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Linkages Between Investment in Extension Services and Farmer's Adoption of Soil Conservation Practices in Southern Honduras

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Front Cover:

The Land Use Productivity Enhancement Project (LUPE) was a joint effort by the U.S. Agency for International Development and the Honduran Ministry of Natural Resources. A primary objective of LUPE was to work with farmers to encourage adoption of sustainable farming practices. In this picture, LUPE extension agents are explaining to a local farm community how the USAID/Texas A&M University Soil Management Collaborative Research Support Program (CRSP) was measuring the amount of crop production and the amount of water, soil and nutrients that move off of steepland fields associated with various types of conservation practices extended by LUPE.

LINKAGES BETWEEN INVESTMENT IN EXTENSION SERVICES AND FARMERS' ADOPTION OF SOIL CONSERVATION PRACTICES IN SOUTHERN HONDURAS

Hector Santos,[1] Amy P. Thurow,[2] and Thomas L. Thurow[2]

[1]US Agency for International Development
Tegucigalpa, Honduras

[2]Department of Rangeland Ecology and Management
Texas A&M University
College Station, Texas 77843-2126 USA

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For more copies of this technical bulletin or further information about the CRSP research program, please contact Dr. Tony Juo, Texas A&M University, Department of Soil and Crop Sciences, College Station, TX 77843-2474. As of August, 1999, Tom is Head of the Department of Renewable Resources, University of Wyoming. Amy and Tom Thurow can be reached at 1071 Duna Drive, Laramie, WY 82072 or <tthurow@uwyo.edu>.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
SOIL MANAGEMENT COLLABORATIVE RESEARCH SUPPORT PROGRAM
TEXAS A&M UNIVERSITY

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LINKAGES BETWEEN INVESTMENT IN EXTENSION SERVICES AND FARMERS' ADOPTION OF SOIL CONSERVATION PRACTICES IN SOUTHERN HONDURAS

INTRODUCTION

Honduras is the most mountainous country in Central America. Eighty percent of Honduras is steeplands (slopes greater than 20%), compared with steeplands comprising 25% of the rest of Latin America and the Carribean. In Honduras, 73% of staple crops (e.g., corn, sorghum, and beans), 62% of perennial crops (e.g., coffee and citrus), and 40% of cattle are produced on cleared steeplands (IICA 1995). Cropland area in Honduras increased by 928,000 hectares from 1974 to 1993; for the most part, this increase in cropland was created by clearing forested steeplands (SECPLAN 1994).

Clearing steepland forests for the sake of cultivating crops increases the risk of runoff and erosion because of the removal of perennial species that provide cover for the soil and have well established root systems which tie the soil to the hillside, thereby increasing these risks. A five year study of field-size steepland catchments in southern Honduras estimated that traditional slash-and-burn systems have an average soil loss of 92 tons/hectare/year compared to a soil loss of less than 1 ton/hectare/year under a forest fallow system (Thurow and Smith 1998).

As topsoil is lost via erosion from cultivated steeplands, there is a corresponding reduction in nutrient and water storage capability, resulting in crop yield decline. Subsistence farmers respond by clearing more adjacent forests, in order to feed their families. As greater proportions of forest are lost, vulnerability to severe landslides increases during periods of intense rain. In the aftermath of Hurricane Mitch in October, 1998, the Honduran agricultural sector experienced losses of $800 million (*The Economist* IU1998). These agricultural sector losses pale in comparison with the downstream loss of life and the infrastructure damage resulting from the associated sedimentation and flooding damage. Total infrastructure damages in Honduras due to Hurricane Mitch - over and above agriculture's $800 million losses - were estimated to exceed $5 billion; experts agree that an important primary cause of these extensive and pervasive damages was mismanagement of steeplands over time (IDB 1999).

Numerous downstream stakeholders are adversely affected by mismanagement of steeplands. Sedimentation and associated siltation reduces the useful life of dams, reservoirs and navigable waterways; it also increases the frequency and severity of flooding. As a case in point, banana plantations in northern Honduras have historically invested in flood prevention structures along silted rivers. Their need to build more and larger structures has dramatically increased over the past several decades.

