under the market conditions prevailing in relatively inaccessible upland areas (Nelson et al. 1996b,c)[4].

Table 8.1. Description of the maize farming methods simulated using APSIM, Tranca.

Method of farming	Description
Continuous open-field farming (open-field)	Repeated annual cropping, without fallow years, of a maize/maize crop rotation in a field without hedgerows.
Fallow open-field farming (fallow)	Annual cropping of a maize/maize crop rotation in a field without hedgerows for two years, followed by two years during which the field was left to revert to shrubby grassland dominated by Imperata grass.[a]
Hedgerow intercropping (hedgerows)	Repeated annual cropping, without fallow years, of a maize/maize crop rotation between leguminous shrub hedgerows.

[a] For comparison with continuous cropping of a single hectare of land, it was assumed that farmers practising field rotation have two fields, each one hectare in size, and that the availability of labour permits one hectare to be cropped each year.

Annual maize yields predicted from continuous open-field farming were initially high but declined dramatically in the first few years of cropping as erosion removed soil organic matter and reduced soil fertility (Figure 8.2). High maize yields from fallow open-field farming in the first four years of cropping reflect the high initial productivity of two separate maize fields. In the long term, predicted maize yields from fallow open-field farming declined to slightly higher levels than those predicted from continuous open-field farming. Hedgerow intercropping was predicted to sustain potential yields around initial levels, though actual yields were sensitive to seasonal climatic fluctuations. Yields from hedgerow intercropping were predicted to fall below those of open-field farming in years of drought, when soil water limited the response of maize crops to higher nitrogen levels (e.g. Year 12, Figure 8.2). Yields from hedgerow intercropping were initially lower than those from continuous and fallow open-field farming because of the cropping area occupied by hedgerows, and because maize yields were suppressed by hedgerow/crop competition for light, nutrients and water. After three or four years, yields from hedgerow intercropping were consistently greater than those from continuous and fallow open-field farming.

APSIM predicted a soil depth decline of 540 mm over 25 years under continuous open-field farming, resulting from average soil loss of 190 t/ha/year (Figure 8.3). Fallow open-field farming effectively spread declining soil depth over twice the cropping area, halving soil depth decline. The lower average rate of soil loss from

[4] Details of modelling with APSIM are presented in Nelson et al. (1996d–f), while assumptions for the cost-benefit analysis are described in Nelson et al. (1996g).

fallow open-field farming is a composite of two rates: an average of 175 t/ha/year in years of cropping, compared to very low predicted erosion in fallow years. The decline in soil depth predicted under hedgerow intercropping was negligible, with soil loss averaging 1 t/ha/year.

Erosion from open-field farming was predicted to be high because the soil surface cover was low during periods of high rainfall. Grass cover during fallow years reduced predicted erosion from fallow open-field farming, but erosion was high in cropping years because surface cover management was the same as continuous open-field farming. Hedgerows provide surface cover for the proportion of cropping area that they occupy, and hedgerow prunings provide surface cover for the cropping

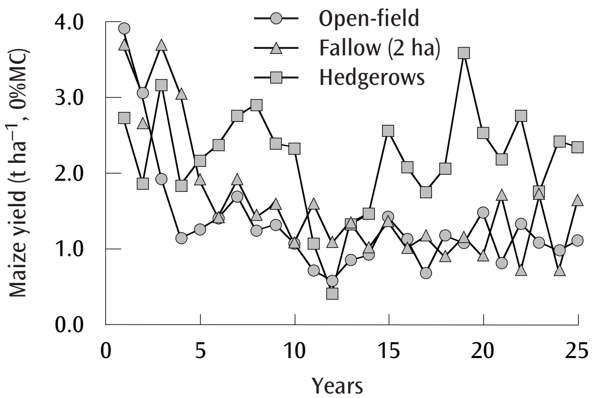

Figure 8.2. Annual maize yields predicted using APSIM on a relatively erodible soil.

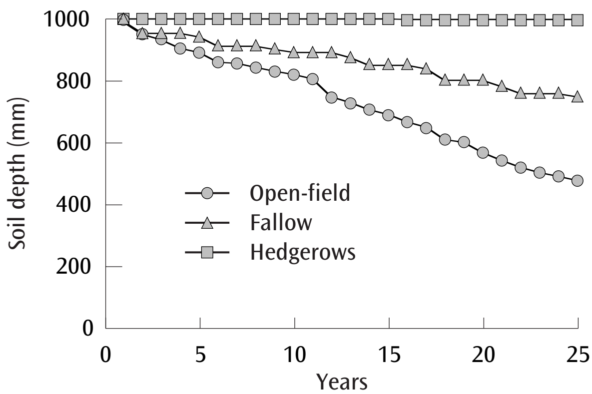

Figure 8.3. Soil depth predicted using APSIM on a relatively erodible soil.

alleys. Hedgerow intercropping was also predicted to have a favourable effect on plant available soil water and soil nitrogen.

Net returns predicted for open-field farming and hedgerow intercropping follow a similar pattern to maize yields predicted using APSIM. Expected net returns predicted from continuous open-field farming were initially high, but declined rapidly and became negative as erosion reduced maize yields (Figure 8.4). Predicted net returns from fallow open-field farming were high in the first four years of cropping because of high initial maize yields from two separate fields. In contrast to continuous open-field farming, fallow open-field farming sustained net returns around break-even point by spreading the impact of erosion over a larger cropping area. In the long term, predicted net returns from hedgerow intercropping were high because of reduced soil loss and sustained maize yields. In the short term, net returns from hedgerow intercropping were lower than those from continuous and fallow open-field farming because of establishment costs. A five-year cycle in net returns predicted from hedgerow intercropping reflected the cyclical nature of hedgerow biomass production and establishment costs.

The probability of negative returns predicted for continuous open-field farming exceeded 25% after three or four years of cropping, while fallow open-field farming deferred a similar probability of negative returns to around five or six years of cropping. The risk of negative returns from hedgerow intercropping was predicted to be less than 25% in the long term, except in years when hedgerow establishment coincided with poor seasonal conditions.

A discount rate of 25% emphasised high returns from continuous open-field farming in the first few years of cropping, and reduced the present value of negative net returns caused by erosion-induced productivity decline in the long term (Figure 8.5). Fallow open-field farming provided high returns from two separate fields in the first four years of cropping, and was predicted to provide high net present value in the long term to farmers with sufficient land. Sustained returns from hedgerow intercropping produced high net present value in the long term, exceeding net present value from continuous open-field farming after five years of cropping, and approaching net present value from fallow open-field farming after 20 years. For planning horizons of five years or less, however, establishment and maintenance costs significantly reduced predicted net present value from hedgerow intercropping relative to the two types of open-field farming.

Risk analysis did not alter the ranking of alternatives based on expected net returns. The input variables predicted to influence the distribution of net present value over 25 years were ranked according to Pearson correlation coefficients. Net present value was predicted to be strongly influenced by the distribution of wet season maize prices. Other variables predicted to have a significant influence on net present value included the dry season maize price, maize yields in the first few years of cropping, and the cost of labour.

Soils of Low Erodibility

The SCUAF model was parameterised by Nelson et al. (1996a) to predict erosion and maize yields from hedgerow intercropping and open-field farming in Claveria, Mindanao, for soils that are more resistant to erosion than those of Tranca, although less fertile. SCUAF was parameterised using data from a research trial of hedgerow intercropping at Compact, near Claveria, established in the late-1980s by the International

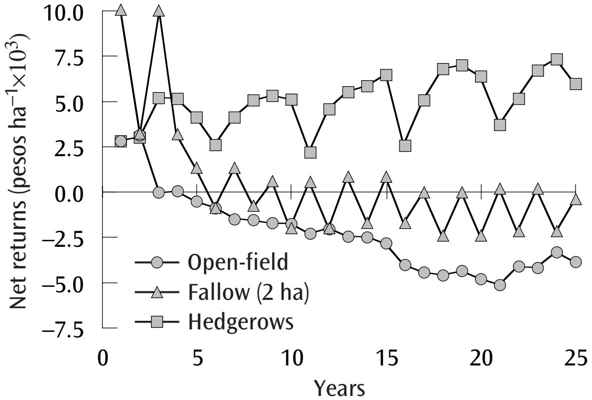

Figure 8.4. Annual net returns predicted using APSIM on a relatively erodible soil.

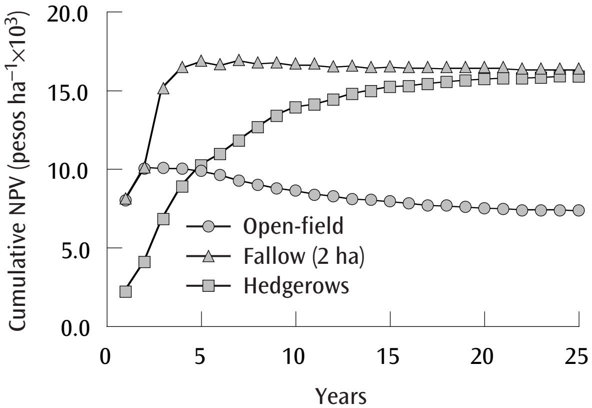

Figure 8.5. Expected net present value predicted using APSIM on a relatively erodible soil, with a discount rate of 25%

Rice Research Institute (IRRI), and managed by the International Centre for Research into Agroforestry (ICRAF) from 1994. The farming systems simulated included continuous and open-field farming, and hedgerow intercropping with leguminous shrub hedgerows, as described in Table 8.1. Claveria is typical of extensive areas of the uplands that are less accessible from urban centres, particularly in the wet season, restricting the employment and marketing opportunities available to farmers. Communities of this type are either remote or, like Claveria, have relatively poor transport infrastructure[5].

Maize yields predicted over 25 years using SCUAF declined under all three farming methods, including hedgerow intercropping with leguminous shrubs, but declined most rapidly under continuous and fallow open-field farming (Figure 8.6). Maize yields predicted from fallow open-field farming were only slightly greater than those from continuous open-field farming in the second year following each fallow, indicating that two-year fallows dominated by Imperata grass are of little benefit for sustaining soil productivity. Maize yields from fallow open-field farming were depressed in the first year of cropping following each fallow because of predicted immobilisation of nitrogen during humification of Imperata grass residues.

The predicted pattern of maize yields was only partly explained by the rates of soil loss predicted under the various farming methods, and so predicted changes in soil nitrogen and carbon levels were considered. Predicted erosion reduced soil depth under continuous and fallow open-field farming more so than under hedgerow intercropping, though overall soil loss was relatively low (Figure 8.7). Predicted erosion from continuous open-field farming averaged 25.0 t/ha/year, compared to 22.7 t/ha/year from fallow open-field farming during years of cropping. However, fallow farming reduced erosion to low levels in years of fallow because of the surface cover provided by Imperata grass. Hedgerow intercropping reduced predicted soil loss to an average of 3.3 t/ha/year, because of the influence of the tree and grass components on surface cover.

Erosion differentially removes the finer, most fertile fractions of topsoil. In the model, erosion contributed to a more rapid decline in soil mineral nitrogen and organic carbon predicted for continuous and fallow open-field farming compared to hedgerow intercropping. The amount of soil nitrogen and organic matter accumulating during the Imperata fallows was small, and had little effect on predicted soil labile carbon levels under fallow farming. Predicted soil nitrogen and organic carbon were higher for leguminous hedgerows, because of the nitrogen and organic matter cycled through hedgerow prunings. However, a decline in mineral nitrogen and soil carbon for hedgerow intercropping was predicted due to high rates of leaching and

[5]. Details of modelling with SCUAF, the economic data and the assumptions for the cost-benefit analysis for Claveria are presented in Nelson et al. (1996b, c).

organic matter decomposition. As a consequence, SCUAF predicted declining maize yields from hedgerow intercropping despite very low rates of predicted erosion.

Expected net returns predicted from continuous and fallow open-field farming declined as erosion reduced soil productivity and became negative after 15 to 20 years of cropping (Figure 8.8). Net returns predicted from hedgerow intercropping declined less rapidly than those predicted from the two types of open-field farming, because lower erosion and higher organic matter cycling sustained higher crop yields. A five-year cycle evident in the annual net returns from hedgerow intercropping was due to establishment and infill replanting costs. The probability of negative returns from

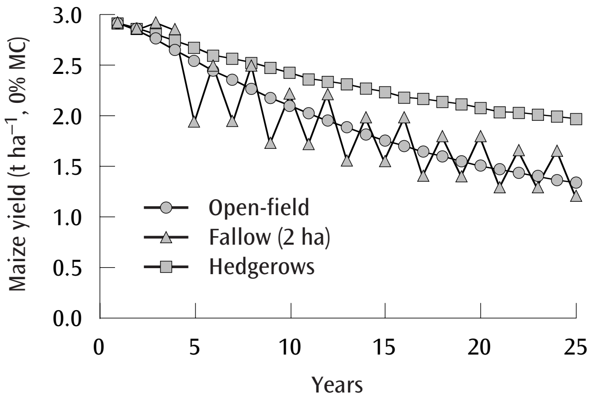

Figure 8.6. Annual maize yields predicted using SCUAF on a soil of low erodibility.

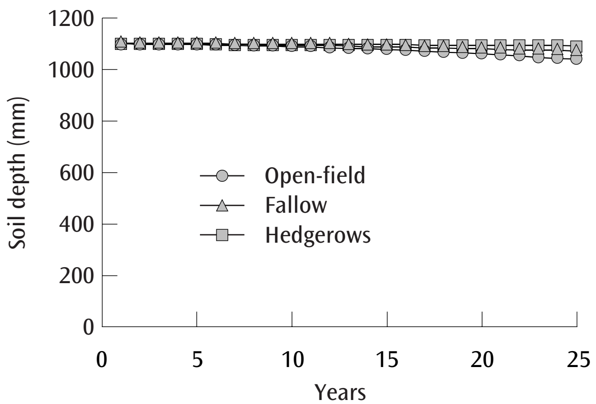

Figure 8.7. Soil depth predicted using SCUAF on a soil of low erodibility.

continuous open-field farming exceeded 25% after around nine years of cropping, and between five and ten years for fallow open-field farming. For hedgerow intercropping, the probability of negative returns was predicted to exceed 25% after five years of cropping, and was particularly high in years of establishment.

With a discount rate of 25%, net present value predicted from continuous and fallow open-field farming was significantly greater than net present value predicted from hedgerow intercropping over 25 years (Figure 8.9). A high discount rate emphasises short-term returns, and sustained benefits from hedgerow intercropping were not realised rapidly enough to compensate farmers for establishment costs, relative to the returns from continuous and fallow open-field farming.

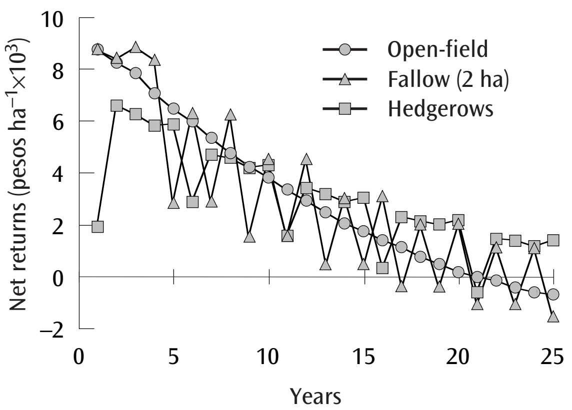

Figure 8.8. Annual net returns predicted using SCUAF on a soil of low erodibility.

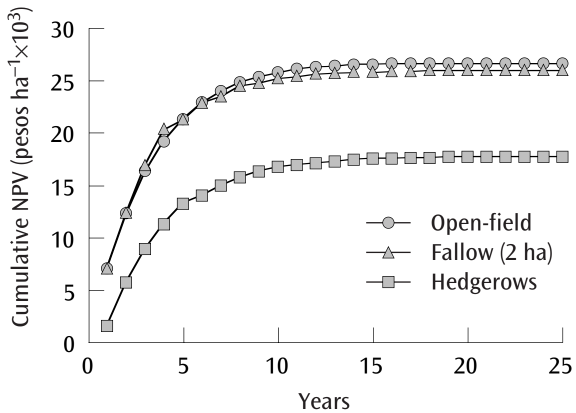

Figure 8.9. Expected net present value predicted using SCUAF on a soil of low erodibility, with a discount rate of 25%.

Risk analysis did not alter the ranking of alternatives from the analysis based on expected net returns. The input variables predicted to influence the distribution of net present value over 25 years were ranked according to Pearson correlation coefficients. As for the above analysis, predicted net present value was strongly influenced by the distributions of wet season maize prices and maize yields in the first few years of cropping. Other variables predicted to have a significant influence on net present value included the dry season maize price, the cost of labour and the amount of labour and animal power required for land preparation.

Peri-urban Communities

Marketing and employment opportunities in peri-urban upland areas can greatly increase the value of maize crops and the opportunity cost of labour. Nelson et al. (1996g) and Nelson (1996) parameterised the SCUAF model to simulate erosion and maize yields on the relatively fertile, though erodible, soils at Tranca, Laguna. Predicted maize yields over 25 years were combined in a cost-benefit analysis with economic data from the nearby peri-urban community of Timugan. Peri-urban communities are common in the uplands because of the high population density and insular nature of the Philippine archipelago. The strong demand for maize as a fresh vegetable in the Los Baños and Manila markets meant that farmers in Timugan were able to sell much larger weights of fresh maize at a price two or three times higher than the price of maize grain in less accessible communities such as Claveria. The farming methods included in the analysis are described in Table 8.1.[6]

Predicted maize yields declined for all three of the maize farming methods, with the most rapid decline predicted for continuous open-field farming (Figure 8.10). Maize yields predicted from fallow open-field farming were only slightly greater than those from continuous open-field farming, indicating that two-year fallows dominated by Imperata grass are of little benefit for improving soil productivity. Maize yields from fallow open-field farming were depressed in the first year of cropping following each two-year fallow because of predicted immobilisation of nitrogen during humification of Imperata grass residues. Maize yields from hedgerow intercropping were initially similar to those from continuous and fallow open-field farming, declining in a series of steps induced by varying the level of prunings over a five-year hedgerow lifecycle.

High rates of erosion predicted for continuous and fallow open-field farming significantly reduced soil depth over 25 years (Figure 8.11). Predicted erosion under continuous open-field farming averaged 123 t/ha/year compared to 54 t/ha/year from fallow farming. In contrast, predicted erosion under hedgerow intercropping

6. This analysis was first presented by Nelson et al. (1996g). The summary provided here includes the refinements in Nelson et al. (1996b) and Nelson (1996).

averaged 7.2 t/ha/year over 25 years, leaving soil depth almost unchanged. High rates of erosion contributed to a rapid decline in soil mineral nitrogen and organic matter predicted for continuous and fallow open-field farming, despite the application of 60 kg/ha/year of nitrogen as urea. Nitrogen and labile carbon levels predicted under fallow open-field farming indicated that two-year Imperata fallows were of limited benefit for maintaining soil nutrient status in the long term. Although soil mineral nitrogen and labile carbon levels declined under hedgerow intercropping, reduced erosion and the addition of hedgerow prunings maintained higher levels than continuous and fallow open-field farming.

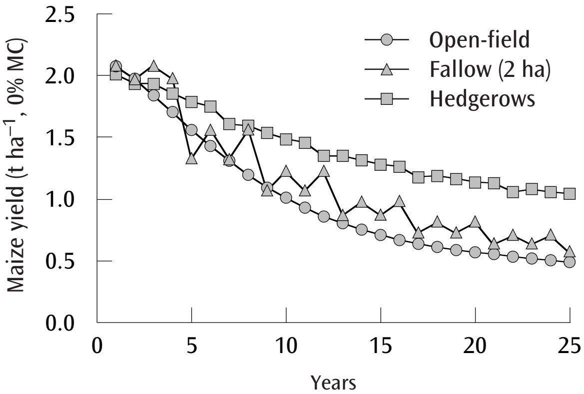

Figure 8.10 Annual maize yields predicted using SCUAF on a relatively erodible soil.

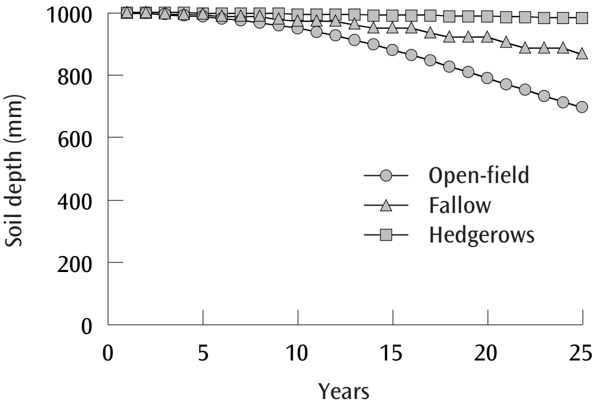

Figure 8.11 Soil depth predicted using SCUAF on a relatively erodible soil.

Expected net returns predicted from continuous open-field farming declined and became negative after ten years of cropping as erosion reduced maize yields (Figure 8.12). Fallow open-field farming was predicted to have little more potential to sustain returns than continuous open-field farming. Net returns from hedgerow intercropping were lower than those from continuous and fallow open-field farming in the short term because of establishment costs and the cropping area occupied by the hedgerows. In the long term, higher net returns were predicted from hedgerow intercropping because reduced soil loss and nitrogen contributed to the cropping alleys maintained higher maize yields. The probability of negative returns from continuous

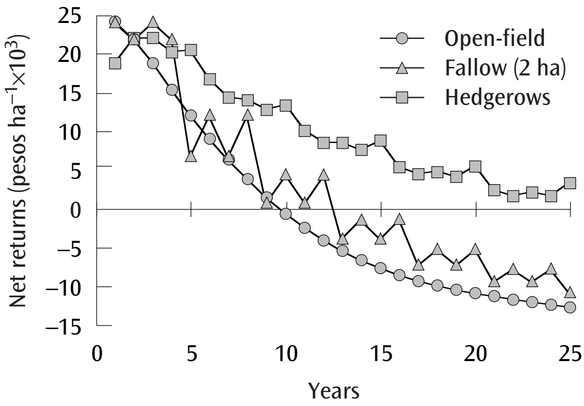

Figure 8.12. Annual net returns predicted using SCUAF on a relatively erodible soil.

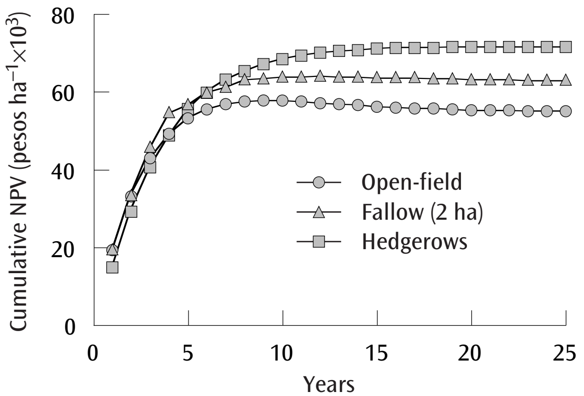

Figure 8.13. Expected net present value predicted using SCUAF on a relatively erodible soil, with a discount rate of 25%.

and fallow open-field farming exceeded 25% after six and eight years of cropping. In contrast, hedgerow intercropping was predicted to reduce the risk of negative returns in the long term, reaching a probability of 25% after 11 years of cropping.