In southern Honduras, substantial effort and expenditures were required to dredge the Choluteca River in the immediate aftermath of Hurricane Mitch to increase the water volume capacity of the channel and thereby reduce the risk of the sediment-choked channel overflowing its banks and washing out the bridges and roads again.

Habitat for wildlife and fisheries populations are adversely affected by high rates of sedimentation which may have significant economic ramifications for the region. For example, Samayoa et al (2000) estimated the costs of sedimentation to the shrimp industry in southern Honduras. shrimp is the third largest foreign-exchange earning industry for Honduras and it is situated directly downstream from cultivated steeplands in the Choluteca River Basin. Water supply channels feeding shrimp ponds are often muddied by sedimentation associated with erosion on nearby cultivated steeplands. The estimated net present value of sediment costs for the southern Honduras shrimp industry as a whole over fifty years is approximately $47 million, assuming a 10% discount rate. The increasing magnitude of

sedimentation, and the costs this sediment imposes on the shrimp industry, raises questions about the long-term sustainability of this important industry for the region.

Tourism opportunities are also degraded by sedimentation. For example, a declining number of tourists are visiting Lake Amatitlan in Guatemala due to environmental problems attributed to the mismanagement of steeplands (Chacón 1998).

PROBLEM STATEMENT

When small-scale steepland farmers modify their farming systems to include soil and water conservation practices - notably, rock terraces, live barriers, and/or mulching - soil erosion is reduced and the deleterious effects of soil loss are mitigated, both on-farm and downstream. Small steepland farmers bear several direct costs of erosion (most obvious is a gradual decline in crop yields.). Most farmers understand the causes and effects of soil degradation but, understandably, action with regard to these concerns is of lower priority than their efforts to meet to meet the immediate subsistence needs of their family. Accordingly, many farmers never get around to making the investments of labor and capital necessary to improve soil conservation unless they are helped to do so by an organization dedicated to this task.

In Latin America, a considerable amount of both external and national funds have been and are being invested to implement projects designed to help small steepland farmers relax constraints to the adoption of soil and water conservation practices (SWCPs). These programs have had varying levels of success. Numerous technologies have been promoted and, in some cases, the soil conservation organizations (e.g., government agencies, non-government organizations) have offered farmers financial incentives to participate. Given the medium- to long-term economic returns associated with investments in SWCPs, however, successful diffusion has proven complex. Significant effort and time is required to secure adoption. Subsequently, the farmers must recognize that it is in their long-term interest to maintain permanent conservation structures.

In Latin America in general, and specifically on steeplands in Honduras, a cost-benefit analysis at the farm level has been a useful indicator of whether or not farmers will adopt particular conservation technologies. However, even when SWCPs are indeed cost effective, education and technical assistance are required to promote adoption and to sustain maintenance of conservation structures. Extension programming often constitutes a large share of the total cost of soil conservation programming, and its effectiveness is a key determinant of the success of public investments in soil conservation.

Particularly in the aftermath of Hurricane Mitch in 1998, heightened awareness of an increasing number of environmental policy challenges has fueled a fierce competition for funding among prospective projects. Ideally, such competition will motivate the efficient allocation of scarce funding and other development resources.

The central premise of the research reported here is that projects to encourage conservation on steeplands deserve attention from policy planners who aim to reduce the risk of catastrophic damages and losses like those associated with Hurricane Mitch (on-farm and downstream), as well as to sustain environmental quality (i.e., the ecological integrity of watersheds in Honduras). The main contribution of this study is an estimate of the per-hectare cost of extension programming to promote adoption of three conservation practices (rock terraces, live barriers, and mulching) and estimates of how much their adoption is likely to reduce erosion.

REVIEW OF SOUTHERN HONDURAS SOIL CONSERVATION RESEARCH

Little research has been conducted on the adoption and diffusion of soil conservation practices in steepland settings (Toness et al. 1998). Most existing studies focus on how erosion affects agronomic production potential. This on-farm emphasis is not unique to tropical

steepland settings: not until the mid-1980s did U.S.-based agronomists, ecologists, and economists begin to seriously consider the off-farm effects of erosion in their analysis of the benefits and costs of soil conservation programs (Crosson 1986).

Scientists affiliated with the Soil Management Collaborative Research Support Project (SM/CRSP) at Texas A&M University seized a unique opportunity to employ cross-disciplinary methodologies in studying steepland soil conservation technologies and their adoption. What distinguishes this SM/CRSP research program on steeplands is its commitment to conduct joint analysis of physical and socioeconomic linkages, and to conduct analysis at the landscape scale.

Evaluations of three conservation technologies

The starting place for the SM/CRSP research program was to conduct on-farm assessments of how much soil is saved when steepland farmers in southern Honduras install SWCPs. Thurow and Smith (1998) summarized lessons learned from a series of complementary studies of alternate soil conservation technologies in use on field-size steepland catchments in the Namasigüe watershed in southern Honduras. Most pertinent to the socioeconomic analysis described in this technical bulletin were assessments of three SWCPs: mulch, vetiver grass live barriers, and rock walls.

Mulch

Thurow and Smith (1998) estimated soil losses on mulch-managed fields with a 60% slope in southern Honduras at an average of 39 tons/ha/year. This compares with an average of 92 tons/ha/yr soil loss from steepland on which traditional slash and burn practices were used. Farmers who adopt mulch-management leave crop residues and weeds from the previous season on their cropland as a ground cover. No grazing or burning is allowed. The slashed vegetation provides an effective ground cover that reduces the energy of rainfall impact and surface runoff, decreasing the erosion rate. The ground cover also prevents water loss by evaporation, reduces soil temperature, reduces weed growth, and increases soil organic matter.

While mulching reduces soil erosion, it does not provide satisfactory erosion protection under all climate conditions. Mulch performs well in low to average precipitation years, but sloughing events occur on mulched fields in high precipitation years, resulting in massive erosion via land slides. For the period 1993-1998, approximately 94% of total soil losses on mulched fields were associated with sloughing events (Thurow and Smith 1998). Sloughing occurs on mulched fields because there is nothing to tie the soil on steeplands to the hillsides, thereby resulting in a land slip when the topsoil becomes thoroughly saturated during prolonged rain events. In contrast, rock walls provide a physical structure or live barriers (e.g., vetiver grass) have a deep root structure that helps to tie the soil to the hillside, thus preventing the landslides that contribute to most of the soil loss on steeplands.

When interpreting erosion data from the tropics it is important to consider the methods used to conduct the study. Research must be conducted at a field scale to gather information on effectiveness of conservation options at protecting against landslides. Since most research done in the tropics has been on a small-plot scale (less than 50 m^2 plots) the results are not conducive to documenting processes such as land slides that only larger scale research designs are able to reliably detect. Small plots are well suited for detecting interrill erosion, which mulching effectively reduces. Soil conservation extension programs sometimes erroneously rely on small plot research to provide a rationale that mulching, or other types of ground covers, are an effective solution for reducing erosion. Such research misses an important point - small plot study designs are not capable of measuring the processes that result in the vast majority of soil loss from steeplands. Allowing crop residue to remain on the field by restricting grazing and

burning is an important *initial* step in steepland soil conservation, but it must be followed by adoption of more intensive practices to tie the soil into the hillside to achieve soil conservation objectives over the long run.

Vetiver grass live barriers

Vetiver grass live barriers (VGLB) are established along the contour of the hillside by planting slips with two or three tillers every 0.1m. The slips grow and multiply, closing the spaces between them to form a dense live barrier within 1-2 years. The spacing between live barriers depends on the slope: the steeper the field, the closer the spacing (Toness et al. 1998). A VGLB filters runoff, retaining the soil and slowly releasing the water. Steepland farmers who installed VGLB have reduced cropland erosion to less than one ton/ha/year, on average (Thurow and Smith 1998, Smith 1997). This research is corroborated by a host of studies at many locations around the world, best referenced by consulting the vetiver grass web site (http://www.vetiver.com).