With a discount rate of 25%, expected net present value was relatively high for all three farming methods, indicating the profitability of producing maize as a fresh vegetable close to an urban market (Figure 8.13). As soil productivity was depleted by erosion, net present value from continuous open-field farming was predicted to fall below that of fallow open-field farming and hedgerow intercropping after three and five years of cropping, respectively. Fallow farming was the most attractive option for the first five or six years of cropping, but was dominated by hedgerow intercropping in the long term. High expected net present value from hedgerow intercropping in the long term indicated that sustained yields eventually offset establishment and maintenance costs relative to the returns from continuous and fallow open-field farming.

A risk analysis did not alter the ranking of alternatives from the analysis based on expected net returns. The input variables predicted to influence the distribution of net present value over 25 years were ranked according to Pearson correlation coefficients. Net present value was predicted to be strongly influenced by the distributions of wet season maize prices and maize yields in the first few years of cropping. Other variables predicted to have a significant influence on net present value included the dry season maize price, the cost of labour, and the labour and animal power required for land preparation.

Alternative Forms of Hedgerow Intercropping

While hedgerow intercropping with shrub legumes has been the most common form of the technology promoted to upland farmers, adoption has been poor and rarely sustained once extension programs are withdrawn. In a few upland areas, including Claveria, there has been limited adoption of modified forms of hedgerow intercropping such as natural vegetation and grass strips. Nelson et al. (1996a) used the SCUAF model to compare the economic viability of alternative forms of hedgerow intercropping in Claveria, on soils of low erodibility. As mentioned above, transport infrastructure limits the marketing and off-farm employment opportunities of farmers in Claveria, from whom the economic data for the analysis were obtained. SCUAF was parameterised using data from the ICRAF research trial at Compact, which is within the municipality of Claveria. Intercropping maize between hedgerows of Gliricidia, natural vegetation, and grass were compared with continuous and fallow open- field farming, though for clarity only continuous open-field farming is included in this summary (Table 8.2).

Table 8.2. Description of farming methods simulated using SCUAF, Claveria.

Method of farming	Description
Gliricidia hedgerows (*Gliricidia*)	Repeated annual cropping of a maize-maize rotation between contour hedgerows of Gliricidia (*Gliricidia sepium).*
Natural vegetation strips (*Natural vegetation*)	Repeated annual cropping of a maize-maize rotation between hedgerows formed by contour strips of natural vegetation.
Grass strips (*Grass*)	Repeated annual cropping of a maize-maize rotation between hedgerows formed by contour strips of Napier grass (*Pennisetum purpureum*).
Continuous open-field farming (*Open-field*)	Repeated annual cropping of a maize-maize rotation in a field without hedgerows.

All three types of hedgerow intercropping sustained yields at higher levels than open-field farming in the long term (Figure 8.14). Gliricidia hedgerows sustained maize yields at slightly higher levels than natural vegetation strips or grass strips. Predicted maize yields from natural vegetation strips were slightly lower than those from grass strips. The predicted pattern of maize yields was explained by the rates of soil loss predicted under the various farming methods, and changes in soil nitrogen and carbon levels. Hedgerow intercropping significantly reduced predicted soil loss compared to open-field farming, because of the influence of the tree and grass components on surface cover (Figure 8.15). Predicted erosion averaged 3.3, 7.0 and 6.4 t/ha/year from Gliricidia hedgerows, natural vegetation strips and grass strips, compared to 25.0 t/ha/year predicted from continuous open-field farming.

Predicted soil mineral nitrogen and soil labile carbon declined more slowly under the three types of hedgerow intercropping than under open-field farming over 25 years. The predicted decline in soil mineral nitrogen and labile carbon under the alternative forms of hedgerow intercropping was influenced by an interaction of soil erosion and organic matter recycling. Predicted soil nitrogen and labile carbon were sustained at the highest levels under Gliricidia hedgerows, because soil loss was low while the amount of organic matter recycled through hedgerow prunings was high. The small legume component of natural vegetation strips produced slightly higher predicted soil nitrogen levels than grass strips, though lower soil carbon levels were predicted due to lower hedgerow biomass production. While the nitrogen content of prunings from grass strips is low, predicted labile soil carbon levels were similar to those under Gliricidia hedgerows, because high rates of biomass production offset organic matter lost through erosion. Hence the potential of grass strips to sustain soil carbon levels could be significantly reduced if cuttings were removed from the field to provide animal fodder, unless animal manure was returned to the soil.

Net returns predicted from all three types of hedgerow intercropping declined less rapidly than those predicted from open-field farming, because lower erosion and higher organic matter cycling sustained higher crop yields (Figure 8.16). A five-year cycle in the annual net returns from Gliricidia hedgerows and grass strips was due to establishment and infill replanting costs. While expected returns from hedgerow intercropping were greater than those from open-field farming in the long term, establishment costs increased the probability of negative returns in the short term. For Gliricidia hedgerows, the probability of negative returns was predicted to exceed 25% after five years of cropping, and was particularly high in years of establishment.

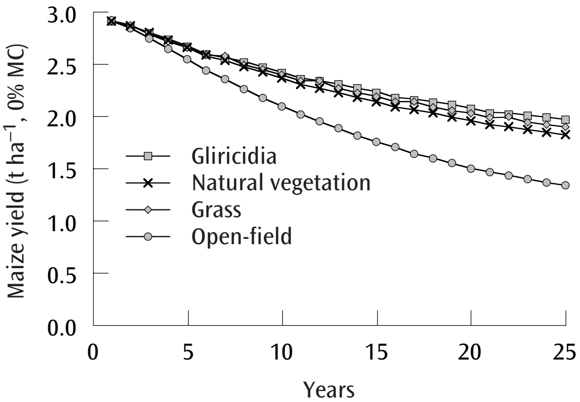

Figure 8.14. Annual maize yields predicted using SCUAF for alternative forms of hedgerow intercropping, on a soil of low erodibility.

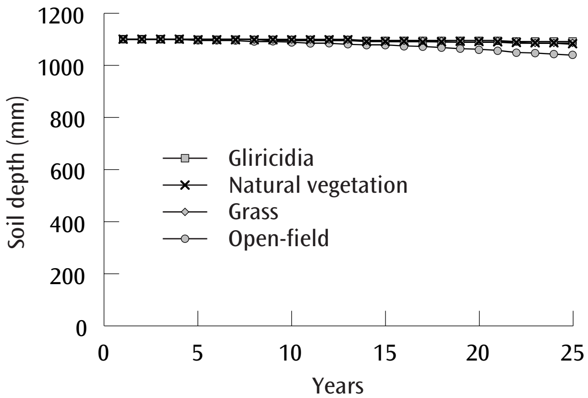

Figure 8.15. Soil depth predicted using SCUAF for alternative forms of hedgerow intercropping, on a soil of low erodibility.

The probability of negative returns from natural vegetation and grass strips exceeded 25% after six or seven years of cropping, and after nine years of cropping from continuous open-field farming.

With a discount rate of 25%, the predicted ranking of net present value from the three types of hedgerow intercropping can be explained by their establishment costs as reported by farmers (Figure 8.17). The lowest establishment costs were reported for natural vegetation strips, followed by grass strips and Gliricidia hedgerows. A high discount rate emphasises short-term returns, and sustained benefits from hedgerow intercropping were not realised rapidly enough to compensate farmers for

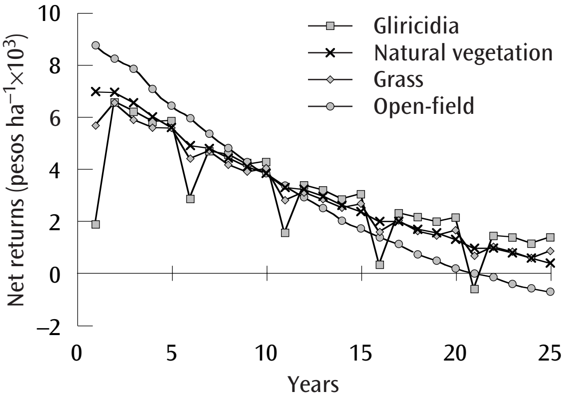

Figure 8.16. Annual net returns predicted using SCUAF for alternative forms of hedgerow intercropping, on a soil of low erodibility.

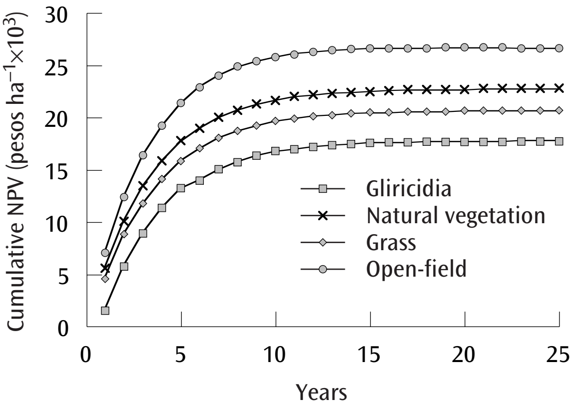

Figure 8.17. Expected net present value predicted using SCUAF for alternative forms of hedgerow intercropping, on a soil of low erodibility, and with a discount rate of 25%.

establishment costs relative to the returns from continuous and fallow open-field farming.

Risk analysis did not alter the ranking of alternatives from the analysis based on expected net returns. The input variables predicted to influence the distribution of net present value over 25 years were ranked according to Pearson coefficients of correlation. As for the preceding analyses, net present value was predicted to be strongly influenced by the distributions of wet season maize prices and maize yields in the first few years of cropping. Other variables predicted to have a significant influence on net present value included the dry season maize price, the cost of labour, and the amount of labour and animal power required for land preparation.

Extensions of the Analysis

Lower Discount Rate

Two discount rates were used in each of the analyses based on the cost of capital reported by farmers in Claveria, and described in Nelson et al. (1996b). A real discount rate of 25% was derived from the cost of interlinked credit from traders. A lower discount rate of 10% was used to reflect the potential of government-sponsored farmer cooperatives to reduce the cost of capital to upland farmers. A discount rate of 10% emphasised the value of sustained yields from hedgerow intercropping, and long-term productivity declined under open-field farming. This altered the ranking of hedgerow intercropping compared to open-field farming in the analysis using APSIM for inaccessible upland areas with relatively erodible soils, because the potential for hedgerow intercropping to sustain productivity was high. Hence lowering the discount rate produced higher net present value from hedgerow intercropping compared to both continuous and fallow open-field farming in the long term. The ranking of the alternative farming methods in the other analyses remained unchanged, though in each case the economic viability of hedgerow intercropping relative to open-field farming improved.

Maize Price

Two maize price scenarios were used to assess the effect of relevant policy options on the economic viability of hedgerow intercropping compared to open-field farming: removing trade protection from maize imports, and improving transport and marketing infrastructure. Maize farming for marketing as grain in relatively inaccessible upland areas was predicted to be uneconomic following the removal of trade protection from maize. In contrast, halving marketing costs by improving transport and marketing infrastructure did not alter the ranking of the farming methods obtained in the base scenario with a 25% discount rate.

Share Tenancy

Many upland farmers do not own the land that they cultivate, and share cropping has been an important form of tenancy. To investigate the implications of share tenancy for the economic viability of hedgerow intercropping, it was assumed that landlords contribute 50% of the cost of external inputs for maize cropping including seed, fertiliser and animal power in exchange for 50% of each crop harvested. Share tenants were assumed to bear the manual labour costs of maize cropping and the full cost of hedgerow establishment. Tenancy arrangements in which landlords do not share hedgerow establishment costs significantly reduce the economic viability of hedgerow intercropping relative to continuous and fallow open-field farming.

Discussion

Direct subsidies to promote hedgerow establishment were not amongst the policy alternatives considered. One-off subsidies have failed to achieve lasting adoption of hedgerow intercropping in the Philippine uplands, because their incidence on farmers' economic incentives has been temporary. Hedgerow intercropping is a biological soil conservation technology requiring reestablishment every few years. To achieve lasting adoption, the economic incentives facing farmers need to be modified permanently so that reestablishing hedgerows continues to be economically attractive.

A review of the literature on rural credit markets in the Philippines by Nelson (1996) revealed that government regulation of interest rates has severely restricted the supply of credit in the uplands. This has contributed to the high cost of credit in the uplands, along with an overall scarcity of capital, the high risk associated with agricultural production, and high transaction costs. Improving the efficiency of rural credit markets has the potential to improve the long-term economic viability of hedgerow intercropping relative to open-field farming by reducing the cost of capital and farmers' discount rates. Expansion of the existing network of government-sponsored farmer cooperatives may reduce the cost of capital to farmers if transaction costs are reduced. However, the full cost of cooperative credit has been similar to the cost of interlinked credit because rationing of government subsidised credit has imposed significant transaction costs. Even if cooperatives were effective in reducing the cost of capital, there is little potential for reductions in farmers' discount rates sufficient to affect the short-term economic viability of hedgerow intercropping relative to open-field farming, because of high establishment costs.

Maize grain has been the only agricultural commodity in the Philippines to have received consistent trade protection in real terms since the 1970s (David 1996a,b). For other agricultural commodities, trade protection has been insufficient to offset negative protection brought about by consistent overvaluation of the Peso. Trade protection of maize was designed to promote domestic self-sufficiency in the production of livestock feeds for the pork and poultry industries. Trade protection has contributed to a dramatic expansion of maize production into steep upland areas, most of which erode rapidly under intensive cultivation.

Removing trade protection could be one of the most effective soil conservation strategies available to the Philippine government, by reducing incentives to produce maize relative to less erosive crops. Because of the insular nature of the Philippines, many upland areas are close to urban markets, and in these areas less erosive alternatives to maize include fruit production. For example, high fruit prices have induced an almost complete shift to fruit production in the community of Timugan. In upland areas without access to fresh produce markets, other perennial crops offer less erosive alternatives to maize production. Coconut has traditionally been an extensive land use competing with maize, but has been disadvantaged by a monopolistic processing industry and trade policies. In some areas, including Claveria, smallholder woodlots are becoming economically attractive to farmers as severe shortages have driven timber prices upwards.

The security of land tenure affects farmers' planning horizons, and the confidence with which they can expect to capture the long-term benefits of investments in hedgerow intercropping. In particular, high sustained crop yields from hedgerow intercropping in the long term are unlikely to be considered by farmers whose planning horizons are limited to two or three years by a fear of eviction. Insecure land tenure has also restricted farmer access to formal credit markets. Furthermore, a redistribution of land ownership from absentee landlords to cultivators would be required for share tenants to capture the full benefits of investing in hedgerow intercropping. It has frequently been claimed that the Philippine government, controlled by a landed elite, has been reluctant to provide farmers with full legal title to the land that they cultivate (Dorner and Thiesenhusen 1990; Goodell 1987; Lara and Morales 1990; Putzel 1992). Progress towards agrarian reform in the Philippines has been very slow because compromises in the legislation have enabled owners to retain or even extend their land holdings. Administrative and funding problems have also hampered agrarian reform. Limited attempts to improve tenure security for farmers on designated public lands, such as the Certificate of Stewardship Contracts of the Integrated Social Forestry Program, have provided only restricted property rights with varying implications for the adoption of conservation farming.

Soil conservation research and extension in the Philippine uplands has addressed concern that excessive soil loss under traditional open-field farming threatens on-site productivity and has contributed to significant, though largely unquantified, off-site impacts. Hedgerow intercropping with shrub legumes has emerged as the focus of these efforts because of its potential to sustain maize yields by controlling erosion and contributing nitrogen, and its relatively low input requirements relative to structural soil conservation technologies. However, the research summarised in this chapter suggests that this is the least attractive form of hedgerow intercropping for upland farmers. Extension strategies that rigidly adhere to hedgerow intercropping with shrub legumes, such as the Sloping Agricultural Land Technology (SALT), therefore need to be reappraised. A more flexible presentation of the technology could include natural vegetation and grass strips as intermediate steps to adoption, as well as hedgerow species with potential to generate economic returns.

Conclusion

Farmers need to decide whether to adopt new farming practices according to their objectives, production possibilities and constraints. The bioeconomic analysis of hedgerow intercropping summarised in this chapter provides insights into the economic viability of hedgerow intercropping relative to traditional methods of open-field maize farming. The economic viability of hedgerow intercropping over limited planning horizons of around five years is critical for adoption decisions, because insecure land tenure has limited the planning horizons of many upland farmers. Establishment costs strongly influence the short-term economic viability of hedgerow intercropping relative to traditional open-field farming. Over limited planning horizons of around five years, there have been strong economic incentives for farmers to reject hedgerow intercropping because the benefits of sustained yields are not realised rapidly enough to compensate for high establishment costs. Alternative forms of hedgerow intercropping such as natural vegetation and grass strips are more attractive to farmers than hedgerow intercropping with shrub legumes because of reduced establishment and maintenance costs.

The long-term economic viability of hedgerow intercropping depends on the economic setting and the potential for hedgerow intercropping to sustain maize production relative to traditional open-field farming. High cost forms of hedgerow intercropping may only be economically viable in peri-urban communities with erodible soils where the value of sustained maize yields is high. In relatively inaccessible areas of the uplands, and with soils of low erodibility, the value of sustained production from all forms of hedgerow intercropping may be insufficient to compensate farmers for establishment costs at high discount rates. In contrast, traditional open-field farming is economically attractive to farmers, particularly those in less densely populated areas who are able to cultivate more than one maize field in fallow rotation.

Few policy alternatives have potential to encourage lasting adoption of hedgerow intercropping by upland farmers. Direct subsidies have failed to induce lasting adoption because their effect on economic incentives has been temporary. Hedgerow intercropping is a biological soil conservation technology requiring lasting economic incentives to promote ongoing reestablishment and maintenance. Subsidised credit, administered through farmer cooperatives, has potential to lower farmers' discount rates, but is unlikely to encourage adoption unless secure land tenure is provided to extend farmers' planning horizons. Progress towards agrarian reform is slow, but is essential for farmers to capture the long-term benefits of investments in hedgerow intercropping.

When considered within the policy environment of the agricultural sector, hedgerow intercropping may not be the most effective strategy for pursuing soil conservation in the Philippine uplands. An integrated approach is likely to be more effective, integrating policies with potential to provide alternative economic opportunities for upland dwellers and modify the commodity base of the agricultural sector. Past efforts to improve the economic welfare of upland communities have focused on farm-level productivity because progress towards economic development and restructuring has been slow, or politically infeasible. Without significant progress at the policy level, hedgerow intercropping may continue to be a focus of efforts to sustain crop production in the uplands. However, research and extension of hedgerow intercropping with shrub legumes needs to be reconsidered in view of the farm-level disincentives and constraints to adoption. In particular, low cost forms of the technology have potential as simple, intermediate steps to conserving soil and sustaining maize yields in the uplands.

Chapter 9

Soil Conservation Adoption and Yield Risk: Evidence from Upland Farms in Bansalan[7]

G. E. Shively

LAND DEGRADATION and soil conservation are important economic and environmental problems throughout the developing world (Anderson and Thampapillai 1990; Blaikie 1985; World Bank 1992). In response to declining yields and off-farm damages, substantial effort has been directed at finding soil conservation measures that are appropriate for low-income hillside farmers. Studies from both experimental trials and farmers' fields demonstrate that given sufficient time, soil conservation measures can reduce rates of soil erosion, increase crop yields, and provide a favourable return on a farmer's investment (Lal 1990; Lutz et al. 1994; Partap and Watson 1994; Shively 1998). However, the impact of soil conservation measures on income risk is an issue that has received little attention to date. In response, this chapter presents a framework for examining the impact of soil conservation adoption on yield risk, and reports empirical findings from a study of hillside farms in the municipality of Bansalan, Davao del Sur.

Understanding the impact of soil conservation on yield risk is important for two reasons. First, production risk has important implications for the adoption of agricultural technologies (Just 1974; Just and Pope 1979; Feder 1980; Feder and O'Mara 1981). The risk characteristics of a soil conservation technology are therefore likely to influence patterns of adoption. For example, Shively (1999) shows how risk-exposure helps to explain patterns of soil conservation adoption by low-income farmers. Second, since soil conservation measures are widely promoted for use on low-income farms, their performance has important implications for farmer welfare.

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[7] This research was undertaken while the author was a visiting Fulbright scholar at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) in the Philippines. The author acknowledges the assistance of SEARCA's Environment and Rural Development Unit.

The soil conservation method analysed in this chapter is contour hedgerows. Contour hedgerows are defined as a spatially zoned agroforestry practice (Kang and Ghuman 1991). Comprehensive reviews of hedgerows are provided by Young (1989), Kang and Wilson (1987), and Lal (1990). They are widely promoted as an effective and low-cost method of erosion control for conserving annual crop cultivation on steep fields. Hedgerows are constructed as permanent vegetative barriers, typically grasses or densely spaced shrubs, planted across the width of a field in rows and spaced 5–10 metres apart. The barriers restrict soil and water movement, and annual crops are grown in alleys between the hedgerows. Contour hedgerows have been widely promoted and adopted by farmers throughout Asia, Africa, and Latin America (Partap and Watson 1994). Nitrogen-fixing species are sometimes used to form hedgerows, and their trimmings are applied to crops as green manure to enhance nutrient recycling. This practice can enhance soil fertility and reduce the need for commercial fertilisers (Cosico 1990; Rosecrance et al. 1992). However, since steeper slopes generate higher rates of soil loss, hedgerows must typically be more closely spaced on steep fields to control soil erosion. As hedgerow spacing intensifies, crop area declines, and competition between alley crops and hedgerows for light, nutrients and water may become severe (Garrity et al. 1995; Nair 1990; Nair 1993; Rosecrance et al. 1992). Thus while more intensive use of hedgerows may increase their long-run performance, more intensive use also increases their opportunity cost.

From the perspective of production risk, hedgerows have the potential to mitigate yield variability. Hedgerows can improve moisture retention during low rainfall periods and can reduce overland water flow and associated crop damage during high rainfall periods. It therefore seems possible that hedgerows could stabilise yields overall and also trim the left-hand tail of the yield distribution. If so, the risk-reducing properties of hedgerows would reinforce recommendations for their use. The analysis presented below is designed to test empirically the hypothesis that hedgerows mitigate yield risk.

A Model of Soil Conservation, Yields, and Yield Risk

Consider a model of agricultural production that relates agricultural inputs to yield, accounting for the fact that yield variance may also depend on technology, levels of input use, or other features of production. Alternative functional forms are available for investigating a hypothesised relationship between inputs, outputs, and production risk. The approach used here follows Just and Pope's (1979) general recommendations for a functional form that imposes as little structure on the risk properties of the arguments as possible. The production function is:

$$g = g(x, \theta, z) + h(x, \theta, z)\varepsilon . \qquad (1)$$

where x, θ, and z represent inputs, a hedgerow indicator, and plot characteristics, respectively, and ε represents a production shock. This additive specification permits increasing, decreasing, or constant marginal risk. A functional form for $g(\ )$ is determined via specification tests reported below in Section 3. Assumptions maintained throughout the analysis include:

$$E(\varepsilon) = 0; V(\varepsilon) = \sigma; E(g) = g(x); V(g) = h^2(x)\sigma;$$

$$\text{and } \frac{\partial E(g)}{\partial x_i} = g(x_i); \frac{\partial^2 E(g)}{\partial x_i} = g_{ii}(x_i); \frac{\partial V(g)}{\partial x_i} = 2hh_i\sigma .$$

To proceed, let $u = y - g(x, \theta, z)$ and let $\hat{u}$ denote the residual from a regression of observed yield on factors of production. With $u^2 = [y - g(x, \theta, z)]^2$ define $v = \hat{u}^2/s^2$ (where s^2 is the sample yield variance). Below, regressions are used to examine the relationships between v and factors hypothesised to influence yield variance. Note that $\hat{u}$ will include measurement error, as well as covariate and idiosyncratic shocks. The latter may include differing environmental outcomes among farms, conditional on farmer behaviour. For now, these limitations in $\hat{u}$ as an indicator of pure yield variability are accepted, although an attempt is made to control for farmer specific factors in the empirical analysis below. In general, correct specification of the stochastic component in equation (1) is necessary for obtaining consistent and efficient estimates of the deterministic component of the equation.

Analysis is conducted at the plot level. Yield per hectare is measured in kilograms of grain and is assumed to depend on the per-hectare rates of application of fertiliser and labour, as well as on the choice of technology. Variables used in the analysis are divided by the area actually occupied by crops (that is, net of area occupied by hedgerows, if any). Both traditional plots and hedgerow plots are included in the analysis.

To account for the impact of soil conservation measures on yields and yield variability, a binary indicator of hedgerows and a continuous measure of the share of land in hedgerows are included in the model. The latter variable measures the intensity of hedgerow use on a parcel, that is, the percentage of the plot area devoted to hedgerows. It is included under the assumption that an increase in hedgerow intensity may influence yield. From another perspective, introducing this variable in conjunction with a binary indicator of hedgerow presence allows both the overall impact of hedgerows on yield and the marginal impact of additional hedgerow intensity on yield to be examined. In addition, because the ability of hedgerows to maintain or enhance fertility may improve over time, a variable measuring the age of hedgerows at planting time (in years) is also included.

Harvest data used in the analysis span a calendar year. Thus the impact of timing on harvests must be considered. For example, seasonal variations in rainfall onset or amount may introduce seasonal variations in yield that are systematic in the sample. To account for this, the data are partitioned into two groups, corresponding to first and second planting periods. These groups are distinguished via a binary indicator, identified as second cropping in the regressions. Harvests that occurred between April and October (wet season) are labeled first cropping; those that occurred between November and March (dry season) are identified as second cropping. Lower second cropping (dry season) yields are expected.

Given that the relative ages of fields differ in the sample, and that the age of a plot may provide some evidence regarding the degree to which the soil's inherent fertility is exhausted, a variable is also included in the model to account for the amount of time the field has been in use. This variable is measured as the number of months of prior use of the parcel at planting time. This variable has been adjusted to account for intervening fallow periods, but likely overestimates the actual number of months the plot has been continuously cropped. The relationship hypothesised is that older plots will have lower yields. Finally, to improve upon months of use as an indicator of land quality, cumulative soil loss is estimated for each plot and from this the imputed value of soil depth is included as an explanatory factor. The regressor measures soil depth at planting time (in mm).

Data and Testing

Data

Production data, including inputs levels and harvested amounts were collected by trained enumerators during the period November 1994 to March 1995. Data for this study include 89 plots that were drawn from a sample of 115 upland farms in Bansalan Municipality, in the province of Davao del Sur. The survey site and farming practices in the area are described by Garcia et al. (1995). For this study, the sample of plots were stratified by hedgerow age. Plots and areas occupied by hedgerows were measured using a forward bearing, compass and tape method. Parcel measurements were checked numerically for closure; all errors fell within 5% of measured area. Both hedgerow and traditional (non-hedgerow) plots are included in the analysis.

Soils on the sample plots are sandy clay loams of volcanic origin, and ranged in pH from 5 to 5.5. More than 80% of land area in the sample was above 18-degree slope, at elevations ranging from 500 to 1200 metres above sea level. Corn production in the area at the time of the survey was characterised by two, or sometimes three croppings per year, short fallows, moderate use of animal traction, and limited application of commercial fertiliser. Hedgerows were typically constructed using double-rows of *Desmodium rensonii* and *Flemengia macrophylla*. At the time of the survey the oldest hedgerows had been in place for seven years. To calculate the estimate of soil depth on each parcel a measure of cumulative soil loss was imputed for each plot as a sigmoidal function of months of use and the presence or absence of soil conservation. Plot-specific soil losses were combined with village-specific estimates of initial soil depths drawn from a 1991 soil survey of the area (Latada et al. 1994). The rate of soil loss is based on experimental data from the area as reported in MBRLC (undated) and procedures reported in Shively (1998).

Sample means of variables used in the regressions are reported in Table 9.1. To summarise these descriptive data, 40% of the plots in the sample had hedgerows, and these hedgerows were 4 years old on average at the time of the survey. Among the hedgerow plots, 12% of the parcel was occupied by hedgerows on average. The average yield from hedgerow plots (1437 kg/ha) was higher than the average yield from traditional plots (1266 kg/ha), and the average yield during the second cropping period (1068 kg/ha) was significantly lower than the average yield during the first cropping period (1670 kg/ha).

Figure 9.1 is a frequency distribution of yields for the sample, which are approximately log-normally distributed. Yields range from 0 to just over 3000 kg per hectare. The frequency distribution includes harvests from both first and second croppings, as well as harvests from hedgerow and traditional plots. It is worth noting that the only plots that experienced large catastrophic losses (e.g. harvests below 200 kg/ha) were traditional plots. Table 9.2 disaggregates and reports average yields on both an observed per hectare basis (including hedgerow area) and an effective per hectare basis (corn area only), by cropping season.

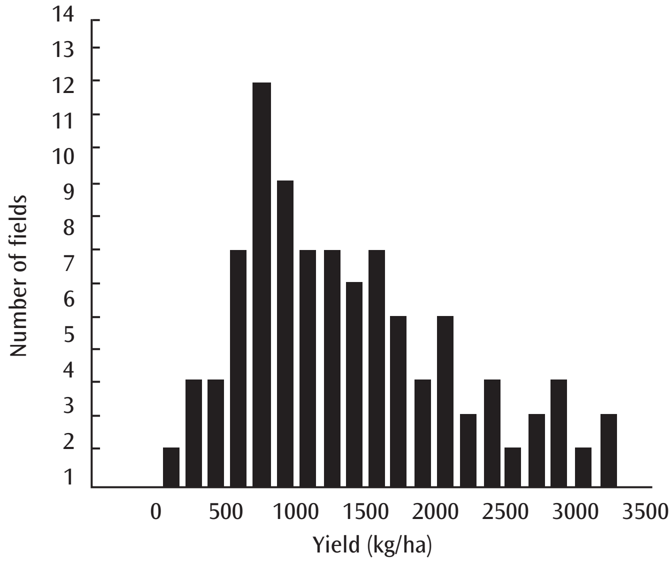

Figure 9.1 Frequency distribution of yields in Bansalan, 1994.

Experimental plot yields from MBRLC (undated) are presented for comparison. In general, hedgerow plots appear to outperform traditional plots on both an effective and observed basis, although in part these differences reflect the fact that hedgerow plots received greater amounts of labour and fertiliser on average than traditional plots. The average plot had been in use for approximately 7 years at the time of the survey. Average remaining soil depth was estimated as approximately 850 mm.

Testing for Functional Form and Heteroskedasticity

A range of possible functional forms are available for estimating the mean equation of a production function. A log-linear Cobb-Douglas model was justified on the basis of a specification test. The test, following MacKinnon, White, and Davidson (1983), assesses the significance of the estimate of the coefficient *a* in the model:

$$g = x\acute{b} + a\left[lng - ln\left(x\acute{b}\right)\right] + e \qquad (2)$$

where *g* represents yield, *x* is a vector of independent variables, *b* is a coefficients vector, and *e* is a vector of regression residuals.

Patterns of coefficient significance were similar in linear and log-linear regressions, but based on the specification test the linear model is rejected in favour of the log-linear model at a 95% confidence level. A fully specified translog production function performed poorly with these data, although the signs and estimated magnitudes of regression coefficients were broadly similar to those reported for the log-linear Cobb-Douglas model.

The presence of heteroskedasticity in yields was confirmed by the results of diagnostic tests for conditional variance in the yield regression. To test for heteroskedasticity in yields the procedures suggested by Breusch-Pagan (1979) and Glesjer (1969) were used. These diagnostic tests examine the null hypothesis of homoskedasticity in the yield function against an alternative hypothesis of heteroskedasticity. The tests require that one regress transformed residuals from a base regression on independent variables of the mean regression. Residuals used in the tests were obtained from a regression of the equation:

$$g = x\acute{b} + e \qquad (3)$$

where variables are defined as in equation (2). The Breusch-Pagan test is a Lagrange multiplier test using squared residuals, while the Glejser test uses the absolute value of the residual. These tests were applied to the data using two subsets of the independent variables. The first set consisted of labour, fertiliser, and a dummy variable for second cropping. The second included these variables as well as soil depth and the hedgerow indicators. The tests and test results are reported in Table 9.3. To summarise, the Breusch-Pagan test allows acceptance of the null hypothesis of homoskedasticity in both instances, but the Glejser test recommends rejecting the

Table 9.1. Sample means for selected production variables in Bansalan.

	Average per hectare				Average per effective hectare			
	All plantings	Second planting	Non-hedgerow	Hedgerow plots	All plantings	Second planting	Non-hedgerow	Hedgerow plots
Yield (kg/ha)	1335	1068	1266	1437	1409	1130	1266	1619
Labour (days/ha)	326	334	267	412	352	366	267	477
Fertiliser (kg/ha)	136	141	130	145	146	151	130	170
Time used (months)	83	85	90	117	83	85	90	117
Slope (degrees)	26	26	25	27	26	26	25	27
Soil depth (mm)	850	847	838	867	850	847	838	867
% of plots with hedgerows	0.39	0.40	-	1.0	0.39	0.40	-	1.0
% of land with hedgerows	0.05	0.06	-	0.12	0.05	0.06	-	0.12
Hedgerow age (years)	1.48	1.60	-	3.80	1.48	1.60	-	3.80
n	89	50	53	36	89	50	53	36

Table 9.2. Observed corn yields for hedgerow plots and non-hedgerow plots.

	Experimental plots		Farmers' plots	
	Observed yield	Effective yield	Observed yield	Effective yield
First planting	n.a.	n.a.	1670	1770
Second planting	n.a.	n.a.	1070	1130
Traditional plots	1910	1910	1270	1270
Hedgerow plots	1480	2880	1440	1620
All plots	1700	2400	1340	1410

Source: Experimental plots, MBRLC; (undated) Farmers' plots, Bansalan survey (figures are rounded).

null hypothesis. Greene (1990) argues that the Glesjer test is more powerful than the Breusch-Pagan test within the specific context of the chosen regression model. Therefore, the null hypothesis of homoskedasticity is rejected.

Table 9.3. Tests of heteroskedasticity in corn yield regression.

Independent variables	Test		
	Breusch-Pagan	Glejser	Critical value
Labour, fertiliser, second cropping dummy	4.32	9.22	7.82
Labour, fertiliser, soil depth, second cropping dummy, hedgerow dummy, hedgerow share	6.52	18.21	12.59

Note: The test statistics are distributed chi-square with degrees of freedom equal to the number of independent variables. Residual regressions contained a constant term in all cases.

Results

Results from four jointly estimated mean and variance regressions are reported as models 1–4 in Table 9.4. The regressions were estimated by maximum likelihood under the assumption of Gaussian errors. Dependent variables in the variance regressions are the squared residuals from mean regressions. For all models the coefficient estimates in the mean regressions are similar in sign, magnitude, and significance to those estimated using Ordinary Least Squares (OLS) under the assumption of homoskedasticity. In most cases point estimates are individually significant at the 95% confidence level.

Table 9.4. Maximum likelihood estimates of heteroskedastic corn production functions.

Mean equation: dependent variable is natural log of corn yield per hectare				
Independent variables	1	2	3	4
Constant	4.3481 (0.4746)	3.7797 (0.6091)	4.2480 (0.3933)	3.7277 (0.4123)
Log of labour (person-days per hectare)	0.3443 (0.0562)	0.3669 (0.0549)	0.2558 (0.0334)	0.3434 (0.0423)
Log of fertiliser (kg per hectare)	(0.0736) (0.0214)	0.0624 (0.0208)	0.0187 (0.0122)	0.0533 (0.0087)
Log of soil depth (mm)		0.1012 (0.0626)	0.1702 (0.0529)	0.1002 (0.0519)

Note: The inverse Mill's ratio is derived from plot-level adoption equations reported in Table 9.5. Asymptotic errors are in parentheses.

Table 9.4. (cont'd) Maximum likelihood estimates of heteroskedastic corn production functions.

Mean equation: dependent variable is natural log of corn yield per hectare				
Independent variables	**1**	**2**	**3**	**4**
Period of use(months)	-0.0003 (0.0003)			
Second cropping (0,1)	-0.4589 (0.1034)	-0.5757 (0.0939)	-0.5637 (0.0546)	-0.4840 (0.0544)
Hedgerows (0,1)		-0.2387 (0.1771)	-0.2686 (0.1934)	0.4767 (0.1003)
Hedgerow share (0,1)		-1.6343 (0.6727)	-1.5881 (0.8805)	-2.7360 (0.9451)
Hedgerow age (years)		0.0448 (0.0364)	0.0485 (0.0370)	0.0211 (0.0129)
Inverse Mill's ratio from adoption Probit (0,1)				-0.1227 (0.0643)
Constant	1.1151 (0.3477)	-0.0982 (0.2821)	0.2099 (0.1613)	-0.3327 (0.1316)
Log of labour (person-days per hectare)	-0.0844 (0.0375)	-0.0826 (0.0313)	-0.1021 (0.0216)	-0.0310 (0.0136)
Log of fertiliser (kg per hectare)	-0.0275 (0.0143)	-0.0206 (0.0124)	-0.0088 (0.0032)	0.0048 (0.0035)
Log of soil depth (mm)		0.1250 (0.0278)	0.0574 (0.0195)	0.0650 (0.0250)
Period of use(months)	-0.0011 (0.0002)			
Second cropping (0,1)	0.10522 (0.0658)	-0.0189 (0.0399)	0.0645 (0.0151)	0.0284 (0.0157)
Log of slope(degrees)		0.1123 (0.0313)	0.1372 (0.0263)	0.1212 (0.0236)
Hedgerows (0,1)		-0.1203 (0.0477)		-0.2624 (0.0577)
Hedgerow share (0,1)			1.9790 (0.7171)	2.9212 (0.8308)
Inverse Mill's ratio from adoption Probit (0,1)				0.1198 (0.0237)
Log-likelihood	-88.90	-83.90	-72.88	-63.06
n	89	89	89	89

Note: The inverse Mill's ratio is derived from plot-level adoption equations reported in Table 9.5. Asymptotic errors are in parentheses.

Results from the mean equations for all models indicate that labour and fertiliser contributed positively to output. Hypotheses of constant returns to labour or fertiliser are rejected in the Cobb-Douglas model in favour of the one-sided alternative of decreasing returns to input use: labour and fertiliser each contributed positively to output, but at a decreasing rate. Similarly, decreasing returns to scale are indicated for combined inputs. In elasticity terms, a 1% increase in available labour is associated with a 0.3% increase in corn yield at the mean. For fertiliser, results indicate that a 1% increase in available fertiliser is associated with a 0.06% increase in corn yield. The marginal impact of an additional kilogram of fertiliser is approximately 0.5 kg of corn per hectare at mean application levels. Given prevailing prices of fertiliser and corn in 1994 (7 pesos ($0.28) and 5 pesos ($0.20) per kilogram, respectively), the regressions indicate that the economic benefit of additional fertiliser application was positive at levels of fertiliser application below 50 kg/ha, but likely negative above that level. In part this pattern reflects the relatively high reliance on native seed which exhibits poor nitrogen response. All regressions clearly indicate that controlling for input use and other factors, second-cropping yields (dry season) were statistically lower than first-cropping yields (wet season) and that an additional month of cropping reduces corn yield by about 1 kilogram per hectare.

Model 2 replaces months of continuous cropping with estimated soil depth. Results indicate that soil depth is positively correlated with corn yield, and that a 1% reduction in soil depth was associated with a 0.12% reduction in corn yield — about 2 kg/ha at the mean. Higher order terms for soil depth consistently failed to indicate either increasing or decreasing rates of yield decline associated with changes in soil depth. In a model (not reported) that included a fertiliser-soil depth interaction term one could not reject the hypothesis that fertiliser served as a substitute for soil depth for the range of outcomes observed.

Models 2–4 include three regressors that measure the impact of hedgerows on corn yield. These three are typically both individually and jointly significant at the 95% confidence level. Results show that as the share of land in hedgerows rises, effective yield falls. However, the mere presence of hedgerows is positively correlated with yield, and this benefit appears to increase over time. At sample means (12% of area and four-year-old hedgerows), the reduction in yield due to loss of cultivated area (approximately 300 kg) is roughly compensated by the benefits of hedgerows (roughly 350 kg). However, more intensive hedgerow use is associated with a net reduction in yield, particularly during early years of adoption. Because hedgerow pruning is generally erratic among farmers in the sample, and because the hedgerow technology itself is new and unfamiliar, this result may indicate that shading or disruptions in farmer practices are occurring. Furthermore, some competition between hedgerows and corn, either for water or for soil nutrients, may be occurring. Unfortunately, neither hypothesis can be tested using the sample data. In fact, if pruning and mulching were performed regularly, shading would be reduced and soil moisture content might be increased, potentially raising yields in the alleys. This underscores the importance of farmer practices, rather than the technology itself, in generating outcomes.

Turning to the variance regressions, not surprisingly, the models indicate that labour is a risk-reducing input. The models also show that fertiliser is a risk-reducing input on upland farms. This finding, which is repeated across most of the reported models, contrasts with findings from lowland agricultural studies that find a positive correlation between fertiliser use and production risk. For example, Roumasset (1976) argues that the means of lowland rice yield distributions consistently increase with nitrogen application, but that the variances in these distributions increase in some settings and decrease in others. In particular, when nitrogen was applied during the dry season it significantly reduced yield variance. Since upland corn is grown under rainfed conditions, a similar pattern may be appearing here. As Figure 9.2 shows, the nitrogen response of corn is somewhat greater, and more wide ranging, during the upland wet season than during the dry season. Lower conditional yield variance during the dry season is a natural byproduct of this relationship.

Model 1 also indicates that second cropping yields were somewhat more variable than first cropping yields. Although the coefficient estimate is not significantly different from zero at standard test levels in this model, the pattern that is established here is strengthened in models 3 and 4. Older plots also appear to be associated with lower yield variance. This result is consistent with the fact that newly opened parcels tend to be on steeper and less stable land. Plot slope, for example, is negatively correlated with plot age in the sample.

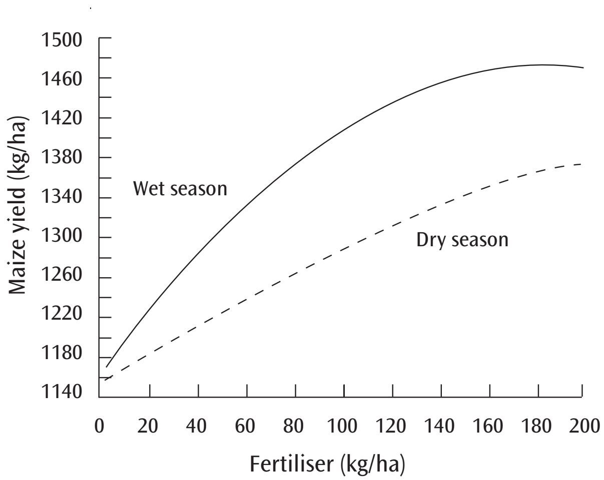

Figure 9.2. Nitrogen response in upland corn.

Model 2 uses soil depth rather than parcel age in the variance regression. Results indicate that prior soil loss reduces yield variability. Figure 9.3 graphs this predicted relationship between soil loss and yield variance. The figure includes upper and lower bounds on yield (defined as mean yield +/- one standard deviation). Patterns suggest that soil loss may reduce the upper tail of the yield distribution and thereby compress the yield distribution downward. Model 2 also introduces a binary hedgerow indicator in the variance regression. The estimated coefficient indicates the overall impact of hedgerows is a slight reduction in yield variance. Model 3, in contrast, uses a measure of hedgerow intensity in the variance regression and suggests that hedgerow intensity is positively correlated with yield variance. Models 2 and 3 both show that yields are more variable on more steeply sloping fields, a finding that is robust to inclusion of soil depth and parcel age in the variance equation.

Model 4 attempts to reconcile the ambiguity regarding hedgerows and risk exhibited in the variance equations of models 2 and 3. Model 4 indicates that the overall presence of hedgerows on a parcel is associated with lower yield variance, but that the marginal effect of hedgerow intensity is an increase in yield variance. In fact, the results suggest that the mean-increasing benefits of hedgerows over time are partially offset by increases in yield variance vis-a-vis traditional plots. Nevertheless, hedgerows are valuable in so far as they afford protection against catastrophic losses.

The mean and variance equations of model 4 also include a measure of latent farmer characteristics in the form of an inverse Mill's ratio. As is well known, estimation of production functions without regard to stochastic features in the maximisation process can produce simultaneous equation bias in parameter estimates. Correction for this potential bias depends on the nature and sources of

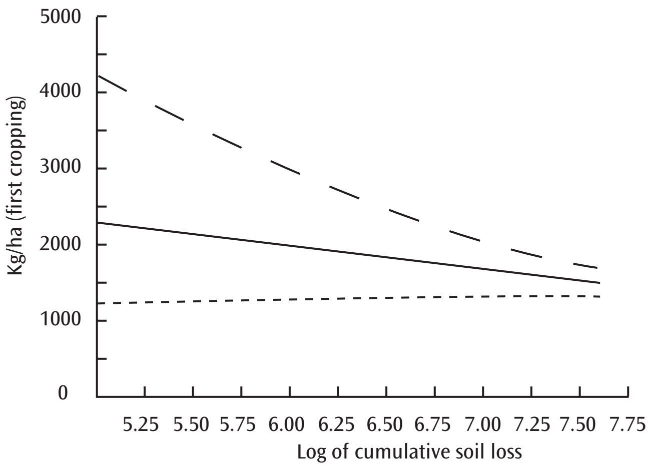

Figure 9.3. Yield and conditional yield variance with hedgerows.

stochasticity. If disturbances are unknown at the time inputs are chosen, then these disturbances cannot enter into the maximisation process (or the first-order conditions), and hence estimation of the production function independent of the factor demand equations appears reasonable. This is the reasoning employed by Zellner et al. (1966) and de Janvry (1972). In contrast, if decision-makers understand the sources of risk, then one potential solution is to estimate jointly the production function and the factor demand equations.