With VGLB in place, soil accumulates behind the rigid leaves of the vetiver grass barriers, eventually forming stable terraces like those formed when rock walls are used. The cost of installing VGLB is significantly lower than for rock walls, but they require more routine maintenance. Specifically, the VGLB must be trimmed at least once per year to keep the vegetation dense.

Rock walls

Rock walls are built along the contours of a sloping field. The spacing between them is determined by the degree of slope (Toness et al 1998). A 50 cm trench is usually sufficient to provide an adequate foundation for the rock walls. Rocks are collected from the field and piled adjacent to the excavated trench. To build the wall, the farmer places the largest rocks in the bottom of the trench, arranging them to fit as solidly as possible. Smaller rocks are placed in the spaces between the larger rocks to form the wall. Finished rock walls are typically one meter high.

Since rock walls do not contain any cementing material, the runoff water is retained, filtered, and slowly released through the existing crevasses. Eroding soil is accumulated when stopped by the wall, to form a terrace behind it. In conjunction with use of rock walls, soil erosion is reduced to approximately 0.7 ton/ha/year, the soil's water holding capacity improves, and crop yields improve (Toness et al. 1998, Sierra 1996, Gomez and Sierra 1993, Thompson 1992). In contrast to VGLB, rock walls have an added advantage in the minds of farmers because, in dry years, the stored water in the soil behind the wall contributes to a significant improvement in crop yields. The contrast exists on any sites with no rock walls or even on sites where vetiver grass barriers are being used. Many farmers perceive this reduction in crop production risk associated with drought as just as important, or more important, than protecting the soil from erosion during rainy periods.

To summarize, in southern Honduras, the lowest soil erosion rates are observed when mulching is combined with either rock walls or VGLB. In such farming systems, soil losses are low, close to soil renewal rates, thus making cropped steeplands more sustainable.

Socioeconomic and policy factors associated with soil conservation

Having developed estimates of the soil savings associated with the three most prevalent SWCPs in use in southern Honduras, the SM/CRSP research agenda is proceeding with policy-oriented socioeconomic studies. The context for initiating these studies was general consensus among local experts that only a small percentage of steepland farmers in southern Honduras in the 1990s were adopting the SWCPs which are the most effective in preventing soil erosion over the long run – namely, rock walls and VGLB – even though a larger number of farmers seemed to appreciate that these

Plate 1. The first step toward achieving more sustainable land use was to encourage farmers to stop burning their fields prior to planting their crops. The exposed soil substantially increased the likelihood of soil loss (averaging 92 tons/ha/yr).

Plate 2. Leaving mulch on the field, instead of burning the site, dissipated the energy of rain and runoff acting to detach and move the soil, substantially reduced the risk of soil loss (mulched sites averaged 39 tons/ha/year soil loss during a 6 year study period).

Plate 3. Terracing fields reduced average soil loss to about 1 ton/ha/year, a rate compatable with sustainable crop production on the field. In addition to preventing soil loss, farmers also very much valued the ability of the rock wall terraces to store water and thereby reduce the risk of drought. Note the greater crop height associated with accessing greater soil moisture stored immediately behind each terrace.

Plate 4. Rock walls were difficult to establish because of the substantial labor associated with their construction. Vetiver grass terraces had about the same soil conservation benefits as rock terraces in terms of reducing erosion, but were much easier to establish.

technologies are cost-effective. A plausible partial explanation is the riskiness of investing in these permanent or semi-permanent structures, since the on-farm payoffs (sustained or increased crop yields) accrue over the long run.