In the current context, we investigate an alternative explanation, namely that latent (and unobserved) farmer characteristics may be correlated with production outcomes. In order to test this hypothesis, a Probit model is used to predict the probability of hedgerow adoption on a plot using a range of household and plot characteristics. The results of this Probit model, which includes as explanatory variables available labour, ownership, soil depth, age, and opportunity cost are reported in Table 9.5. Using this Probit regression, a measure of self-selection into the sample was generated for each household. This inverse of the 'Mill's ratio' is a monotone decreasing function of the probability an observation falls into the sample (Heckman 1979). In the current context, it measures the degree to which yields are influenced by the same unobserved factors that determine hedgerow adoption. The yield and variance equations of model 4 both incorporate this measure to account for latent farmer characteristics in the production function. Production results presented earlier are invariant in sign and magnitude to the inclusion of the inverse Mill's ratio in the mean and variance equations. Results indicate that, controlling for plot-specific factors, farmers exhibiting characteristics associated with hedgerow adoption tend to have lower corn yields and higher yield variance, on average than those who do not exhibit these characteristics. That is, a hypothesis that hedgerow farmers perform no worse than non-hedgerow farmers is rejected for this sample. Inclusion of the inverse Mill's ratio in the variance regression strengthens the power of hedgerows in explaining yield variance.

Discussion

Analysis shows that soil conservation measures have the potential to increase yields and can reduce yield variance slightly. However, evidence also clearly indicates that hedgerows initially reduce effective yields, and substantially reduce observed yields. This argues against their use in short planning horizons, although in the long run the highest effective yields are attainable only through more intensive use of hedgerows. Based on sample data, the break-even point for contour hedgerows (in terms of yield) is found to be approximately 7 years.

The analysis supports the hypothesis that hedgerows are variance reducing. Furthermore, variance around the yield trajectory decreases over time when hedgerows are in place. However, the analysis also shows that yield variance increases as hedgerow intensity rises. Including an inverse Mill's ratio in the variance regression strengthened the power of hedgerows in explaining yield variance. The results suggest that yield variability on hedgerow plots may reflect underlying characteristics of hedgerow adopters or unobserved features of the land that they use. This pattern may also reflect extension efforts in the area that have targeted hedgerows to resource-constrained households.

Table 9.5. Results of Probit analysis of soil conservation adoption.

Independent variable	Coefficient estimate (standard error)
Constant	1.1722 (1.9255)
Farm size (ha)	0.1666 (0.0821)
Available household labour per hectare (person-days per hectare)	0.0021 (0.0011)
Proportion of cultivated area with secure tenure (0,1)	1.2737 (0.6700)
Plot size (ha)	-0.9187 (0.5200)
Soil depth of plot (mm)	-0.0028 (0.0014)
Period of continuous cropping on plot (months)	-0.0162 (0.0084)
Ratio of initial cost of adoption on plot to total household corn availability	-0.4498 (0.1663)
Value of log-likelihood function	-48.71
Percentage correct predictions	0.65
n	89

Note: Asymptotic standard errors are presented in parentheses. Likelihood ratio test for regression with constant only is -60.1.

To illustrate the empirical findings on the impact of hedgerows on yields and yield variance, Figure 9.4 illustrates a 10-year trajectory for effective yield and an approximate lower bound on yield (1 standard deviation below the mean). The *x*-axis in Figure 9.4 corresponds to time and the *y*-axis corresponds to the hedgerow share.

Figure 9.4 illustrates several important empirical findings. First, the underlying tendency is for yields to decline as a parcel becomes older. Hedgerows can dampen or reverse this decline, but they initially reduce effective and observed yields. This recommends against their use over short or greatly discounted planning horizons, and helps explain why low-income farmers are reluctant to adopt hedgerows.

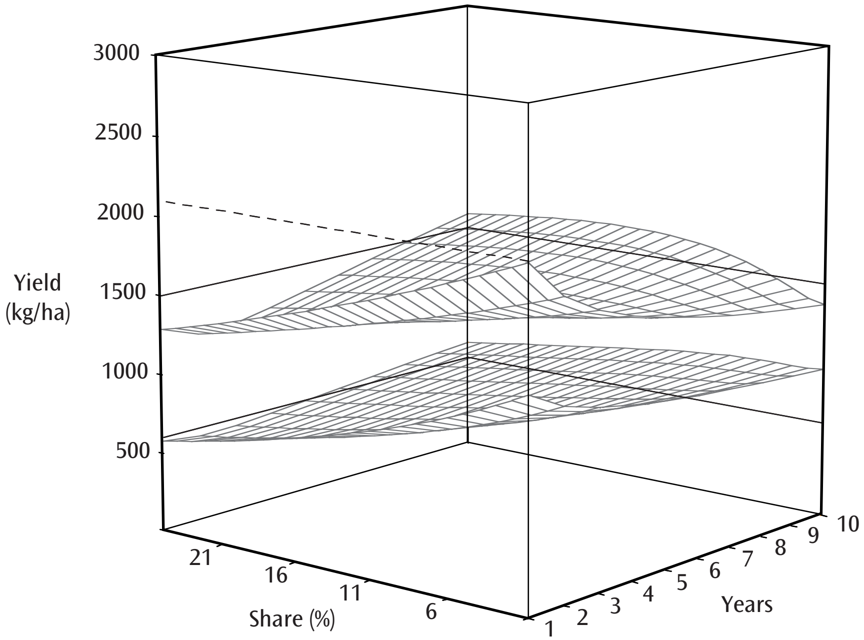

Figure 9.4. Trajectory surface for corn planted with hedgerows.

Second, as hedgerows increase in age, their soil-conserving and yield-enhancing properties improve. The increase in yield depends on hedgerow intensity: more intensive use of hedgerows increases effective yields. The maximum effective yield after 10 years (exclusive of hedgerow area) is estimated as 1650 kg/ha, and would be achieved with a 15% hedgerow share (corresponding to hedgerow spacing of approximately 5.5 m). By comparison, the maximum per-hectare yield (inclusive of hedgerow area) is estimated as 1450 kg/ha, and would be provided by an 8% hedgerow share (corresponding to spacing of 10 m).

Third, hedgerows reduce yield variance. The lower bound on yields rises with more intensive hedgerow use, which suggests that hedgerows provide protection against downside risk, especially risk of yields falling below 500 kg/ha. However, as the intensity of hedgerow use rises, overall yield variability increases. This suggests that yield variability due to crop-hedgerow competition or management difficulties may arise when hedgerows are used more intensively. These results are robust to inclusion of measures of parcel slope in the regressions.

Conclusion

This chapter examined the impact of soil conservation measures on yields and yield risk. A heteroskedastic production function was used to test the hypothesis that contour hedgerows mitigate yield risk using data from corn production on hillside farms in Bansalan. Regression analysis was used to show that hedgerows can dampen or reverse the rate of reduction in yields on farmers' fields. However, evidence clearly indicates that hedgerows initially reduce effective yields, and substantially reduce observed yields.

Regarding the main investigation of the chapter, namely the influence of hedgerows on production risk, the analysis supports the hypothesis that hedgerows are variance reducing. Furthermore, variance around the yield trajectory decreases over time when hedgerows are in place. However, the analysis also shows that yield variance increases as hedgerow intensity rises. These results should be of value to those who are interested in both the practical application of soil conservation strategies in low-income settings, and also those who wish to consider broader welfare issues related to resource conservation by low-income farmers. Future work should extend this analysis to other settings and focus on further distinguishing the factors explaining yield variance, including technology, plot, and farmer-specific effects.

Chapter 10

Analysis of Farmer Decisions to Adopt Soil Conservation Technology in Argao

Y.T. Garcia

THE PROBLEM of soil erosion in the Philippine uplands and elsewhere in the world is multi-dimensional and inherently dynamic. In one sense it can be likened to a problem in capital theory, involving the management of the soil resource as an asset over time (Rausser 1980). There is an on-going decision-making process on the part of the farmer whether to adopt and implement soil conservation practices. However, the decision to adopt soil conservation practices is heavily influenced by the complex interplay of physical, biological, demographic, institutional and socioeconomic factors which may uniquely affect a given farm enterprise. Variations in the impacts of these factors on the decision of the farmers, i.e. whether or not to include soil conservation in their land management strategies, accounts for the difficulty in targeting technology packages that would be socially acceptable and, at the same time, economically viable from the point of view of the farmers.

This study aimed to identify the factors that were likely to affect farmers' adoption of soil conservation technologies in the uplands at different stages of the decision process. Understanding the decision-making process of the farmers with regard to soil erosion abatement is an essential take-off point in the development of policy instruments that will achieve conservation objectives. Without a thorough understanding of the factors that eventually lead to conservation investments, environmental policymakers and extension agents may not be able to communicate effectively with farmers. Therefore, identification of these factors that are significant in determining conservation investments can be useful in designing appropriate policy instruments and measures that could lead to effective soil conservation.

Conceptual Framework

There is a host of interdependent factors that influence a farmer to allocate resources for soil conservation, i.e. to invest in a soil conservation technology (Barbier 1990; Burt 1981; Earle et al. 1979; Featherstone and Goodwin 1993; Napier et al. 1991;

Seitz and Swanson 1980). Thus, the decision to adopt a soil conservation technology should consider the interactive play of social, institutional, economic, and physical factors in the adoption process. This decision process, therefore, must be looked at as a system with different parts that are linked together.

Based on the modified framework used by Ervin and Ervin (1982), the adoption and use of soil and water conservation technologies can be modelled as a decision-making process and decomposed into three stages, namely: 1) perception of the soil erosion problem; 2) a decision to adopt soil conservation technologies; and 3) investment in soil conservation technologies (Figure 10.1). As shown in the figure, these three components are simultaneously influenced by social, institutional, physical, and economic factors.

This framework suggests that the farmer must first recognise the existence of soil erosion problems through awareness of the adverse effects of soil erosion. The

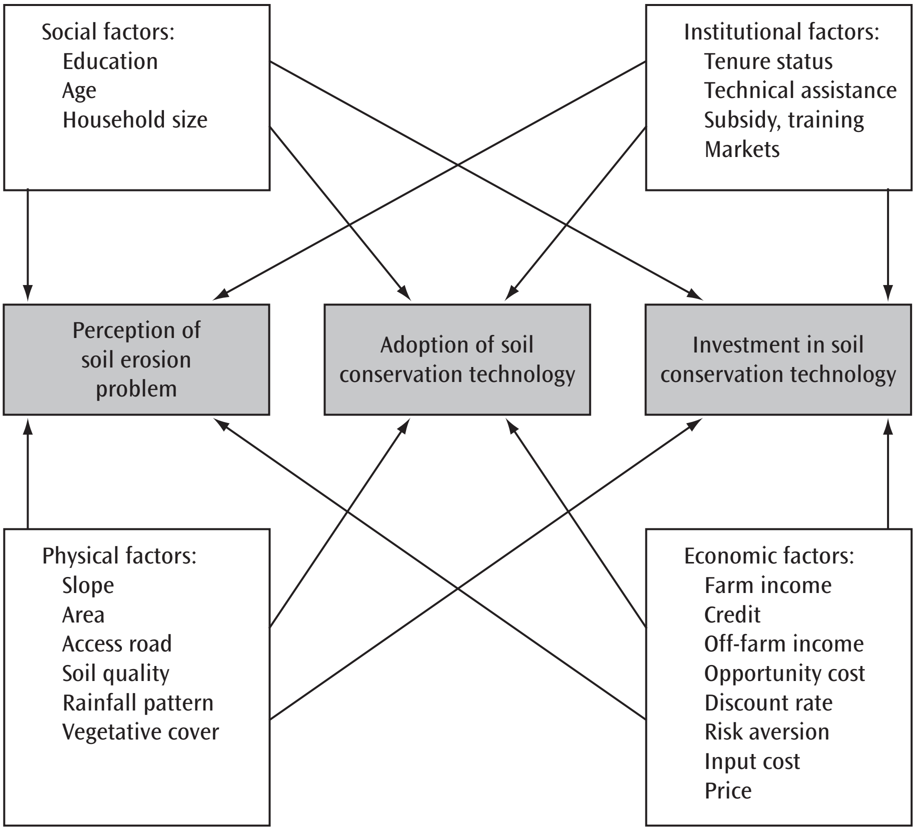

Figure 10.1. Decision-making process for the adoption of soil conservation technology.

farmer's awareness is a result of his/her exposure to educational and training programs (either formal or informal) that demonstrate the seriousness of soil erosion problems. It could also be triggered by his/her own personal experiences and inferences regarding the relationship between crop productivity and soil quality.

Once the erosion problem is perceived, the farmer then decides whether to adopt soil conservation technologies. The decision to adopt soil conservation leads to yet another array of decisions over what type of soil conservation technology to employ. Since soil erosion is a biophysical process with micro- and macro-social causes, the adoption of conservation technologies is also seen to depend on the four factor categories identified in the figure which interact and shape the farmer's choice.

Social factors like educational background and age can influence the farmer's disposition towards soil conservation through better information about the benefits of erosion control and receptiveness to diffusion of innovations. The soil erosion potential of the farm due to steepness and elevation can also guide farmer's choice on appropriate conservation structures.

The role of economic factors can be seen as incentives or constraints to adoption of soil conservation technologies. For example, short-term profitability of a certain conservation practice can encourage farmer adoption, while shortages in family labour can prohibit construction of soil conservation structures. Institutional instruments like technical assistance, training, subsidies, and promotion of erosion control programs can help persuade farmers to adopt soil conservation technologies.

The decision to adopt soil conservation technologies will then lead to the determination of the amount of resources that farmers are willing to invest to install the soil conservation structures. Investment in such technologies represents conservation effort by the individual farmer. The success of the farmer's conservation effort is determined by the effectiveness of the chosen technology and the extent to which the technology is adopted. The influence of the four factor categories on the final stage of the decision process can be perceived on a higher plane. For example, the ability of the farmer to properly employ and maintain his chosen technology is determined by his management potential. Likewise, since this stage calls for actual capital investment, then economic factors are expected to play a major role.

Methodology

This study aimed to verify the statistical significance of the relationships embodied in the four factor categories as they affect the three stages of the farmer's decision-making process. It also sought to test the relative importance of economic versus non-economic factors in influencing the decision of farmers to adopt and invest in soil conservation technologies. To carry out these tasks, three dependent variables were defined to correspond to each component of the decision-making process: 1)

PERCEPTION for the first component, i.e. perception of erosion problem; 2) ADOPTION for the second component, i.e. adoption of soil conservation technology; and 3) CONSERVATION for the third component, i.e. soil conservation investment.

To construct the variable PERCEPTION, the farmer's awareness of the degree of erosion problem encountered in his/her farm was elicited. Responses were categorized as follows: 1) 0 - do not know; 2) 1 - hardly at all; 3) 2 - slowly; 4) 3 - moderately; and 5) 4 - rapidly/needs abatement. The variable ADOPTION was constructed as a dichotomous variable, equal to 1 if the farmer was an adopter of soil conservation technologies and 0 if otherwise. The variable CONSERVATION, which represents the farmer's effort towards erosion control measures, was constructed as a censored variable with double limits, i.e. a lower limit equal to zero for non-adopters, and the proportion of the farm under soil conservation technologies, with an upper limit of 100%, for adopters. This variable was chosen to represent the third component, rather than using the total cost of investment in soil conservation technologies, due to the community-based nature of constructing these structures which made actual cost measurements difficult.

The models were specified as follows:

Model 1: PERCEPTION = f (social, institutional, physical, economic factors)

Model 2: ADOPTION = f (social, institutional, physical, economic factors)

Model 3: CONSERVATION = f (social, institutional, physical, economic factors)

The definitions of the explanatory variables that were contained in each factor category are presented in Table 10.1. Below is a discussion of the hypothesised relationships of the explanatory variables to the adoption of soil conservation technologies at different stages of the decision-making process.

Table 10.1. Definition of explanatory variables used in the adoption models.

Variable name	Description
Social factors	
AGE	Age of the farmer respondent (years)
FSIZE	Family size of the farm household
EDUCATE	Number of years in school
STAY	Length of stay in the village (years)
Institutional factors	
TENURE 1	Dummy variable for tenure status of the farmer
	= 1 if the operated farm is owned
	= 0 otherwise
TENURE 2	Dummy variable for tenure status of the farmer

Table 10.1. (cont'd) Definition of explanatory variables used in the adoption models.

Variable name	Description
	= 1 if the farmer is a recipient of a certificate of land tenure
	= 0 otherwise
COOP	Dummy variable for membership in a cooperative
	= 1 if the farmer is a coop member
	= 0 otherwise
RADIO	Dummy variable for radio listening to agricultural programs
	= 1 if the farmer is a radio listener
	= 0 otherwise
AGENTS	Dummy variable for change agents contact
	= 1 if the farmer has contacts with change agents
	= 0 otherwise
SUBSIDY	Dummy variable for any form of subsidy received (pesos)
	= 1 if the farmer receives any form of subsidy for soil conservation
	= 0 otherwise
Physical factors	
AREA	Total operated farm area (ha)
DPH	Distance of farm lot to homestead (km)
DPM	Distance of farm lot to nearest market centre (km)
SLOPE	Average slope of the farm lot (degrees)
INTENSITY	Dummy variable for cropping intensity of the farm
	= 1 if the farm is cropped at least twice
	= 0 otherwise
TEXTURE	Dummy variable for soil texture
	= 1 if soil is sandy and rocky
	= 0 otherwise
Economic factors	
PRICE	Price of maize crop harvested in the farm (pesos)
COST1	Cost of traditional inputs used in maize production (pesos)
COST2	Cost of labour inputs for soil conservation structure (pesos)
OCNA	Opportunity cost of non-adoption/late adoption of soil conservation technologies represented by net return gap (pesos)
FINC	Total annual farm income (pesos)
OFFARM	Total annual off-farm income (pesos)

Table 10.1. (cont'd) Definition of explanatory variables used in the adoption models.

Variable name	Description
PROFIT	Total net return from one season of maize crop (pesos)
DRATE	Dummy variable for discount rate
	= 1 if the farmer expects his children to inherit the farm
	= 0 otherwise
CREDIT	Total institutional debt related to maize farming (pesos)
OPTIMISM	Mean of farmer's expectation on yield
RISK	Risk index of the farmer respondent

Social Factors

Personal characteristics of farmers like age, family size and educational attainment were hypothesised to influence the decision process at all stages. Age of the farmer (AGE) was expected to be negatively related to adoption and investment. Younger farmers would perceive a longer time horizon than an older farmer and expect to enjoy long-term benefits of conservation investments, despite its intertemporal nature. Also, younger farmers have greater personal energy and receptiveness to innovations.

Family size (FSIZE), on the other hand, was expected to have a positive impact on conservation efforts. The larger the family size, the higher the probability that future generations will farm the land and reap the long-term benefits of conservation investments. Likewise, larger family size would indicate more labour that could possibly be available for the construction of soil conservation structures.

Education (EDUCATE) likewise was expected to have a positive effect on adoption since higher levels of education could be associated with greater information on conservation measures and the productivity consequences of erosion, and greater management expertise.

Institutional Factors

Institutional factors were likewise hypothesised to influence the decision process at all stages. The tenure status of the farmer (TENURE) normally plays a significant role in the adoption of soil conservation technologies and was expected to be positively related. If the farm is leased, the farmer is less likely to make conservation expenditures than when the farmer is the owner. Therefore, farmers with insecure tenure may not adopt soil conservation technologies due to uncertainty about capturing the long-term benefits.

The holding of a Certificate of Stewardship Contract (TENURE 2) was also expected to be positively related to adoption. Certain acceptable conservation practices were usually tied up with the government's Integrated Social Forestry Program. To obtain CSCs, farmers had to follow these conservation practices before they could cultivate and develop public forest lands into productive farms.

The extension of a subsidy (SUBSIDY), either from the government or non-governmental organisations, was seen to provide an incentive to adopt. Moreover, farms that received any form of subsidy were thought to have initially conformed with the government's conservation requirement or the NGOs development program.

Membership in a farmers' organisation or local cooperative (COOP), supported by either government or non-governmental organisations, was thought to enhance adoption. Local cooperatives and farmer organisations are often used as a medium for the promotion of government and NGO programs. Lack of access to extension services due to non-membership to such organisations is frequently cited as an impediment to the adoption of soil conservation technologies.

Listening to agricultural programs on the radio (RADIO) and contacts with extension agents (AGENTS) were seen as factors that helped promote soil conservation technology adoption through the creation of awareness and provision of technical assistance. Hence, positive signs were expected for these variables.

Physical Factors

The influence of physical characteristics of the farmer's plot was also hypothesised to span across the three stages of the decision process. The size of the farm (AREA) can influence the decision of farmers to invest in soil conservation technologies. Studies from developed countries show that larger farms are more likely to use conservation technologies than smaller farms (e.g. Ervin and Ervin 1982). However, farms in developing countries like the Philippines are often small, averaging about 2 ha or less. Small farm sizes can be a constraint to the construction of conservation structures, especially if it means withdrawing a portion of the land from production.

The distance from the farmlot to the homestead (DPH) and the nearest market (DPM) can be incentives for, or constraints to putting in soil conservation structures. Nearness of the farmlot to the homestead indicates ease of accessibility which can be an incentive for improvement of the farmlot. Hence DPH was expected to be negatively related to adoption. At the same time, nearness of the farmlot to market centres allows better access for marketing of farm products, giving an incentive for increasing production. One way of increasing productivity of farms in the highly erodible uplands is to construct proper soil conservation structures, hence the expected sign of the variable DPM was also negative.

The slope of the farm (SLOPE), on the other hand, was expected to be positively related to adoption since soil conservation technologies are specifically designed for rolling to steep slopes. Cropping intensity (CI) was also expected to be positively related to adoption. Farms with soil and water conservation structures are able to manage soil moisture and fertiliser use more efficiently, enabling farmers to crop their fields more intensively.

Soil texture (TEXTURE) was expected to be negatively related to adoption, i.e. the more sandy and rocky the soil, the greater the need for soil conservation technologies to prevent further losses of organic matter and nutrients gained from green manuring and application of fertiliser.

Rainfall pattern and vegetative cover are physical variables that are commonly hypothesised to affect adoption and investment in soil conservation technologies. In this study, rainfall pattern was not included in the set of variables considered in the model since the cross-section survey would not generate enough variability for this variable to warrant inclusion. Likewise, vegetative cover was left out since the investigation was focused specifically on the farmer's maize plots which were found to exhibit relatively homogenous cropping patterns.

Economic Factors

Economic factors are often strong justification for adoption and investment in any innovative technology. In this study, the relative importance of this factor category was tested against non-economic variables as determinant of adoption of soil conservation technologies.

Farm income (INCOME) was expected to be positively related to adoption, i.e. higher farm income would give the farmer more money for possible investment in conservation technologies. The influence of borrowings (CREDIT) on a farmer's adoption was thought to be ambiguous. It could be negative if the farmer's debt condition was beyond his earning capacity, thus requiring current cash income to pay back loans instead of investing in conservation technologies. On the other hand, it could be positive in cases where debt was a source of available funds to be used to finance conservation investments. The second option was hypothesised here.

The role of off-farm income (OFFARM) could also be seen in two ways. It could indicate supplemental income for financing conservation expenditures or it could reflect the need for supplemental income for family living expenses. Again, the second argument was adopted. Farm households with larger off-farm income were hypothesised to have greater need for that income and hence less time available to implement and maintain unfamiliar conservation practices as family members became more engaged in non-farm employment.

The discount rate (DRATE) can affect the farmer's valuation of benefits from adoption of soil conservation technologies. Since a lower discount rate implies a longer effective planning period for the farmer, the discount rate was expected to have a negative relationship with adoption.

The farmer's perception of risk (RISK) reflects his/her expectations of yield variability brought about by technology adoption, e.g. risks associated with new practices and loss of short-run income. Farmers who avoid risk may be reluctant to sacrifice short-run returns for the less certain benefits of conservation practices. This implies that operators with a lower risk index (RISK) have less confidence in the beneficial effects of soil conservation technologies and hence are expected to engage in less conservation effort. On the other hand, farmers with a higher risk index have greater optimism and confidence in the ameliorative effects of soil conservation technologies, hence are expected to have greater conservation effort. Therefore, the RISK variable was expected to have a positive relationship with adoption and investment in soil conservation technologies.

Econometric Techniques

Since the early 1980s, there has been growing interest in the use and development of qualitative and limited response models in the field of econometrics (Madalla 1983). These models deal with dependent variables that are not generally amenable to the principal tool of econometrics, i.e. regression analysis. Such variables are generated from quantal responses and limited responses. The quantal response category includes dichotomous, qualitative and categorical outcomes. The approach usually used for this type of discrete choice variable is either the Probit or logit model. These two techniques invariably generate the same results due to the similarities in the shapes of their underlying distribution, i.e. logistic distribution for the logit model and standardised normal distribution for the Probit model (Greene 1990). The choice, therefore, between the two procedures is often trivial and can be decided by convenience factors like availability of computer software.

The limited response category, on the other hand, covers variables which take on mixtures of discrete and continuous outcomes. The method of analysis generally employs limited dependent variable models for which the Tobit analysis has gained considerable popularity. The Tobit model evolved out of the Probit model and both share many properties and characteristics. However, in this case their objectives and results are sufficiently different.

Given the censored nature of distribution in the adoption of soil conservation technologies, the logit and Tobit models were used in the study. First, the logit model was used to analyse the dependent variable ADOPT due to its dichotomous response outcomes, i.e. the farmer's decision takes the form of whether or not to adopt soil conservation technologies, hence the observed value of Y is either 0 or 1. Second, the Tobit model was used to analyse the dependent variable CONSERVE due to the limited response nature of the proportion of farms under soil conservation technologies among adopters and non-adopters. For non-adopters, the value of Y is 0 while for adopters, Y is a continuous variable with values ranging from 1 to 100%.

The Logit Model

The logit model assumes that the probability of an individual making a given choice is a linear function of the individual attributes (Pindyck and Rubinfeld 1981). Adoption studies deal with individuals who are faced with a choice of whether or not to adopt a given technology, and often the choice depends on the characteristics of the individuals. The logit analysis was used in this study to predict the likelihood that a farmer will choose to adopt soil conservation technologies given information about his characteristics.

The logit model is based on the cumulative logistic probability function and is specified as:

$$P_i = F\left(\alpha + \beta X_i\right) = \frac{1}{1 + e^{-\left(\alpha + \beta X_i\right)}} \qquad (1)$$

where:

P_i is the probability that an individual will make a certain choice given X_i

e is the base of natural logarithms and approximately equal to 2.718

X_i is a vector of exogenous variables

α and β are parameters of the model

The above function can be rewritten as:

$$\text{Log}\left[P_i / \left(1 - P_i\right)\right] = \alpha + \beta_i X_i + \varepsilon_I \qquad (2)$$

where ε_I is a disturbance term and the parameters α and β_ι are estimated using maximum likelihood techniques. The marginal effects of X_i on P_i is calculated by taking the partial derivative of P_i with respect to X_i. The estimated marginal effect is given as follows:

$$\partial \hat{P}_i / \partial X_i = \hat{\beta}_i \hat{P}_i \left(1 - \hat{P}_i\right) \qquad (3)$$

In the logit model, the predicted value is a probability, hence the marginal effects represent changes in probability brought about by a unit change in X_i.

The Tobit Model

In standard regression model, the dependent variable is generally assumed to take on any value within the set of real numbers and the probability of any particular value is zero. In the dichotomous Probit model, the dependent variable assumes only two values, i.e. 0 and 1, each of which is assigned a probability mass. Tobin (1958) proposed a limited dependent variable model, later called the Tobit model by Goldberger (1964), to handle dependent variables which are combinations of these two cases, specifically mass points at the low end called the limit value and continuous values above the limit.

Whereas censoring at the lower end of the distribution is common among many economic variables, double censoring on both tails of the observations can likewise occur, as in the case of the variable CONSERVATION which had a lower limit equal to 0 and an upper limit of 100%.

The limit of the variable can be due to truncation or censoring of observations in the data set. Truncation occurs when the sample data are drawn from a subset of a larger population under consideration. Censoring, on the other hand, is essentially a defect in the sample data brought about by some random mechanism, i.e. Y assumes a value Y* if it falls within some specified range, otherwise Y is equal to a limit value often set to zero. This implies that outside the specified range, the true values of Y* become masked and are all transformed to a single value which is the limit. As a result, the dependent variable contains zero values for a significant fraction of the observations. To analyse these kinds of problem, the model is specified as follows:

$$\begin{aligned} Y_{it} &= \beta X_{it} + \mu_{it} && \text{if } \beta X_{it} + \mu_{it} = > 0 \\ &= 0 && \text{if } \beta X_{it} + \mu_{it} = \leq 0 \end{aligned} \quad (4)$$

where Y_{it} is the dependent variable, defined as the proportion of the farmer's plot with conservation technologies for farm *i* in year *t* (*i* =1,2,...,n; *t* =1,2,...T). X_{it} is a vector of exogenous explanatory variables consisting of personal attributes of farmers that are relevant to conservation investment in farm *i*. μ_{it} is a residual error that is assumed to be normally distributed with zero mean and constant variance σ^2. The parameters of the model β_i, and σ^2, were estimated using maximum likelihood techniques.

Caution must be exercised in interpreting the Tobit coefficients β_i. It is a common error in the literature to assume that the generated coefficients measure the correct regression effects for observations above the limit value (McDonald and Moffitt 1980). Tobit model parameters do not directly correspond to changes in the dependent variable brought about by changes in the independent variables. To obtain the correct regression effects for observations above the limit, the β coefficients must be adjusted as follows:

$$\partial E\left(Y \mid X_i\right) / \partial X_i = \phi\left(\beta_i X_i / \sigma\right)\beta_I \quad (5)$$

To measure the goodness of fit of the logit and Tobit models, an analog to the R^2 in a conventional regression model can be used which is computed as follows:

$$\text{LRI} = 1 - \left(\frac{ln\ L_{\max}}{ln\ L_o}\right) \quad (6)$$

This measure is bounded by zero and 1. However, the upper limit of LRI is substantially less than unity (Greene, 1990). Hence, even though LRI is expected to increase as the fit of the model improves, a generally low LRI is expected in these models. At the same time, unlike the R^2, the LRI has no intuitive interpretations.

Results and Discussion

Comparison of Adopters and Non-Adopters

The study was conducted in Barangay Tabayag in the municipality of Argao which is located in the southern portion of Cebu Province (see Figure 1.1). The data were collected through a survey conducted in March 1995. Complementary data were partly generated from ACIAR Project 1992/011 (Garcia et al. 1995a).

The adoption of at least one of the soil and water conservation technologies promoted by the Mag-uugmad Foundation Incorporated (MFI) in the area (i.e. bench terraces, contour rockwalls and hedgerows), was used to characterise the adopter farmers in this study. The non-adopter farmers were identified as those who employed traditional methods of soil and water conservation or none at all. The adoption rate in the area was documented at 50%.

Tests of mean differences were undertaken for all variables in the four factor categories to characterise the adopter and non-adopter farmers. Physical and soil chemical analyses were also undertaken to characterise farmers' fields with respect to the fertility and productivity effects of conservation structures.

Results of the analyses showed that adopter farmers were generally males, younger, more educated, better informed on the problems of soil erosion, and more optimistic about the yield effects of soil conservation technologies. Although they were relatively new farmers with smaller farm sizes, net returns from their maize cropping were significantly higher.

Cost and return analysis of their farm enterprise showed that adopters were able to gain higher net return than non-adopters due to higher yield. Among adopters, however, the effect of soil conservation was more pronounced. It was found that early adopters (10–15 years since adoption) gained higher net returns compared to late adopters (2–5 years since adoption), not just because of higher yields but also due to lower input costs resulting from lower fertiliser use.

Differences in net returns of non-adopter and late adopter farmers as compared to the set of the earliest adopters were computed. The net return gaps (referred to as opportunity costs of non-adoption and late adoption, respectively) showed that non-adopters were incurring a significant opportunity cost in terms of foregone benefits due to non-adoption of soil conservation technologies. On the other hand, while opportunity cost of late adoption did occur, the magnitude was significantly smaller than that of the non-adopters.

With respect to the farm's physical and chemical characteristics, the adopter farms exhibited significantly lower pH, and higher silt and lower sand components in their soils. This suggests that soil conservation structures in the adopters' farms were successful in controlling soil erosion and improving soil quality. In turn, these characteristics resulted in higher soil fertility which helped to enhance crop productivity.

Among adopters, the non-significant differences in yield and soil quality (i.e. level of organic matter, nitrogen, phosphorus and potassium) found in their plots, despite varying years of adoption, raised an important point. The early adopters were observed to sustain crop yield even with lower fertiliser use under similar soil conditions to the late adopters. This, therefore, implies that the economic benefits of adopting soil conservation technologies can only be realised in the long term, which was established in this study to be at least ten years. Further, early adopters can gain greater yield potential by increasing their fertiliser use.

With respect to farmers' subjective belief about adoption of soil conservation technologies, the adopters showed greater optimism and lower risk perception than the non-adopters. Among adopters, the early adopters showed greater optimism and less uncertainty in their yield expectations from soil conservation efforts as compared to the late adopters.

Econometric Analysis

Multiple regression analysis was used to test the hypothesised relationships in the PERCEPTION model. On the other hand, given the dichotomous nature of the ADOPTION variable and the censored nature of the CONSERVATION variable, limited-dependent variable models, i.e. logit and Tobit models, were used to test the hypothesized relationships in the last two models. Results of the runs are summarised in Table 10.2.

Perception of soil erosion problem

Table 10.2 shows that five of the seven variables tested had the hypothesised signs. However, only the variables RADIO, TRAINING and AREA were found to significantly affect farmers' perception of the soil erosion problem.

The TRAINING variable was found to be the most important among the three variables as indicated by the magnitude of the coefficient and its level of significance. The sign was found to be positive, suggesting that the greater the number of field visits and training courses on soil and water conservation technologies the farmer had attended, the higher his perception of the erosion problem. This was expected, as educating farmers about the adverse consequences of soil erosion and the alternative technologies that can effectively abate it broadens their perspective of the problem.

Table 10.2. Estimated β-coefficients and slopes for PERCEPTION, ADOPTION CONSERVATION models.

VARIABLES	PERCEPTION	ADOPTION		CONSERVATION	
	OLS Slope	Logit	Slope	Tobit	Slope
Social factors:					
AGE	–0.014			–1.775*	0.958*
EDUC	–0.023*	2.908*	1.570*		
Institutional factors:					
RADIO	0.616*				
TRAINING	0.630***				
Physical factors:					
AREA	–0.906***	–19.341 **	10.44**		
SLOPE	0.010				
CI	–0.554				
Economic factors:					
FINC		0.0008 *	0.0004*	0.008**	0.004**
OCNA		–0.0001	–0.002	0.004	0.0002
RISK		–0.2766	0.1494	4.933	2.664
CREDIT		0.0127 **	0.0068**	0.061***	0.033***
R^2 / LRI	0.50	0.89	0.60		

* significant at α = 10%; ** significant at α = 5%; *** significant at α = 1%

The non-significance of the AGE and EDUCATE variables can be attributed to the significance of the TRAINING variable. Since these three variables were highly correlated, the variable TRAINING most likely masked the effects of the variables AGE and EDUCATE, thus rendering them less useful in explaining variation in the dependent variable PERCEPTION.

The coefficient of the variable AREA was also found to be highly significant. However, the sign was negative, indicating that farmers with larger plot areas had less perception of the soil erosion problem. It should be noted that farmers with larger plot sizes tended to be non-adopters of soil conservation technologies. At the same time, they were the ones who registered lower perception scores. This suggests that, due to larger plot areas, the non-adopters were hardly concerned about soil erosion, since they were not critically constrained by farm size in their crop production. The adopters, on the other hand, had smaller plot sizes. Hence, they tended to be more receptive to the erosion problem due to the need to sustain current farm productivity for their subsistence.

The variable RADIO, which represented the farmer's exposure to alternative media for agricultural production and technology dissemination, was also found to increase awareness regarding the negative consequences of soil erosion. Although not statistically significant at conventional levels, the coefficient of the RADIO variable had a positive sign which suggests that media communication can be utilised to stimulate farmers' perception of the erosion problem and the need for abatement measures.

The variables for farm slope and cropping intensity were included in the model due to their strong relation to erosion potential. The steeper the slope and more intensive the cropping pattern, the higher the rate of erosion expected from the farmer's plot. However, neither SLOPE nor CI showed any strong statistical influence in the PERCEPTION model.

The sign of the SLOPE variable, however, conformed to expectation. The positive sign of its coefficient indicates that farmers who were cultivating the relatively steeper slopes had a greater perception of the soil erosion problem. The negative sign of the CI coefficient, on the other hand, was unexpected. The switching of sign for the CI variable was probably due to the multicollinearity problem. However, checking the correlation coefficient between PERCEPTION and CI variables showed positive r. This suggests that the farmers who were able to perceive the seriousness of the soil erosion problem were also the same farmers who were cropping their farms more intensively. Most of these farmers were the adopter farmers and they were able to crop more intensively due to the construction of proper soil and water conservation technologies in their farms.

On the whole, weighing the relative importance of the three factor categories, it can be concluded that among the social, institutional and physical factors which were likely to influence a farmer's perception of the soil erosion problem, only the institutional and physical factors showed dominating effects.

Adoption of soil conservation technologies

Results of the logit run showed that five of the six variables tested had the hypothesised signs. However, only the variables EDUCATE, FINC, AREA and CREDIT were found to significantly affect farmer's decision to adopt soil conservation technologies.

The AREA variable was found to be the most important among the four variables as indicated by its level of significance and absolute magnitude of its coefficient. The negative coefficient of AREA implies that farmers with larger holdings had lower probability of adopting soil conservation technologies. This can be attributed to the labour-intensive nature of constructing soil conservation structures like bench terraces, rockwalls and contoured hedgerows. A smaller landholding would easily be amenable to the construction of these soil conservation structures as compared to the larger ones.

The variable CREDIT was equally important in explaining variation in the ADOPTION model. It serves as an indicator of a farmer's access to formal and informal credit for agricultural inputs. Table 10.2 shows a positive and significant coefficient for CREDIT. This implies that access to credit facilities increases the probability of adopting soil conservation technologies. In the case of adopter farmers, the relationship between credit and the adoption decision was directly linked by the presence of MFI which promoted conservation farming in the area through the formation of a local cooperative. From this cooperative, farmers could avail themselves of crop loans in terms of fertiliser, subsidy in terms of seeds for growing contour hedgerows, and farm tools like hoes, bolo and pick mattocks. This arrangement, therefore, caused the variables TRAINING, AGENT, SUBSIDY and CREDIT to be highly correlated with each other. As a consequence, only one among them, i.e. CREDIT, was chosen to be included in the ADOPTION model. Hence, caution should be exercised in interpreting the effect of the CREDIT variable. Although it was basically an economic variable, since it was being utilised as an instrument to attract members for the farmers' cooperative, it also represented institutional effects on adoption.

The level of education of farmers was also found to significantly influence farmers' decision to adopt soil conservation technology. The positive and significant coefficient of the education variable (EDUC) implies that farmers with more education were more likely to adopt the MFI-promoted soil conservation technologies than those with lesser educational attainment. This was likewise expected since educated farmers tended to be more informed about the productivity consequences of erosion and ways to prevent it. Educating the farmers, therefore, is one way of increasing the probability of adoption of soil conservation technologies.

Three other economic variables, namely, FINC, RISK and OCNA, were included in the logit run. The coefficient of farm income (FINC) was found to be positive and significant, indicating that higher farm income increases the probability of adoption. This can be explained via the relationship of farm income and supply of family labour. Since construction of soil conservation structures was labour-intensive, a household with less family labour would not trade opportunities to work and earn from farming or non-farm activities for work with other farmers in the *alayon* group. On the other hand, a family with relatively higher farm income could afford to join the *alayon* group, hence the probability of adoption increased.

OCNA, the opportunity cost of non-adoption or late adoption, represented the farmer's foregone income from maize cropping due to sub-optimal implementation of the package of soil and water conservation management technology that was being promoted in the area. However, the coefficient for this variable was not significant.

RISK represented the farmer's perception of risk regarding maize production under varying conditions (i.e. favourable, normal and unfavourable conditions). The negative sign of the coefficient for this variable did not conform to expectation. Checking the correlation coefficient between ADOPTION and RISK indicated a positive sign. This suggests that farmers who registered higher risk perception were those who adopted soil conservation technologies. This implies that farmers who were willing to accept more risk in their farming system were more likely to adopt the new conservation farming technologies. On the other hand, farmers who registered lower risk indexes were those who perceived more stable yield and less uncertainty. These were the farmers who were likely to be satisfied with their present farming system which could have dampened their interest to experiment with innovations.

Therefore, among the four factor categories investigated in the model, the physical, institutional and social factors were found to be the more important factors in influencing the decision of farmers to adopt soil conservation technologies.

Investment in soil conservation technologies

Results of the Tobit run showed that four of the five variables tested had the hypothesised signs. However, only the variables AGE, FINC and CREDIT were found to significantly affect farmers' decision to invest in soil conservation technologies.

The variable CREDIT was found to be the most important among the three variables as indicated by its level of significance. The positive coefficient of the CREDIT variable implies that farmers' access to credit facilities encouraged more investment and conservation effort. As in the case of the ADOPTION model, the effect of the CREDIT variable should be seen as both economic and institutional.

Another economic variable that played an important role in explaining variations in investment or conservation technologies was total farm income (FINC). The sign of its coefficient was found to be positive, indicating that farmers with more farm income showed greater conservation efforts. Since construction of conservation technologies required extensive work on the part of the farmer, families with limited income could not afford to channel family labour for soil conservation activities and forego opportunities to earn elsewhere. However, families with more farm income could free some labour hours and other resources for erosion protection measures.

The coefficient of AGE, although not significant at conventional levels, was found to be negative. This suggests that younger farmers tended to make greater conservation efforts. On the other hand, older farmers seemed to be uninterested in adopting the MFI-promoted technologies since they could no longer join the *alayon* work groups for physical and health reasons.

Therefore, among the four factor categories that were investigated in this model, the economic and institutional factors were found to be the most important factors in influencing the decision of farmers to invest in soil conservation technologies. These results support the claim that, for technologies with inter-temporal and positive externality effects, economic motives alone may not be enough to encourage conservation efforts from farmers. Institutional factors should likewise be harnessed to go hand in hand with economic incentives to ensure success in conservation endeavours.

Conclusion and Recommendations

Analysis of the three models showed that institutional and physical factors (i.e. training in soil and water conservation technologies, listening to agricultural programs on radio, and farm size) were the most important variables in explaining differences in farmers' perception of the soil erosion problem and the decision to adopt soil conservation technologies. On the other hand, economic and institutional factors (i.e. farm income and access to credit) were the dominant factors in explaining variations in soil conservation investment. These results imply that the relevance of each factor category, specifically the relative importance of economic versus non-economic factors, varies as the farmer move from one stage of the decision process to the next. Specifically, the role of economic factors became prominent only in the last stage of the decision process which called for actual resource allocation. On the other hand, in the early stages, the non-economic factors were more instrumental in explaining variations in the adoption of soil conservation technologies.

This study, therefore, supports the recent claims that non-economic variables play dominant roles in the adoption of soil conservation technologies, but only in the first and second stages of the adoption process, i.e. perception of the soil erosion problem and the decision whether to adopt. However, in the final stage, i.e. conservation investment, which determines the degree of conservation effort, farmers evaluate their decision based largely on economic factors.

The empirical findings in the models representing stages of the adoption process can be useful in developing and targeting policy strategies for soil conservation programs. The proponents, whether government or non-government organisations, should recognize the response differences among possible cooperators of any proposed programs. For example, young and better-educated farmers can easily be encouraged to adopt soil conservation technologies. However, technical assistance and financial support in terms of credit, subsidy, and technical extension are highly important in raising their capacity to invest in erosion abatement technologies to ensure an effective conservation effort. On the other hand, older and less educated farmers need awareness-raising strategies through technology transfer and support programs to help them understand the negative consequences of soil erosion, new farming practices with soil conservation components, and possible gains from new conservation practices.

So far, the choices for appropriate farming technologies in the uplands are still limited. Research on technology development and extension should be oriented towards addressing the upland ecosystem as a whole for more effective soil conservation. At the same time, the farmers should be included in the testing and evaluation of these technologies to allow not only timely adoption but also local adaptation.

Matching the right soil conservation technology with the farmer's immediate needs and objectives calls for a serious commitment on the part of the proponents of the development project, whether government or non-governmental organisations. Targeting the right mix of institutional and economic incentives can serve as a goal and a challenge for designing future conservation technology packages to achieve a truly effective soil conservation program.

Chapter 11

A Socioeconomic Analysis of Adoption of Soil Conservation Practices by Upland Farmers in Cebu City and Claveria

Ma. L.A. Lapar and S. Pandey

THE NEED for measures to halt the continuous degradation of the uplands has never been more urgent than at present. The continuous population pressure forces an increasing number of farmers to move into the upland areas in search of more land to cultivate. Extensive upland farming has been observed to result in serious environmental problems, most notable of which is increased erosion leading to soil infertility, loss of water retention, and low crop yields (USAID 1994). If left unchecked, this could endanger the country's sustainable development.

The soil degradation problem in the Philippine uplands could be the direct result of four major factors (Sajise and Ganapin 1991; Garrity and Sajise 1993), namely, (1) the inadequate technical or social solutions to alleviate poverty and environmental problems in the upland area, (2) the unclear designation of official responsibility for land use in the uplands, (3) the absence of clear titling to sloping public upland areas, and (4) the high level of poverty and illiteracy in upland communities making it difficult to transfer knowledge and provide services for a more sustainable agriculture production.

A number of government projects with funding from international donors have been initiated to introduce and spread hillside conservation farming practices aimed at managing sloping upland soils for sustainable crop production. Programs in agroforestry and watershed management have always had a soil conservation component, e.g. the Integrated Social Forestry Program of the Department of Environment and Natural Resources (DENR) and the Central Visayas Regional Project of the Department of Agriculture (DA). More often than not, these programs provide incentives to farmer-participants as added inducement for them to adopt the suggested soil conservation technology. Some non-government organisations have likewise initiated community development projects with soil conservation components, such as those undertaken by the World Neighbors and the Mag-uugmad Foundation, Inc. While some of these initiatives were able to successfully convince farmers to adopt the soil conservation technology, others were not quite as effective. Apparently, incentives alone do not guarantee a farmer's adoption of a soil conservation technology even if such incentives appear to have increased the adoption rates in several government-sponsored projects. There are a number of socioeconomic factors that affect a farmer's decision to adopt or not to adopt a soil conservation technology.