It was obvious to several natural resource managers and to astute policy makers – and even more obvious in the aftermath of Hurricane Mitch – that soil erosion on steeplands has deleterious downstream effects. Publicly funded education and technical assistant programs, therefore, have a crucial role to play in accelerating the pace of the adoption of SWCPs. Yet in policy forums, both in Honduras and with donor agencies, it had become increasingly difficult to justify spending scarce development resources on conservation extension programs solely to sustain farm revenues by maintaining or slightly raising crop yields for production of *granos basicos*.

Two linked SM/CRSP socioeconomic studies, completed in 1999, endeavor to influence the tone of policy dialogue on conservation in southern Honduras. The first study sought to broaden the policy justification for conservation on steeplands by demonstrating the costs of sedimentation to one important group of downstream stakeholders, i.e. shrimp producers (Samayoa et al. 2000). If accounting for the downstream costs of steepland erosion makes the option of promoting adoption of SWCPs more compelling, then the second study – summarized in this technical bulletin – anticipates a pragmatic policy-implementation question: if policy makers deem more steepland conservation to be desirable, then what does it cost to implement extension programming to get conservation practices installed by steepland farmers?

Policy makers are most likely to be allocating public funding to extension programming if convinced that off-site damages from soil erosion are important. Samayoa's preliminary evidence supporting this notion is presented in some detail, to set the stage for a detailed discussion of the costs of extension programming to promote adoption of SWCPs on steeplands.

Taking account of the off-farm costs of erosion

A fundamental hypothesis being examined by SM/CRSP researchers is that the off-farm effects of soil erosion from cultivated steeplands in southern Honduras are important. A corollary is that understanding the magnitude of these off-farm costs might increase public support for extension programming to support on-farm investments in SWCP by small farmers.

Samayoa (1999) detailed the linkages in southern Honduras between displaced soil and its downstream effects, such as clogged navigable waterways, increased drinking water treatment costs, diminished quality of wildlife habitat, and increased risks of flooding. A maintained assumption is that while soil erosion from cropland is not the only source of sedimentation problems in southern Honduras, it is an important cause of muddied waters downstream. Rather than attempting to describe precisely where sediment from steeplands is deposited and estimate the cost of managing that particular sediment, instead Samayoa et al. (2000) estimated what downstream stakeholders spend to manage sediment – whatever its source – and how much they would save if there were less sediment to manage.

Analysis by Samayoa et al. (2000) focused on the costs of managing sediment to the shrimp industry in southern Honduras, the nation's third most important foreign exchange-earner. Currently, managing sediment constitutes two percent of the cost of producing shrimp for large semi-intensive producers (who are responsible for 73% of the shrimp produced in Honduras). Honduran shrimp is traded in world markets; accordingly, this expense stifles Honduran producers' competitiveness. In addition to raising the industry's costs of production, the future economic and ecological viability of shrimp farms in southern Honduras may be compromised if sedimentation continues at its current rates, or accelerates. Most shrimp producers today dispose of dredged sediments on nearby parcels which are not being used to raise shrimp.

In some cases, however, environmental advocacy groups allege that these practices are damaging both the quality and quantity of adjacent mangrove ecosystems (Hagler 1998). If sediment continues to accumulate at its current rate for the next fifty years, and if public policies change so that producers must dispose of dredged sediment only on land which is currently under shrimp ponds, then the area in shrimp production would shrink by 41% in fifty years.

On-farm steepland conservation could curtail the problems faced by the shrimp industry by reducing the amount of sediment entering the rivers which feed their water supply channels. Without measuring or even claiming a direct relationship between steepland conservation and sediment management on shrimp farms, Samayoa et al. (2000) showed how much 20% and 40% reductions of sediment delivered to shrimp farms would be worth to the industry over 50 years. Assuming a policy which expects shrimp farmers to manage dredged sediment within the area currently being used for shrimp production (a land-constrained scenario), then 20% and a 40% less sediment in their water supply channels, respectively, would reduce a representative producer's average costs of managing sediment by 13% and 28% (assuming a 50 year planning horizon and a 10% discount rate).