This study looks at the issue of adoption to be able to determine the various socioeconomic factors that significantly influence the decision of upland farmers to adopt a soil conservation technology. While it looks at soil conservation in general, it focuses on a particular soil conservation technology, the contour hedgerow technology. Hence, adopters as used in the subsequent discussions refer to adopters of contour hedgerows while non-adopters refer to non-adopters of contour hedgerows.

The Research Design and Survey

The Research Design

The research is focused on the socioeconomic factors affecting the adoption decision of upland farmers. The examination of the socioeconomic factors is done while controlling for the effects of population density and market access on adoption. Population density and market access indirectly affect the farmers' adoption decision through their impact on the evolution of farming systems including land-use patterns (see Boserup 1965 and 1981). Population pressure induces more intensified land cultivation in areas with limited land resources, resulting in shorter fallow periods and the subsequent acceleration of soil degradation. Access to markets, on the other hand, provides opportunities for income generation from activities in the market. Hence, the opening up of market opportunities could provide the incentive for more sustainable farming practices including those that could maintain farm productivity.

A matrix of possible survey sites with different population density and market access characteristics was constructed as a guide for survey site selection. As shown in Table 11.1, there are four combinations of population density and market access characteristics, namely, high population density/high market access, high population density/low market access, low population density/high market access, and low population density/low market access. Within each of the cells representing a particular set of characteristics is a possible survey site.

Table 11.1. Matrix of population density-market access characteristics for site selection.

Market access/population density	High population density	Low population density
High market access	Cebu City mountain *barangays*	Claveria, Misamis Oriental
Low market access	Tabayag, Argao	Bayawan, Negros Oriental

High population density/high market access areas are characteristics of peri-urban upland areas where good road networks are present, thus providing the residents in these areas with good access to the urban markets. The easy accessibility of the urban centres to these areas likewise triggers the accelerated migration of people from the urban centres due to congested housing facilities and limited opportunities for unskilled labour, resulting in increasing population density in these areas. High population density-high market access areas are hypothesised to have higher rates of adoption of soil conservation practices. There is more incentive to invest in soil conservation practices when land for farm production becomes scarce due to population pressure and when market opportunities for high-value crops are available.

Areas characterised by low population density/high market access may be considered as transition areas where there are still relatively more land per capita compared to the high population density area. Hence, there is less intensified cultivation of land due to less population pressure. The accessibility of the area to the market may encourage more cultivation of crops that have high market demand. Moreover, being a transition area, population pressure on the land is expected to increase mainly due to migration from the lowlands or from areas with low access to markets. In this case, the rate of adoption of soil conservation practices may be slow, but is expected to accelerate with the increase in population density.

In areas with high population density but with low market access, one is more likely to observe intensified cultivation of the land in response to population pressure. However, with low market access, there is less incentive for more commercial production so that subsistence farming is expected to prevail, with food crops as the major crops produced. Soil conservation practices may be adopted by some farmers in response to problems from land degradation as a result of intensified land cultivation practices.

Areas characterised by low population density/low market access are more likely to be observed with the prevalence of traditional, subsistence farming producing mainly food crops. There may also be less incentive to adopt a soil conservation practice, mainly because of the abundance of land available for cultivation. Hence, traditional open-field farming with fallowing in between cultivation may be the more common practice in these areas.

Ideally, a survey in each site should be done to be able to study adoption in all cases, however, the difficulty of finding suitable sites that meet all the required characteristics and that also have contour hedgerow structures is one constraint. For purposes of the study, the final decision on the sites to be surveyed was based on site suitability and the prevalence of adoption of contour hedgerow technology.

The Survey

Two separate field surveys were undertaken in two sites, namely, Claveria, Misamis Oriental in Mindanao and six mountain *barangays* in Cebu City, Cebu province in Central Visayas. These two sites represented one with low population density/high market access (Claveria) and the other with high population density/high market access (Cebu). The decision to concentrate on these two sites for the field survey was based on the difficulty of finding suitable sites with low market access-high population density and low market access/low population density characteristics, and where contour hedgerows have been constructed by farmers in those areas.

Sixty respondents were interviewed in Claveria, consisting of 39 adopters of contour hedgerows and 21 non-adopters of contour hedgerows. In Cebu, there were 70 respondents interviewed consisting of 35 adopters and 35 non-adopters of contour hedgerows, respectively. Thus, a total of 130 respondents were interviewed from the two survey sites.

A structured questionnaire was used for the field interviews. The survey questionnaire included questions about farmer and household characteristics, farm production including output and inputs, farm and non-farm income sources, soil conservation practices including attitudes and perceptions, and data on contour hedgerow structures for adopters. Interviews with key informants, including local government officials, non-government organisations, and other government agencies engaged in soil conservation were also conducted.

Some Descriptive Characteristics

Farm households

A comparison of farm household characteristics of adopters and non-adopters is shown in Table 11.2. The descriptive statistics indicate that adopters are younger than non-adopters, on average. They are also better educated, live closer to the road suggesting that they have better access to transportation and markets, and a larger proportion of them are members of local organisations like the *alayon* group and/or cooperatives.

In terms of landholdings, adopters operate larger parcels, a larger number of parcels, and larger farm sizes, on average. Their farms are also relatively steeper than the farms of non-adopters, on average. There is also a larger proportion of land owners among adopters relative to non-adopters.

Table 11.2. Farm household characteristics of respondents.

Characteristics	Adopters	Non-adopters
Mean age[a]	45.0 (11.9)	47.2 (12.8)
Mean years in school[a]	6.1 (3.1)	4.2 (3.2)
Mean household size[a]	6.3 (2.7)	6.2 (2.5)
Mean distance of home to the nearest road (km.)[a]	0.47 (0.76)	0.55 (0.82)
Member in local organisation[b]	47.0 (63.5)	12.0 (21.4)
Total no. of parcels operated per household[a]	2.6 (1.4)	2.2 (1.1)
Total area operated per household (hectare)[a]	2.5 (2.8)	2.1 (2.4)
Average parcel size (hectare)[a]	1.0 (0.9)	0.9 (0.8)
Average slope (percent)[a]	29.2 (11.2)	26.7 (9.9)
Tenancy status on parcels operated		
Owner[b]	25.0 (33.8)	13.0 (23.2)
Renter[b]	34.0 (45.9)	35.0 (62.5)
Own and rent[b]	15.0 (20.3)	8.0 (14.3)
Total	74.0 (100.0)	56.0 (100.0)

Note: a - Figures in parentheses are standard deviation.
b - Figures in parentheses are per cent shares to total.
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

Parcels with contour hedgerows

The average parcel size with contour hedgerows is less than a hectare (see Table 11.3). An adopter cultivates about two parcels with contour hedgerows, on average. Total area of farm with contour hedgerows is almost 2 ha per adopter, on average. The average slope of parcels with contour hedgerows is about 30 percent.

Cropping pattern

The adoption of contour hedgerows in the survey sites appeared to have resulted in a change in cropping pattern among the respondents. The majority of adopters of contour hedgerows were observed to follow the food crop/cash crop pattern compared to the food crop/food crop pattern commonly practised by non-adopters. Table 11.4 shows the distribution of type of crops planted on parcels with and without contour hedgerows during the wet[8] and dry[9] seasons. It can be observed that about three-quarters of all parcels with contour hedgerows are planted with food crops during the wet season, but this proportion declines to only about one-third during the

8. Wet season or *panuig* usually starts in May–June and lasts until September–October.

9. Dry season or *buklas* usually starts during October–November and lasts until March–April.

dry season while the proportion of parcels planted with cash crops increases from about one-quarter (wet season) to about two-thirds (dry season) of all parcels with contour hedgerows. Among parcels without contour hedgerows, the majority of parcels are planted with food crops during both the wet and dry season. The shift from food crops to cash crops among adopters during the dry season suggests that the production of cash crops must be a profitable undertaking, providing them with adequate income to enable them to purchase food rather than produce them. Additionally, for some adopters, the wet season production of food crops may have provided them with enough output to sustain their food requirements for the entire year.

Table 11.3. Selected characteristics of parcels with contour hedgerows.

Characteristics	Average for all adopters
Parcel size (ha)	0.80 (3.5)
No. of parcels per adopter	1.8 (1.0)
Total area with contour hedgerows per adopter (ha)	1.61 (1.37)
Slope (per cent)	29.7 (10.6)
Height of the riser (metre)	0.8 (0.5)
Width of the hedgerow (metre)	1.3 (0.6)
Length of contour hedgerow per hectare contoured (metre per hectare)	1,282.3 (868.9)
No. of years of practice of the technology	8.1 (6.9)
Labour person-days for construction (person-days per ha)	33.25
Labour person-days for maintenance (person-days per ha)	5.31

Note: Figures in parentheses are standard deviations.
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

Table 11.4. Distribution of type of crops planted on parcels with and without contour hedgerows.

Type of crops planted	CH parcels		Non-CH parcels	
	Wet season	Dry season	Wet season	Dry season
Food crops (corn and rice)	89 (73.6)	43 (34.7)	97 (74.6)	85 (65.9)
Cash crops (vegetables and cut flowers)	32 (26.4)	81 (65.3)	33 (25.4)	44 (34.1)
Total	121 (100.0)	124 (100.0)	130 (100.0)	129 (100.0)

Note: Figures in parentheses are per cent shares to total.
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

Factors Affecting the Adoption of Soil Conservation

Factors Affecting Adoption

A number of variables are hypothesised to affect the farmer's decision to adopt a soil conservation technology. These variables are classified into four categories, namely, personal factors, economic variables, institutional factors, and the degree of soil erosion potential (see Ervin and Ervin 1982).

The effect of age of the farmer on adoption decisions can be taken as a composite of the effects of farming experience and planning horizons. While more farming experience as equated with older farmers is expected to have a positive effect on adoption, younger farmers, on the other hand, may have longer planning horizons (i.e. a lower discount rate) and may be more likely to invest in a conservation technology like the contour hedgerows. Hence, the effect of age on adoption cannot be determined a priori. Hoover and Wiitala (1980) found in their study of Nebraska farmers that age had a significant negative influence in the farmer's adoption decision.

Higher education levels should be associated with greater information on conservation measures and the productivity consequences of erosion, and higher management expertise (Ervin and Ervin 1982; Hoover and Wiitala 1980; Feder et al. 1985). As a human capital variable, education was also found to positively affect the efficiency of a farmer's adoption decision (Rahm and Huffman 1984). Hence, adoption is hypothesised to be positively correlated with the farmer's education level.

Membership in a local farmers' organisation is posited to have a positive effect on the adoption of a soil conservation technology. Community or farmer organisations have been found to be effective in providing follow-up support (USAID 1994) to farmer-members. Membership in such organisations not only provides additional labour but also entails a training component which benefits farmer-members. Indeed, Sajise and Ganapin (1991) contend that the presence of mechanisms for group labour is a factor that contributes to the increase in adoption of conservation measures. In the case of contour hedgerow adoption, the availability of exchange labour in *alayon* groups could relax the labour constraints in the construction of the contour hedgerow structures. Gabunada and Barker (1995) indeed found that membership in the *alayon*[10] group has a significant positive effect on the probability of adoption of contour hedgerow adoption in Leyte, Philippines.

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[10]. *Alayon* groups are local organisations composed of farmers who get together to provide labour to members, under the principle of reciprocity, in the construction of contour hedgerows. It takes about 35–45 person-days to complete the construction of contour hedgerows on an average parcel of 0.8 ha.

Household size is an indicator of the availability of family labour. It is posited that adoption is more likely with larger household size since there is more available labour to provide assistance in farm work and in the construction and maintenance of soil conservation structures.

Household income can come from both farm and non-farm sources and the proportion of each income source to total income could affect adoption in an ambiguous manner, a priori. For example, while a higher level of household income is hypothesised to positively affect the adoption decision of farmers because of less financial constraints to adoption, if the proportion of non-farm income to total income is larger, then the opposite effect may predominate. With more time spent on non-farm activities, farmers may allocate less time and effort for implementing soil conservation practices. On the other hand, if non-farm income largely comes from remittances and other non-labour intensive activities, it is possible that this could have a positive effect on adoption.

The total area of the farm operated is hypothesised to have an ambiguous effect on the adoption decision of farmers. With a larger landholding, the loss of planting area for contour hedgerows is small relative to a farmer with a much smaller landholding.[11] Hence, farmers with larger farms are more likely to adopt the technology than farmers with smaller farms. On the other hand, farmers with larger landholdings may choose not to invest in soil conservation but instead follow a more extensive land use strategy.

The effect of tenure status, specifically that of insecure property rights, has often been argued to discourage farmers from engaging in conservation practices that have longer time periods because they may not be able to reap the long-run benefits (Ervin 1986; Feder and Onchan 1987). However, equating land titles with secure tenure and thus with increased investment is too simplistic (Lutz et al. 1994). In fact, ownership may not be as significant a factor in soil conservation decisions as is sometimes thought, as suggested by the findings of studies on conservation practices by farmers in Central America (Lutz et al. 1994) and in the Philippines (USAID 1994). Place and Hazell (1993) also found that legal land rights were not significant determinants in African farmers' decision to undertake land-improving investments. These results suggest that, while ownership of the land is an enabling factor to conservation, it is not a sufficient condition.

Credit effects on adoption decisions may be rationalised under two opposing effects. On the one hand, the lack of credit limits the ability to finance the required conservation investments. On the other hand, the fungibility of cash credit may induce farmers to use the funds for household consumption or for other activities that are

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11. Loss in cultivable area due to contour hedgerows is estimated to range from 10–20% (see Lutz et al. 1994; Cenas and Pandey 1995; and Nelson et al. 1996, for example).

perceived to generate larger returns in a much shorter time than investments in soil conservation like contour hedgerows. In this case, consumption or other investment activities will substitute for the use of credit for investment in contour hedgerows, suggesting a negative effect on the likelihood of adoption. Hence, the effect of credit on adoption is ambiguous, a priori.

Access to technical assistance and extension services are believed to positively affect adoption. Farmers who have access to extension offices and/or workers are more likely to obtain information on the benefits of soil conservation and the available conservation technologies being promoted. A study by USAID (1994) of the Sloping Agricultural Land Technology (SALT) in the Philippines found that where farmers have exposure to effective training programs, they adopt and continue to follow conservation farming practices; and where training is less effective, so is the adoption. Involvement in government farm programs and the frequency of contact with extension and conservation agents are also among the factors shown to affect participation in soil conservation programs in the United States (Napier 1989).

Access to markets provides the farmer with opportunities for income-earning activities. Thus, there is more incentive for the farmer to ensure that farm productivity is improved or at least maintained in order to take advantage of market opportunities. Farmers who are generating good returns from the production and sale of crops that are in great demand in the market may therefore find soil conservation economically attractive (Clarke 1992). This suggests that access to markets is more likely to be positively correlated with adoption.

Slope is an indicator of the likelihood of erosion in the land. The steeper the slope, the more likely it will be subject to erosion. Hence, farmers cultivating farms with steeper slopes are more likely to undertake a soil conserving measure than a farmer whose farm is relatively flat.

Farmers' perception of the degree of erosion could determine conservation response. Farmers who perceive soil erosion to be a problem in their farm are more likely to undertake a conservation measure. Lynne et al. (1988) found that farmers who perceived their land to be highly erodible generally expended more conservation effort. Hence, the greater the degree or extent of erosion perceived, the more likely the adoption of a soil conserving measure.

The Empirical Results

Two separate Probit equations were estimated for each site after an F-test conducted on the data set turned out significant for the null hypothesis of no structural differences between the data from the two sites. The results of the Probit estimation are shown in Table 11.5.

Table 11.5. Probit estimates of the likelihood of adoption.

Variable	Claveria		Cebu	
	Coefficient	Chi-Square	Coefficient	Chi-Square
Constant	–0.88	1.19	–0.82	1.25
Age of household head	–0.40	1.45	–0.24	1.04
Household size	0.03	0.15	0.03	0.07
Education (years)	0.09	0.12	0.76	7.47***
Tenure (dummy)[a]	1.20	3.51*	0.33	0.42
Member (dummy)[b]	5.05	2.38E–9	0.98	1.73
Farm size (hectare)	–0.06	0.09	0.70	4.47**
Slope (per cent)	0.88	6.54***	0.47	3.07*
Erosion (dummy)[c]	–	–	1.12	2.49
Non-farm income	–0.22	0.71	0.77	5.28**
Livestock income	0.13	0.18	0.67	4.18**
Extension (dummy)[d]	0.45	0.94	–	–
Distance from the road	–0.58	3.11*	–0.66	2.17
Strip cropping (dummy)[e]	0.48	0.65	0.99	4.62**
Fallow (dummy)[f]	–0.08	0.03	–	–
Credit (dummy)[g]	–	–	0.07	0.02
–2Log Likelihood ratio	52.21		50.96	
Probability of adoption	0.61 (0.27)***		0.50 (0.37)***	

Note: *** Significant at the 1% level, ** Significant at the 5% level,* Significant at the 10% level.
a – 1 for owner, 0 otherwise
b – 1 for *alayon* member, 0 for coop member
c – 1 for observed, 0 otherwise
d – 1 for those with access, 0 otherwise
e – 1 for those practising, 0 otherwise
f – 1 for those practising, 0 otherwise
g – 1 for those who obtained, 0 otherwise
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

Adoption in Claveria is significantly influenced by tenure status, slope, and access to markets. The results suggest that a farmer who owns the farm, has better access to markets, and operates a farm with steeper slope, is more likely to adopt the contour hedgerow technology. All the other variables except for farm size, have the expected signs although they turned out to be statistically not significant. Farm size, while not statistically significant, has a negative sign, implying that the likelihood of adoption decreases as farm size increases. The fallow dummy variable also has a negative sign, implying a substitute practice to the contour hedgerow technology. The likelihood of adoption in Claveria is estimated at 61% on average and this is statistically significant at the 1% level.

For Cebu, adoption is significantly influenced by education, farm size, slope, non-farm income and livestock income, and the practice of strip cropping.[12] The results indicate that biophysical considerations like slope and the size of landholding have positive influences on the likelihood of adoption. Education is also a positive influence on adoption and this is consistent with the results of Ervin and Ervin (1982) and Rahm and Huffman (1984). Both non-farm income and livestock income positively affect the likelihood of adoption. This is particularly true for livestock raising which benefits from the contour hedgerow technology through the use of fodder species such as *Setaria sphacelata* and *Gliricidia sepium* as hedgerow species.[13] The practice of strip cropping is also shown to be a complementary conservation practice as those farmers who practice strip cropping are also more likely to adopt the contour hedgerow technology. This is probably because the adoption of contour hedgerows also allows multi-cropping of different types of crops. The likelihood of adoption in Cebu is estimated at 50% on average and is statistically significant at the one percent level.

While the Probit estimates give indications of the factors that affect the likelihood of adoption, they do not indicate the factors affecting the extent of adoption for those who actually adopt the technology. In the case of contour hedgerow adoption, this would necessitate the estimation of the expected area contoured for adopters. This issue is addressed by estimating Tobit equations for each site, with area contoured as the dependent variable. The estimated Tobit equations are shown in Table 11.6. The squared term of the loan variable was included in the empirical model to capture the possible nonlinear relationship between this variable and the extent of adoption of contour hedgerows.

For Claveria, the extent of adoption is significantly influenced by tenure status, slope, access to markets (as indicated by the distance of the homestead from the nearest road), and the amount of loans received which is an indicator of access to credit. Farmers who own their farms, cultivate steeper farms, and have more access to markets and credit would have a larger area contoured. The extent of adoption in Cebu, on the other hand, is significantly influenced by the education of the farmers and slope of the farm. Hence, farmers with more schooling and who are cultivating farms with steeper slopes are more likely to construct contour hedgerows on a larger area of their farm.

It is estimated that farmers who are actual adopters in Claveria will contour an area of almost 2 ha, which is about 66% of the average farm size of adopters, while in Cebu the expected area contoured is about 2 ha, which is about 96% of the average farm size of adopters (Table 11.7). An average farmer in Claveria is expected to

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12. This is a practice wherein crops are planted across the slope of the farm. In most cases, multi-cropping is undertaken, i.e. different kinds of crops are planted in alternating strips along the contour of the farm.

13. Survey data shows that adopters raise more livestock than non-adopters, i.e. adopters have an average of 1.8 heads compared to about 1.2 heads for non-adopters.

contour about 0.75 ha or approximately 23% of the average farm size in that particular area, while farmers in Cebu are expected to establish contour hedgerows on about 0.66 ha and this is approximately 38% of the average farm size in that particular area (Table 11.7).

Table 11.6. Tobit estimates of the extent of adoption.

Variable	Claveria		Cebu	
	Coefficient	Chi-Square	Coefficient	Chi-Square
Constant	–0.267	0.076	–5.773	5.558**
Age of household head	–0.004	0.040	0.009	0.126
Education (years)	–	–	0.326	6.712***
Household size	0.0006	0.00009	0.109	0.707
Member[a]	–	–	0.884	1.141
Tenure status (dummy)[b]	0.850	4.976**	0.937	2.038
Slope (per cent)	0.047	6.800***	0.051	2.700*
Non-farm income	–0.008	1.548	0.016	1.730
Livestock income	–0.002	0.106	0.022	1.913
Distance from road (km)	–0.416	4.351**	–1.221	1.106
Discount rate	–	–	–0.001	0.020
Loan (in 000's)	0.033	8.353***	–	–
Loan squared	–0.00007	3.477*	–	–
2Log likelihood	151.56		189.11	

Note: *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level
a - 1 for alayon member, 0 for coop member b - 1 for owner, 0 otherwise
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

Table 11.7. Expected area contoured.

	Claveria	Cebu
Expected area contoured for those who are actual adopters (in hectare)[a]	1.84 (0.66)	2.08 (0.96)
Expected area contoured by an average farmer (in hectare)[b]	0.73 (0.23)	0.68 (0.38)

[a] Computed as $E(y) = x\beta\Phi(x) + \sigma\phi(x)$ where $\Phi(x)$ is the cumulative distribution function and $\phi(x)$ is the probability density function. (McDonald and Moffitt 1980).
[b] Computed as $E(y^*) = x\beta + \sigma[\phi(x)/\Phi(x)]$ where $E(y^*)$ is the expected area contoured for those who are actual adopters (McDonald and Moffitt 1980).
Note: Figures in parentheses are per cent shares of average farm size.

The Impact of Contour Hedgerow Adoption

On Corn Yield

The impact of adoption of contour hedgerows on corn production is analysed using the production function approach. A Cobb-Douglas production function is estimated using data from 150 parcels with and without contour hedgerows. The model is specified using the logarithm of corn yield in kilograms as the dependent variable and the logarithm of labour and fertiliser as independent variables, including dummy variables for corn variety, season, location, and the presence or absence of contour hedgerows on the plots where data were obtained. Labour is measured in person-days and fertiliser is measured in kilograms of nitrogen.

The adoption of contour hedgerows is hypothesised to have an impact on corn yield when the dummy variable for contour hedgerows shows a positive coefficient. The estimated coefficients of the production function are shown in Table 11.8. The results show that labour and fertiliser inputs have statistically significant positive effects on corn yield and these are consistent with theoretical expectations. Corn variety and location also have statistically significant positive effects on corn yield. The hypothesis that contour hedgerows have a positive effect on yield is not rejected at the five percent level. The statistically significant positive coefficient of the dummy variable for contour hedgerows indicate that plots with contour hedgerows are expected to have larger corn yield than plots without contour hedgerows. The yield gap between plots with and without contour hedgerows can be observed in the computed values of expected yield using the mean values of the continuous variables and the dummies taking the value 1 in the production function (Table 11.9). The expected yield values show that plots with contour hedgerows have larger output than plots without contour hedgerows, holding all other variables constant.

Table11.9. Expected corn yield (kg/ha) from production function estimation.

Location	With contour hedgerows	Without contour hedgerows
Claveria	1510	954
Cebu	584	369

Note: Estimates were derived using the mean values of the continuous variables in the production function and the dummies taking the value 1.
Source: Table 11.5.

On Profitability

While the production function estimates show the positive productivity gap between adopters and non-adopters of contour hedgerows, there is a need to determine whether the estimated increase in corn yield from contour hedgerow adoption is sufficient for a profitable corn production. This could be determined through a cost-benefit analysis of the corn production with contour hedgerows compared with production without contour hedgerows. Assuming the corn production technology is unchanged with and without contour hedgerows implying constant costs, the additional costs due to contour hedgerow adoption would come from the additional labour person-days required to construct the hedgerows as well as the loss in corn yield from the area planted to hedgerow species. This loss in yield is estimated to range from 15–20% of yield per hectare without contour hedgerows (Nelson et al. 1996). Using these cost estimates, the yield increase needed for a farmer to break-even under a reasonable internal rate of return (IRR) is calculated. The IRR used for the calculations was 40% which is the shadow cost of capital in the uplands (Nelson 1996). Cost estimates were done only for the first five years as the majority of upland farmers have very short planning periods so that projections beyond five years may not be important in their point of view. The yield estimates are shown in Table 11.10.

Table 11.8. Estimated coefficients of the Cobb-Douglas production function for corn.

Variable	Coefficient	Standard error
Constant	4.31	0.44***
Log of labour person-days	0.26	0.08***
Log of fertiliser kg	0.14	0.04***
Contour dummy[a]	0.46	0.18**
Corn variety dummy[b]	0.47	0.14***
Season dummy[c]	0.15	0.13
Location dummy[d]	0.95	0.18***
Contour*location[e]	–0.66	0.24***
Adjusted R^2	0.29	
F-value	9.67***	

Note:
[a] – 1 for plots with contour hedgerows, 0 otherwise.
[b] – 1 for modern variety, 0 otherwise.
[c] – 1 for first season, 0 otherwise.
[d] – 1 for Claveria, 0 for Cebu.
[e] – interaction term for contour and location dummy variables.
*** significant at the 1% level.** significant at the 5% level.
Source of data: IRRI socioeconomic survey of upland farmers, 1996.

The yield estimates indicate that for farmers in Cebu, they need to obtain a yield increase of more than 300 kg/ha for them to break-even at a discount rate of 40%. Comparing this yield increase with the expected additional yield from adoption of contour hedgerows which is about 200 kg/ha (Table 11.9), it is evident that the expected productivity gain from hedgerow adoption is not sufficient to cover the additional costs incurred in adoption. In the case of Claveria, farmers need to obtain an additional corn yield of about 500 kg/ha which is just about the same as the expected yield increase with hedgerow adoption. Hence, it is shown that in both cases, the expected yield from hedgerow adoption is not enough or barely enough to cover for the additional costs incurred with adoption. These results suggest that while the adoption of contour hedgerows may result in positive productivity effects in terms of yield increase, the expected yield increase may not be sufficient to cover the substantial costs incurred due to the additional labour required for construction as well as the yield loss due to the area taken up by the hedgerow species. These additional costs are quite substantial and the adoption of the technology does not appear to be economically feasible, given the estimated yield increase from adoption compared with the yield increase required to break-even.

Table11.9. Expected corn yield (kg/ha) from production function estimation.

Location	With contour hedgerows	Without contour hedgerows
Claveria	1510	954
Cebu	584	369

Note: Estimates were derived using the mean values of the continuous variables in the production function and the dummies taking the value 1.
Source: Table 11.5.

Table 11.10. Costs and benefits of contour hedgerow adoption.

Increase in corn yield to break-even	Discount rate	Year	Costs in kg of corn	
			Const. & maint.	Yield loss in CH area
Claveria:				
479	40%	1	283	191
		2	142	191
		3	142	191
		4	142	191
		5	154	191
Cebu:				
333	40%	1	283	74
		2	142	74
		3	142	74
		4	142	74
		5	142	74

Conclusion

The empirical results show that certain socioeconomic variables significantly affect the likelihood and the extent of adoption of a soil conservation technology in the uplands of the Philippines. For example, biophysical factors like slope and perception of the incidence of soil erosion are positive influences on the likelihood and extent of adoption. Hence, targeting conservation programs to areas that are highly eroded and/ or have high potential of degradation would be an effective strategy. In addition, there is merit in increasing the farmers' awareness of soil erosion and its consequences, as well as the provision of information on the most effective soil conservation practices for farms with certain topographic and slope characteristics.

Ownership of the land did show up to be a positive and significant influence of adoption in Claveria but not in Cebu (although it exhibited a positive sign). This suggests that the effect of tenure status could be site specific. It appears that ownership of the land may not be the issue in Cebu but rather the security of access to the land. It was observed that while the majority of farmers are non-owners in Cebu, they do have security of access and land use. Recent government policy changes have provided non-owners who cultivate public lands the opportunity to obtain a Certificate of Stewardship Contract on the land they cultivate, which may ultimately grant them the right to own the land (USAID 1994).

Liquidity constrained households may be induced to increase their likelihood and extent of adoption if the liquidity constraint is relaxed, for example, by improving their total income through the promotion of income-generating non-farm and complementary activities or by improving the state of rural financial markets in order to make access to credit easier and loan rates more affordable. The need to improve the state of rural financial markets in the uplands appears to be justified in this context.

Access to markets also appears to be a significant positive influence in the extent of adoption. This suggests that improvement of rural infrastructure like roads and the establishment of marketing institutions could act as accelerators to the adoption process.

Productivity gains in terms of increased corn yield are also shown to have resulted from the adoption of contour hedgerows. However, cost-benefit calculations indicate that the expected yield increase may not be sufficient to compensate for the additional costs incurred by adopting the technology. Research should be directed at finding ways to substantially lower these costs to make the technology more economically feasible to adopt by upland farmers.

Chapter 12

Evaluation of Soil Conservation Technologies: A Summing Up

R.A. Cramb

THE TASK of Project 1992/011 was to conduct a socioeconomic evaluation of soil conservation technologies for upland farming systems in the Philippines. This chapter attempts a summing up of the evidence and considers some of the implications for research and policy. First it is necessary to revisit some conceptual issues in light of the observations and analysis reported in the preceding chapters.

Issues in Technology Evaluation

What is Being Evaluated?

The first issue relates to the question: What precisely are we evaluating? This question arises because technologies can be described along at least three dimensions, and our evaluation of them will depend on how we specify these dimensions.

First, a 'soil conservation technology' is a complex entity (a system) which can be viewed at many levels. For example, Sloping Agricultural Land Technology (SALT) is in fact an entire cropping system comprising many sub-systems or component technologies, including the method and pattern of laying out the field, the selection, establishment and management of hedgerow species, the tillage system, the pattern and rotation of crops in the alley, and so on. As well as evaluating the entire system, each of these components can be evaluated separately, which is precisely what farmers do when they selectively adopt elements from the overall system.

Second, a 'soil conservation technology' can also be viewed at various developmental stages (Figure 12.1). In Chapter 2 reference was made to three stages of technology development: notional, preliminary, and developed (Anderson and Hardaker 1979); or experimental, prototype, and off-the-shelf (Scherr and Muller 1991). The point was made that technology is only fully developed when it is incorporated in a specific, operational farming system. The tools and criteria for evaluation vary with each of these stages.

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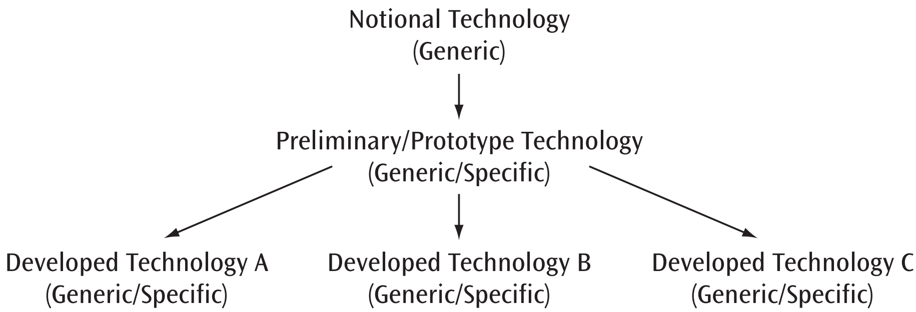

Figure 12.1. Stages of technology development.

The three stages of technology development are clearly evident in Harold Watson's first-hand account of the development of SALT (Partap and Watson 1994, pp. 29,30):

> Obviously, a farming technology that could conserve the topsoil and, if possible, improve its fertility and productivity was needed for these uplands [of Mindanao]. Recognising this problem, from 1971 the [Mindanao Baptist Rural Life Centre] started to *conceptualise* a system now known as Sloping Agricultural Land Technology, or SALT. After testing different intercropping schemes and observing *Leucaena*-based farming systems, both in Hawaii and at the Centre, efforts to develop the first-ever SALT *prototype* model commenced in 1978…. By 1980, MBRLC had acquired the confidence that SALT could fulfil the objectives adequately. But, it took about four more years of testing and refining before SALT could be *heralded as 'applicable'*… [emphasis added].

Partap and Watson recognise that the developed form of the technology has been modified and adapted to suit individual farmers' conditions; in fact, they state that 'on-farm experimentation with SALT is an essential element …' (1994, p.91).[14]

A third way of analysing a technology is to distinguish between its generic and specific aspects (Figure 12.1). This does not exactly correspond to the notional/ developed distinction emphasised by Ashby (1991). For example, SALT in both its prototype and developed forms is a specific technology — with a specific field layout, hedgerow system, cropping pattern, etc. In this sense the technology is applicable to a particular set of farm conditions, i.e. it is location-specific (Menz and Knipscheer 1981). However, this same technology has generic aspects which are of much wider applicability, for example the principle of contour hedgerows. In evaluating the technology this distinction must be kept in view — a specific form of the technology may turn out to be inappropriate in a given location, but the generic technology may

[14] Watson's account also illustrates well the 'multiple-source' model of agricultural innovation (Biggs 1990).

still be applicable. Having tried the specific form of the technology, farmers may take these generic principles and apply them to develop alternative specific technologies which are more applicable. The Claveria story (Fujisaka 1993; Garrity et al. 1998, 1999), where farmers abandoned contour hedgerows of shrub legumes and reverted to natural vegetative strips, illustrates this (see Chapter 8). In almost all of the case study sites studied in Project 1992/011 a similar process of adaptation had occurred (Chapters 4–7).

The question whether it is a better extension strategy to promote generic technology rather than a specific prototype is an open one (though, as discussed in Chapter 2, most upland projects follow the latter approach). The answer will depend on how farmers learn. There is certainly evidence that farmers respond more readily to a fully worked example (such as SALT) than a set of ideas or principles, provided the specific form is not promoted inflexibly (e.g. with sanctions for 'deviations' from the blueprint or 'poor adoption'). Farmers in various circumstances are then in a position to use the technologies as 'raw material' in their own routine 'experimentation' (Chapter 2; Sumberg and Okali 1997). If this is the case it addresses the concern expressed by Menz and Knipscheer (1981) that the opportunity cost of developing location-specific technology may be too high. This point is taken up again below when considering different sequences and pathways of adoption.

At one level in Project 1992/011 we have been evaluating a range of specific, developed soil conservation technologies, many of them based on the SALT prototype. These technologies have been developed and adapted by farmers and project staff in the process of implementing them in specific locations. At another level, however, the focus has been on evaluating a generic technology with potentially widespread application, namely contour hedgerows, or even more generally, contour farming. These two levels of evaluation need to be kept in mind in the discussion which follows.

Criteria for Technology Evaluation

In evaluating the economic impact of a new technology we need to examine at least two components: the net benefits to society when the technology is adopted, and the rate of adoption. A technology with high potential net benefits but a low rate of adoption must score poorly in any economic evaluation. In this project we have not attempted to measure the net benefits *to society* of soil conservation technologies. However, the evidence suggests that contour hedgerows are privately profitable in many cases, and if a social rate of discount was applied and off-site benefits taken into account it is likely that substantial net benefits to society would be identified (Chapter 7).

The main focus here has been on the rate of adoption, because regardless of whether the net benefits of adoption are high or low, if the rate of adoption is low, the technology cannot rate highly in terms of its aggregate impact. This focus is also consistent with the farming systems perspective outlined in Chapter 2 in that it gives priority to farmers' goals and circumstances in evaluating a technology. What has the project found regarding the rate of adoption?

Adoption of contour hedgerows and other soil conservation practices is occurring in the Philippines, but at a very slow rate. The low rate of adoption may of course represent the early segment of the classical S-shaped adoption curve. However, this seems unlikely. We are simply not dealing with a technology which 'spontaneously diffuses' through a target population, like hybrid maize. The adoption process begins with a project intervention in a particular upland location. Potentially these upland projects become 'nodes of diffusion' for soil conservation technologies. However, *within* project sites the adoption process is problematic — it is mainly better-off farmers who adopt, and there is a high incidence of post-project discontinuance in many sites. *Beyond* project sites there is little or no evidence of diffusion, even within the immediate location, unless there is ongoing intervention to facilitate adoption. There are vast areas of the uplands without such well-resourced projects or programs to initiate and sustain adoption.

Given the importance of adoption as a criterion for technology evaluation, Project 1992/011 has given considerable attention to investigating the various factors affecting the rate of adoption of soil conservation technologies. These can be summarised as follows:

- attributes of the technology (which together determine its 'adoptability');
- the economic environment;
- the social environment; and
- the institutional environment.

These factors provide a convenient set of headings for summing up the evidence reported in previous chapters regarding the suitability of contour hedgerows and other soil conservation measures for the Philippine uplands.

Attributes of the Technology

Rogers (1995) outlines five attributes which have been found to influence the rate of adoption of a technology: relative advantage, compatibility, trialability, observability, and complexity. In considering these attributes it is useful to compare contour hedgerows, the main conservation technology promoted, with seed-fertiliser technology for maize, which was also in the process of being taken up in many of the study sites. Hybrid maize provided considerable relative advantage to farmers in the form of higher yields and net returns, within one crop season; the technology was compatible with existing cropping systems which were already based on maize; it was eminently trialable in that farmers could plant part of their field with hybrid maize and part with their traditional variety, or plant hybrid maize in one season and their traditional variety the next; the yield impact was readily observable to farmers in the vicinity; and the technology package was simple to implement, merely involving a change in the variety of an existing crop and the purchase of additional fertiliser. Partly as a consequence of these attributes, the adoption of hybrid maize was extensively promoted and financed by private agencies. While not minimising the potential problems associated with hybrid maize, the contrast with conservation technologies is readily apparent in what follows.

Relative advantage of conservation technologies was assessed primarily in economic (benefit-cost) terms. The benefits included the maintenance of crop yields, increased effectiveness of fertiliser applied, greater ease of land preparation, and, in the case of hedgerows, the provision of by-products such as fodder or fuelwood (Chapter 5). The main costs were the land foregone to conservation structures and the labour required to establish and maintain them.

Did the farmers realise positive net benefits? The evidence obtained from both modelling and surveys suggests that, in the case of hedgerow intercropping, they did, particularly where the soil was eroding rapidly, where land was scarce, and where crops had a high market value (Chapters 6, 8, and 11). However, for many farmers with high discount rates and short planning horizons the benefits of the recommended technology package took too long to be realised. Alternative forms of hedgerow intercropping, such as natural vegetation and grass strips, were found to be more attractive to such farmers than hedgerow intercropping with shrub legumes, primarily because of reduced establishment and maintenance costs. Similarly, as discussed in Chapter 5, farmers modified specific hedgerow recommendations (e.g. increasing the spacing) to make the technology more profitable in the short term.

In the case of bench terraces with rock walls, as encountered at Tabayag, Argao, in Cebu, high initial investment of labour for terracing and rock-wall construction was rewarded in the long term (perhaps up to 10 years) by significant improvements in net returns due to higher yields and reduced input costs (Chapter 10). However, as with hedgerows, high discount rates and short planning horizons, and (specific to rock-wall terraces) a lack of young male labour in the household, all mitigated against adoption of this form of technology.

Farmers also considered the variability of net benefits, or risk, associated with adoption of recommended conservation measures. Shively (Chapter 10) found that hedgerows reduced production risk (as measured by yield variance), the more so the longer they were in place, though yield variance increased as hedgerow intensity increased (another reason for farmers to opt for wider spacing). Nelson (1996) also found that, at low discount rates (10%) and over long planning horizons (25 years), hedgerow intercropping showed first-order stochastic dominance over open-field maize farming, meaning hedgerows would be preferred regardless of farmers' attitudes to risk.

However, in particular contexts, downside risk may have been the overriding factor. For example, at Guba, with heavy clay soils, hedgerows created a drainage problem during unusually wet seasons. This prevented adopters from planting their maize crop, making them considerably worse off than non-adopters in those seasons. Subjective risk may also have been a factor, at least initially, due to farmers' uncertainty about the long-term impacts of hedgerows and other conservation measures. This uncertainty was progressively reduced as farmers gained experience with the technologies, both directly and by observing their neighbours.

The technologies were *compatible* with the needs and priorities of upland farmers in that they contributed to the long-term production of food for the household and the generation of cash income. However, they were not always compatible with farm-level resource constraints — where land was scarce the loss of perhaps 20% of cultivable area to conservation structures was a significant short-term cost; where labour was scarce, the diversion of family labour to establish and maintain conservation measures had too high an opportunity cost, particularly in the planting season. This was compounded for households with limited working capital or farm cash income, in that use of family labour off-farm to generate cash income limited the availability of labour for on-farm investments.

Relatedly, the technologies were not always compatible with the existing farming system. Of course, adoption of new technology necessarily implies a process of farming system development, so initial incompatibility is not necessarily a problem. However, it was clear that hedgerow and terrace technology were incompatible with shifting or short-fallow systems, particularly where fire was used, but were potentially compatible with annual or multiple cropping systems.

The *trialability* of the technologies varied considerably. Contour hedgerows could certainly be implemented by a single farmer on just one plot or part of a plot, leaving open the possibility of expanding the area under hedgerows if the trial proved promising. Some farmers initially put in just one hedgerow across the middle of the plot. Bench terraces required more of a commitment on a larger scale to be worthwhile. Water-diversion technologies, involving the construction of canals and waterways for several farms on a mini-catchment basis, were even less capable of small-scale testing, hence were rarely implemented.

In a superficial sense hedgerows and terraces rated well on *observability* in that they involved a highly visible change to the landscape. Even so, many sites were tucked away in remote villages in the upper reaches of watersheds and were not visited by many farmers, except where farm tours were organised. Moreover, the 'software' used to produce the visible 'hardware' in the field was not easily observed. For example, the use of the A-frame to mark out contour lines, and the techniques for the successful establishment and maintenance of shrub legumes, required hands-on training over a period of time. Farmer-to-farmer training in small groups proved to be the most effective means of communicating these aspects of conservation technologies (Chapter 7).

The generic technology (contour farming) was not inherently *complex*. However, the specific forms of technology promoted (e.g. SALT) were highly complex, in at least two senses. First, they were complex to implement. Farmers had to acquire a range of new skills and to proceed through many stages, from field layout and hedgerow establishment through to management and ultimately re-establishment of hedgerows. Second, the technologies had complex impacts over time, both at the field level (soil erosion, soil moisture, organic matter, fertiliser efficiency, crop yields, etc.) and at the level of the farming system (labour profiles, input requirements, crop-livestock interactions, etc.) (Chapters 5 and 6). This made it hard for both farmers and researchers to observe and assess the impacts.

The Social Environment

The rate of adoption and diffusion of soil conservation technologies is also affected by the social environment of upland farmers. The term 'diffusion' is often taken to imply steady communication from person to person within an entire population of prospective adopters. However, farm-households in the Philippine uplands are clustered into relatively small communities. The primary communities are smaller than a village (*barangay*) and sometimes smaller than a sub-village (*sitio*). They comprise small clusters of close kin and neighbours in a single hamlet (*purok*). Sometimes such clusters comprise a single church congregation, perhaps of a different denomination to neighbouring clusters (e.g. Sitio Pananag in Davao del Sur). Traditionally, farmers living together in a given cluster or hamlet also exchange labour in small work groups (termed *alayon* in Cebuano-speaking areas).

Within these primary communities there is a high degree of interconnectedness, but between communities the level of interaction falls away rapidly. Beyond the hamlet there is at best a low degree of connectedness and communication and, at worst, factionalism, suspicion and even conflict (e.g. Magdungao in Iloilo, where clan-based factions undermined the prospects for an on-going community-based conservation program). Beyond the *barangay*, communication is almost non-existent, the major exception being the group of *barangay* surrounding Guba in the hinterland of Cebu City, where a good road network and longstanding interaction facilitated the dissemination of contour hedgerow technology by farmer-extensionists of the Mag-uugmad Foundation (Chapter 4).

Because of this low level of interaction beyond the primary community, there is little communication of the details of soil conservation technologies. A notable historical example is the 100-year-old *balabag* system in Barangay Nalaad, Cebu, in which *Leucaena leucocephala* is cut to make barriers across the slope during a five-year cropping period, then replanted and allowed to grow during a five-year fallow period (Garcia et al. 1995a). This system has not diffused to neighbouring communities in the same valley, except through intermarriage. In the case of SALT and other conservation farming projects studied, it was found that neighbours outside the project might observe the contour hedgerows and perhaps seek to mimic them on their own farms, but would not readily seek or obtain technical advice or planting materials from the original adopters.

This has implications for extension strategies. It is clearly important for government and non-government extension agencies to work closely with farming communities, but it cannot be assumed that larger *barangay*-level organisations (cooperatives, farmer associations) will necessarily be effective, especially without ongoing support. Surveys found repeated evidence of the demise of such organisations following the withdrawal of project staff and inputs (e.g. in Magdungao and Salogon), potently symbolised by dilapidated signs and project buildings and abandoned nursery sheds.

Collective action, including participation in farmer cooperatives and associations, has costs as well as benefits, and the incentive for free-riding increases as the group gets larger and more complex (Johnston and Clark 1982). This may account for the demise of most community nurseries in the projects studied. Successful collective action occurred at the level of the primary community or below. In particular, farmer working groups or *alayon* proved to be the most effective unit for mobilisation, training, labour exchange, provision of inputs, and injection of credit.