Samayoa's preliminary evidence on how much sediment management costs shrimp producers makes a case for the importance of upland/downstream linkages and, in addition, suggests a methodology for estimating the magnitude of the costs of sediment management to other groups of downstream stakeholders.

If studies similar to this one were conducted to demonstrate how other downstream stakeholders – such as melon growers and those who use and maintain transportation infrastructure – are affected by sediment management problems, then policy dialogue on watershed-level options for coordination of public programs to support steepland conservation would be broadened. Preliminary results on the costs of sedimentation to the shrimp industry also suggest that failure to invest in steepland conservation is likely to impose costs downstream which increase over time.

Assessing policy options for promoting steepland conservation

Convincing evidence about the effectiveness of mulch, VGLB, and rock walls in curtailing erosion on steeplands, and about why downstream stakeholders might wish to support more steepland conservation, raises a key issue for policy makers who wish to be responsive and take action: what is the cost of education and technical assistance programs to get SWCPs adopted?

The main research findings summarized in the remaining pages of this technical bulletin are (1) estimates of the costs of education and technical assistance programs to promote the adoption of mulch, VGLB, and rock walls among steepland farmers in southern Honduras, and (2) descriptive analysis of evidence from interviews with 163 farmers in two adjacent localities in the Namasigüe watershed in southern Honduras concerning their decision making about whether and when to adopt and maintain SWCP. These findings are described in turn, following a description of the study site, the conservation extension programs in place there, and the data on the costs of extension programming which were analyzed for this study.

STUDY SITE AND DATA

Estimates of the costs of delivering education and technical assistance on SWCP for steeplands were calculated for two adjacent localities in the Namasigüe watershed. The Los Espabeles research plot, the site where the series of studies summarized in Thurow and Smith (1998) were conducted, is located in this subwatershed.

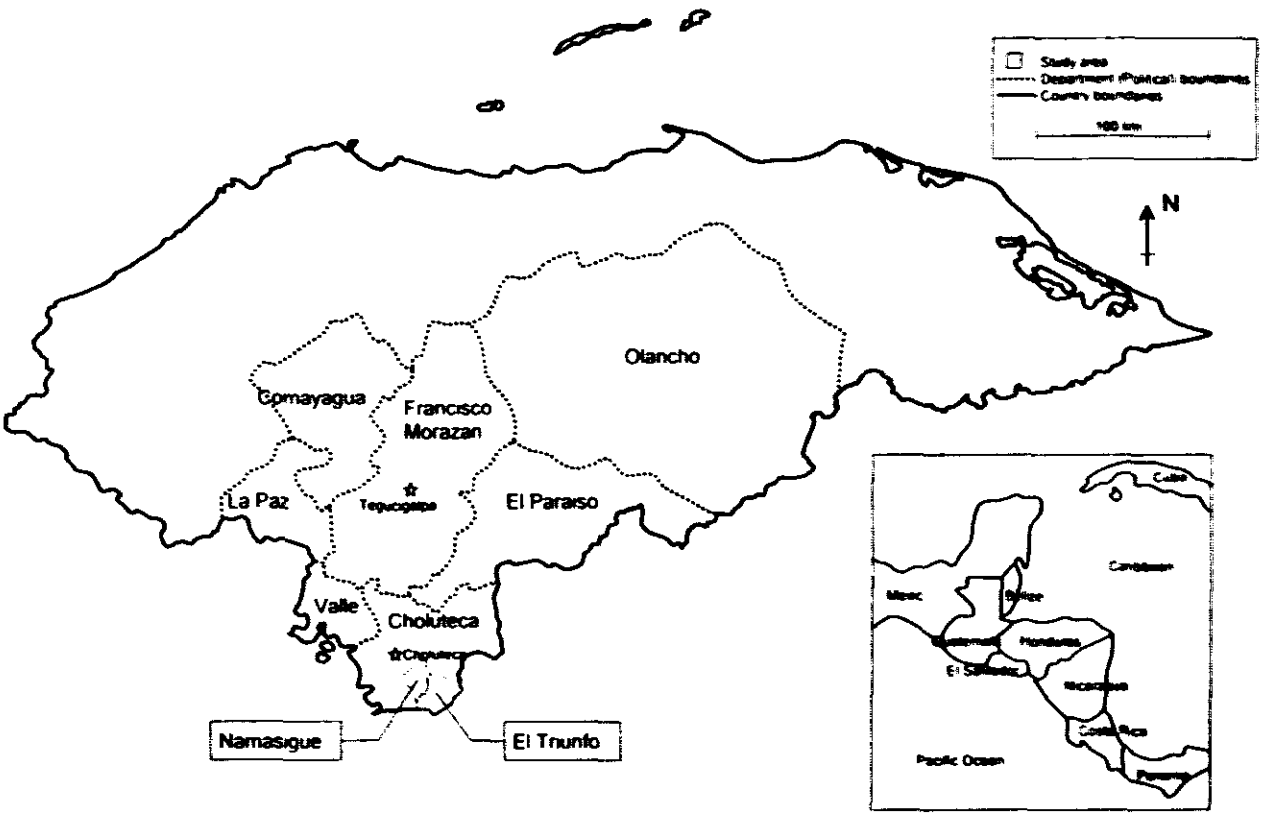
Characteristics of the Namasigüe watershed