The Economic Environment

The scarcity of land was an important economic factor affecting the appropriateness of recommended conservation technologies. Where land was relatively scarce (in quantity and quality) and therefore more valuable, there was greater incentive to develop it. For example, in Tabayag, Cebu, farmers invested heavily in terracing, constructing rock walls, and planting hedgerows on their small degraded plots as this provided their only basis for increasing food production and cash income — the alternative was outmigration. On the other hand, where land was relatively abundant, as in Salogon, Palawan, farmers preferred to fallow their land rather than invest in permanent conservation measures. The influence of land tenure on these investment decisions is discussed below.

Access to markets was clearly an important factor affecting the choice of soil conservation technologies (Chapters 6 and 8). Increased market access increased the number of cropping and livestock options which were commercially viable. This included a range of annual crops (maize, root crops, vegetables, etc), tree crops (fruit, timber, etc), and livestock (pigs, goats, etc). These commercial land-use options increased the *incentive* for soil conservation. At the same time, improved access to inputs (seed, fertiliser) and the increased cash income from the farm improved the *capacity* for investment in soil conservation and land husbandry.

In these situations soil conservation measures provided a platform for building up a more productive and profitable farming system. For example, farmers who invested in bench terraces and rock walls at Argao, Cebu, then had the incentive to build up soil fertility through the purchase of chicken manure and to develop a commercial vegetable-growing enterprise. The conservation measures were a necessary but not a sufficient condition to boost farm income. The commercial farming opportunities provided the catalyst for a sequence of complementary investments.

With poor access to markets, farm households were faced with low returns to farm labour, poor cash flow, and hence a greater need to work off-farm. This resulted in the double bind of 'no money' and/or 'no time' to invest in soil conservation.

On the input side, markets were not working to facilitate the adoption of conservation measures. This was particularly evident in the capital market and the market for planting materials.

For most farmers, the capital market was restricted to short-term, high-cost credit supplied by local traders. Credit for farm development was non-existent. Cooperative credit was not much cheaper and was rationed, creating high transaction costs for farmers, particularly those in remote areas. Direct planting grants to farmers (e.g. the ISF Program's subsidy of P6 per metre of double-hedgerows established) were sometimes successful in inducing adoption (e.g. at Domang in Nueva Vizcaya) but were typically followed by a high incidence of discontinuance.

Various conservation projects experimented with forms of group credit, based on mutual support and accountability within a small, close-knit group. For example, the *alayon* groups established by the Mag-uugmad Foundation in Cebu served not only for the pooling of labour and skills but as rotating credit groups. In this instance the Foundation was the recipient of grant funds which it could on-lend to the farmer groups. This model seems the most promising for relieving the capital constraint on investment in conservation measures. However, it requires the presence of a local-level organisation (government or non-government) as the intermediary in order to reduce transaction costs and provide technical back-up, and to ensure that the credit is tied to locally appropriate conservation technologies.

The argument that on-farm conservation provides off-farm benefits, and therefore warrants a subsidy, is a strong one (a form of the 'beneficiary compensates' principle). However, the practical limitations of providing direct grants or subsidised credit to farmers have been well established. The subsidisation of local-level agencies which can then provide group credit for appropriate technical packages seems a feasible way of implementing the principle.

The market for planting materials (e.g. shrub legumes) — crucial inputs for contour hedgerow technology — was generally poorly developed. Many farmers identified lack of access to planting materials as a constraint to the adoption of hedgerows. Direct farmer-to-farmer exchange of planting materials was found to be quite limited. All projects established nurseries to provide planting materials for farmers, but project nurseries almost invariably became defunct after the withdrawal of project staff and funding. Communal nurseries appeared to be faced with the difficulty of maintaining collective action, as discussed above. Private nurseries run by local entrepreneurs did not readily emerge. This may have been due to the initially low and intermittent demand, high capital requirements, and high risk associated with such ventures in remote locations.

There were some exceptions, however. Some farmers in Pananag, Davao del Sur, supplied hedgerow seed to the Mindanao Baptist Rural Life Centre. Some communal and private nurseries have proved viable in Claveria, with backup from the Claveria Land Care Association and ICRAF. Given the economic constraints to the spontaneous emergence of commercial nurseries, it seems that farmers need to be linked to a strong local-level organisation if they are to be involved in the production and supply of planting materials, at least until the demand for such materials reaches a critical level.

The Institutional Environment

Land Tenure

A major element of the institutional environment affecting the appropriateness and uptake of soil conservation technologies is land tenure. It is frequently asserted that formally registered, private title to land is a prerequisite to the adoption of soil conservation measures. However, project findings indicate that the key factor is *security of tenure*, which can be obtained in various ways. The complexity of land tenure arrangements in the uplands makes any simple equation between formal private ownership and security of tenure misleading.

Much of the uplands are designated as public land. Yet farmers who have settled on these lands recognise de facto land ownership, enabling land to be bought and sold, sharecropped, leased for cash, or mortgaged.[15] Payment of land tax to the local government results in the issuance of a tax declaration certificate, which farmers regard as documentary evidence of ownership. Batangantang and Collado (1995) classify such farmers as 'claimant-cultivators', comparable to 'owner-cultivators' who have formal title to the land they farm. Provided community recognition of their claims is strong, claimant-cultivators may have just as strong a sense of security of tenure as owner-cultivators, hence they will be willing to invest in conservation measures if they consider them appropriate. However, if their claims are contested by powerful individuals and/or by the state (which was the experience of Ifugao settlers in Domang, Nueva Vizcaya, in the 1970s and early 1980s) they may lack the security of tenure to adopt soil conservation measures with a long-term pay-off.

Many upland farmers belong to 'indigenous cultural communities' who are occupying their ancestral lands. Such farmers have an even stronger sense of ownership and a willingness to invest in maintaining their land resources, despite the lack of formal title. Where traditional community institutions remain viable, or have been buttressed by their transformation into modern institutional forms, ancestral lands can be very effectively managed in the collective interest (e.g. the Kalahan Educational Foundation in Nueva Vizcaya, discussed below (Lucas-Fernan 1997)). Nevertheless, lands claimed by indigenous farmers have often been simply classed as public lands or even allocated to individuals from outside the community, resulting in overlapping and contested land claims. This undermines the security of tenure of the original owners. In such cases the foremost need is for legal recognition of indigenous land ownership through the issuance of a Certificate of Ancestral Domain Claim (CADC). In the absence of such recognition, insisting on the adoption of technologies such as contour hedgerows is literally 'rubbing SALT into the wound'.

Share tenancy is clearly a factor affecting the adoption of contour hedgerows and other conservation structures. Share tenancy is widespread on both public and private lands. However, not all tenants are reluctant to adopt. Where tenancy is reasonably long-term and secure (e.g. Guba in Cebu) and/or where landlords see the benefits of conservation farming (i.e. if they are farmers themselves), tenancy presents no obstacle to adoption and may even be a positive factor. Nevertheless, in many cases tenant farmers are less likely to invest in contour hedgerows because they incur the up-front costs of establishment without being assured of reaping the full benefits. Agrarian reform programs have not been successful in eliminating tenancy. For example, at Ned in South Cotabato, where settlers had been allocated private lots of 4 ha with Certificate of Land Ownership Awards (CLOA), a process of land accumulation was well underway, resulting in the emergence of a landless class of tenants and mortgagees. Given that tenancy is not going to disappear, it is important to tailor conservation technologies to the circumstances of tenant farmers, e.g. low-cost practices with a quick return such as natural vegetation strips. Where possible, it will

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[15] In a mortgaging arrangement, the mortgagee transfers a sum of money to the mortgagor in exchange for the right to use the mortgagor's land, usually for a period of years. The harvest from the land is regarded as interest on the loan. According to Krinks (1988), this practice has long been established in the Philippine lowlands, where it is known variously as *pacto de retrovendendi*, *salda gatang* and *predahan*.

be important to recognise landowners as well as their tenants as stakeholders in any soil conservation program, though this will clearly be difficult in the case of absentee landlords.

It goes without saying that farmers occupying land affected by 'peace and order' problems frequently lack the security of tenure needed to invest in conservation measures, or any form of land development for that matter, regardless of whether the land is formally in private or public ownership. The activities of various rebel groups and the military in remote upland areas has been a major disincentive to the dissemination and adoption of conservation farming, though the extent of such activities has significantly declined in the 1990s.

Certificate of Stewardship Contracts (CSCs) have been the primary tenure instrument used to provide security of tenure to upland farmers occupying public lands and to induce them to adopt agroforestry technologies, primarily SALT. These are individual, non-transferable, 25-year leases, with land-use conditions attached. CSCs primarily provide security of tenure relative to the state. Where this is an issue in the minds of farmers, the issuance of CSCs can be used as an instrument to induce adoption of conservation measures (e.g. Salogon in Palawan, where farmers could be evicted by the DENR for practising shifting cultivation, though in fact they were occupying their ancestral lands). In other respects, however, CSCs are often of no real consequence. Land is still sold, share-cropped, mortgaged, or leased within a de facto land market. It appears that where farmers are not convinced of the benefits of soil conservation measures, the conditions attached to a CSC can at best induce token adoption which is not sustained.

Some well-organised indigenous communities have opted for Certificate of Community Forest Stewardship Contracts (CCFSCs), pioneered by the Kalahan Education Foundation (Lucas-Fernan 1997). These are 25-year communal leases of public land, but in the Kalahan case the CCFSC gives effective governance of the communal domain to the community itself, enabling it to allocate land equitably to individual families according to need and to plan the overall use and management of land on a catchment basis. However, few other communities have been as successful in managing their land resources collectively. Hence technologies which can be independently adopted on individual farms remain the priority.

There is a need to rationalise the land tenure situation in the uplands. It would seem sensible to acknowledge that vast areas of Public Forest Lands are in fact agricultural lands and to reclassify them accordingly. Titles to such land could be issued subject to the provisions of land-use planning schemes administered at the local government or community level. Soil conservation measures would feature prominently in such schemes, but would not necessarily be tied to the agroforestry technologies currently promoted.

Upland Development Institutions

As discussed above, upland development projects, whether implemented by government or non-government institutions, were expected to be 'nodes of diffusion' for conservation farming technologies. Yet the evidence indicates little spatial diffusion beyond the boundaries of the initial project and, in many cases, even the project farmers who adopted conservation technologies did not maintain them. The most successful examples of sustained adoption, adaptation and 'diffusion' have been in cases where there has been a continuing institutional presence (e.g. Mag-uugmad Foundation, Mindanao Baptist Rural Life Centre, ICRAF). Clearly, *projects* need to be seen as part of on-going long-term *programs,* requiring an institutional presence to facilitate such critical activities as adaptive research, farmer-to-farmer training, cross-site and cross-institutional links, and the introduction and propagation of planting materials. Non-government agencies are in many cases filling a gap left by over-stretched and under-resourced government research and extension agencies, notably the Department of Environment and Natural Resources (DENR) and the Department of Agriculture (DA) (Chapter 3).

The DENR, of course, does implement the Integrated Social Forestry Program (ISFP) which is targeted at upland communities occupying Public Forest Lands. However, resource constraints mean that this program is effectively reduced in any one site to a short-term, top-down project which typically has little sustained impact. Even when the ISFP is buttressed by a large aid project (e.g. the USAID-funded Rainfed Resources Development Project), there is little or no capacity for follow-up once the aid is withdrawn (e.g. in Passi Municipality, Iloilo, where the Magdungao Agroforestry Project had been implemented, there remained one ISF field officer for the entire municipality who was also required to implement programs of the DA).

The ISFP has also tended to promote a specific technology package rather than responding to farmers' technology needs. Contour hedgerows of shrub and tree legumes (as in SALT) were appealing because they put the 'forestry' into agro-forestry, justifying the promotion of such technologies on Public Forest Lands. However, as noted above, it would be better to recognise that much of these lands are in fact agricultural. Hence the need is for farming systems development based on suitable agricultural technologies, rather than 'social forestry' which is necessarily based on agroforestry technologies.

All this requires adaptive research and extension in collaboration with farmers in a range of environments. However, there has been very little investment in such research. Typically researchers at government and university research stations take a specific technology package (e.g. *Gliricidia sepium* hedgerows at a given spacing) and proceed to quantify the desirable biophysical outcomes of that package (e.g. reduced run-off and soil loss), without examining the elements of that package (e.g. varying hedgerow species or inter-hedgerow spacing). At one DA research station for the uplands, a so-called SALT experiment cum demonstration was being cultivated using a large tractor, and the hedgerows, which were said to be planted with shrub legumes, were dominated by weeds. The experiment bore little resemblance to a neighbouring farmer's SALT plot. Some NGOs such as the Mindanao Baptist Rural Life Centre and the Mag-uugmad Foundation conduct good quality adaptive research, but most NGOs have no such capacity. There is a need to build the capacity of government agencies, regional universities, and NGOs to undertake adaptive on-farm research in collaboration with farmers.

The process of devolution to local government units (LGUs) which has been occurring throughout the 1990s, though fraught with problems, has also created some opportunities for strengthening upland development institutions (Chapter 3). LGUs have the advantage that they are permanent institutions, they have a multisectoral orientation, they are close to the local situation, and they are potentially responsive to farmers' needs. LGUs thus have the opportunity to provide the institutional framework for on-going support of farmers' conservation efforts. They can do this through such means as the employment of field extension workers or facilitators, provision of support for farmer-to-farmer training programs, working in partnership with competent local NGOs, maintenance of linkages with national and international research agencies, and provision of fiscal and legislative support for locally appropriate land management activities (e.g. specific conservation incentives for farmer groups, local land-use planning schemes). For LGUs to fulfil this role they will need vastly increased support to improve their technical and managerial capacity. As noted in Chapter 3, the current priorities of donor agencies favour environmental initiatives at the local level, hence the prospects for building the capacity of LGUs are reasonably good.

Conclusion

The socioeconomic evaluation of soil conservation technologies undertaken in Project 1992/011 clearly confirms the appropriateness and potential of (generic) contour farming technologies for upland farming systems in the Philippines. However, adoption of the specific technology packages promoted to date has been limited, partly because of the attributes of the technologies themselves, and partly because of constraints in the social, economic, and institutional environments in which the technologies have been promoted. Nevertheless, the evaluation also suggests ways in which the attributes of the currently promoted technologies can be improved to make them more 'adoptable', as well as ways in which the social, economic and institutional environments can be harnessed or modified to facilitate more rapid and widespread adoption.

In light of the above analysis, making contour farming technologies more 'adoptable' primarily involves increasing their relative advantage to farmers and their compatibility with existing farming systems, and reducing their complexity. This can be done by 'unwrapping the technology package' — separating out the components, their functions and their impacts (Figure 12.2a).

One of the theoretical attractions of hedgerows has been that, as well as functioning as a barrier to erosion, they can provide a source of mulch, organic matter, nutrients, fodder, fuelwood, seed, and other byproducts. However, farmers trying to pursue all these options within a hedgerow system may not be optimising the use of their resources. For example, it may be more efficient to establish a separate fodder plot or a woodlot of an appropriate size and location, and to use low-cost natural vegetative strips to control soil loss on the maize farm. The ideal of productive, multipurpose hedgerows may not be suitable for many farmers.

Unwrapping the package means explicitly allowing for step-wise adoption (Figure 12.2b).

For example, a farmer may progress from ploughing across the slope, to ploughing on the contour, to leaving a single strip unploughed (creating a natural vegetative strip), to leaving several such strips, to enriching these strips with grasses, legumes, or trees, to changing the cropping system in the alleys between the strips (crop rotations, perennial crops).[16] The end result in this case would be very similar to the full SALT package, but step-wise adoption would increase the relative advantage and compatibility of the technology while reducing its complexity. It is noteworthy that the first step of cross-slope or contour ploughing has in fact been widely adopted during the past two decades, being a simple, observable, trialable innovation in tillage practice which farmers soon find is quite compatible with their existing system and confers significant advantage in terms of reduced soil loss.

Unwrapping the package also means explicitly allowing for branching pathways of adoption. For example, it is clear that farmers practising fallow systems will select different components to those practising continuous cropping (e.g. the former may be more interested in planting *Leucaena* spp. as woodlots for timber and fuelwood than as hedgerows). Among the latter group of farmers there will be different adoption pathways for semi-subsistence farmers in remote areas (who have a greater need for low-input systems based on nutrient cycling, and will therefore be more interested in the nutrient contribution of hedgerows) and for commercial farmers producing

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[16] Mercado et al. (1999) have demonstrated that a single natural vegetative strip can reduce soil loss to half the rate observed on an open-field control plot. As the number of strips per hectare increases, soil loss declines, but at a decreasing rate, while the labour requirement increases and the available area for planting decreases. In economic terms, there are diminishing marginal net benefits to increased investment in conservation strips.

hybrid maize and vegetables for sale (for whom it is economic to use external sources of nutrients, including purchased organic fertilisers). Table 12.1 relates these different pathways to the key site characteristics of population density and market access, as discussed in Chapters 2, 4 and 11.

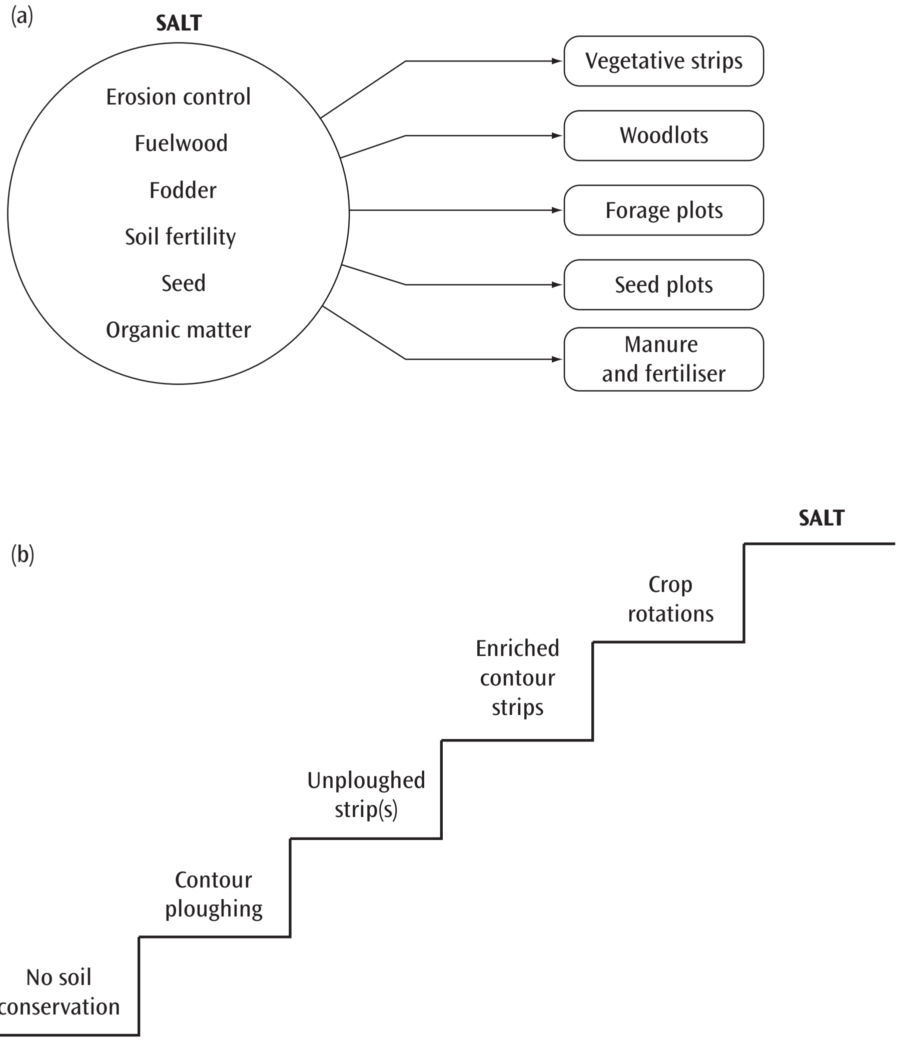

Figure 12.2. Unwrapping the SALT Technology Package: (a) Separating components and functions and (b) Allowing for step-wise adoption.

Table 12.1. Allowing for different pathways of adoption.

Population density	Market access	
	Poor	**Good**
Low	• Grass and bush fallow systems • Semi-subsistence orientation • No terraces or hedgerows adopted • Scope for enriched fallows • Scope for fruit and forest tree crops	• Less common situation • Combination of intensive & extensive systems • Semi-commercial orientation • Terraces or hedgerows adopted for erosion control on intensively cropped land • External inputs • Commercial tree crops (fruit, timber, etc) • Forages for commercial livestock
High	• Annual cropping • Semi-subsistence orientation • Simplified hedgerows adopted for erosion control & fertility management • Small woodlots for local use • Small forage plots	• Annual cropping • Semi-commercial orientation • Hedgerows adopted for erosion control • External inputs for fertility management • New commercial crops (e.g. vegetables) grown on conserved soil • Semi-commercial woodlots • Forage plots for semi-commercial livestock activities

The lessons regarding the social, economic, and institutional constraints to the adoption of appropriate conservation technologies can be summarised briefly. First, the social environment of upland farmers does not always correspond to the image of homogeneous and harmonious communities (*barangay*), capable of sustained collective action for the common good, which is part of the Philippines national ideology, as well as the ideology underpinning the currently fashionable notion of community-based sustainable development (Cramb et al. 2000). When such notions form the basis of development interventions in the uplands, their failure to be realised in practice results in an easy slide into the classic, top-down, transfer-of-technology approach to soil conservation (Chapters 3 and 7). In reality, effective social interaction occurs at a much lower level, involving small groups of neighbours and close kin, who can work together to achieve a limited number of practical outcomes. External support for conservation efforts needs to focus on mobilising and supporting such groups, providing back-up and linkages within and beyond the community, which the larger social system does not otherwise provide.

The economic environment of upland farmers is a crucial factor influencing the appropriateness of conservation technologies. In the long term, population growth and economic development (including the development of rural infrastructure, linking upland farmers to larger, more diverse markets) would be expected to encourage farm-level investment in intensive conservation measures such as hedgerows and terraces. In the short term, however, technologies must be adapted to varying economic constraints which cannot be easily changed. Intensive hedgerow technology is clearly not appropriate in remote regions with relatively low population densities where fallow systems are the norm. Conversely, it makes no sense to promote low-input, subsistence-oriented technologies in situations with good market access in which intensive commercial agriculture using purchased inputs is likely to be not only more profitable but more effective in conserving resources. These considerations reinforce the arguments for 'unwrapping the package' advanced above.

With regard to the institutional environment, the priorities would seem to be twofold. First, there is a need to reform the land tenure situation in the uplands, recognising that much of the public forest zone is in fact agricultural land which needs to be classified accordingly and for which appropriate tenure instruments need to be devised and implemented, such as a more developed form of the conditional leases (CSCs) currently issued by the DENR. This could be combined with the introduction of locally developed and administered land-use planning schemes. Second, there is a need to build the capacity of local government units, both to undertake municipal-level land-use planning and management, and, in cooperation with other agencies, government and non-government, to facilitate and support the adaptive research and farmer training activities of conservation farming groups.