The Namasigüe watershed is located 15 kilometers southeast of Choluteca City in the

Department of Choluteca, southern Honduras (Figure 1). The Namasigüe watershed is part of the Sampile River basin that drains to the Gulf of Fonseca. From 1990 until 1998, steepland farmers in 24 communities in the watershed had access to education and technical assistance on conservation, as administered through the Land Use and Productivity Enhancement project (LUPE). Programming was coordinated through two offices located in the towns of Namasigüe and El Triunfo. The operational effectiveness of extension programming in the physically similar localities of Namasigüe and El Triunfo are compared and contrasted in the study.

Precipitation in the study area follows a bimodal pattern, with the first rainy season beginning in early May and ending in mid-July. The second rainy season begins in late July and ends in early November. Average annual rainfall in the Sampile River basin ranges from 1,800 mm in areas with the lowest elevation (48 m) to 2,900 mm in its highest reaches of the basin (1,007 m elevation). Smith (1997) observed that during 1993 to 1995, approximately 95% of the rainfall occurred as storms of more than 12.5 mm or rainfall events greater than 5.4 mm in 15 minutes, events classified as erosive by Wischmeier and Smith's (1978) criteria. The annual rainfall during the same period followed a bimodal pattern and ranged from 1,459 mm to 2,795 mm. Average monthly temperatures in the Choluteca region range from 27.7°C to 30°C.

Figure 1. Map of the study sites, Namasigüe subwatershed, southern Honduras



Extension programming on soil conservation

The SM/CRSP scientists collaborated with extension agents and administrators affiliated with the Land Use and Productivity Enhancement (LUPE) project in carrying out. first, field research on watershed plots and. later. this socio-economic study. LUPE was a joint effort by the Honduran Ministry of Natural Resources and the US Agency for International Development (USAID). In operation from 1990 to 1998, LUPE's goal was to increase the socioeconomic well-being of 25,000 steepland families in southern and central Honduras, primarily through the transfer of SWCPs to improve agricultural productivity on steeplands. LUPE was one of the largest extension programs in Latin America.

A brief history of NRMP and LUPE

LUPE was a continuation of the Natural Resource Management Project (NRMP), 1980 to 1989. also a collaborative initiative between the Honduran Ministry of Natural Resources and USAID. NRMP had emphasized the use of incentives (in particular, food for work) to reward farmers who constructed rock wall terraces and who used mulch cover. NRMP agents measured the linear meters of rock walls built and farmers were paid a predetermined quantity of food (e.g., grains. cooking oil, sardines) for the work they completed.

Rock walls accounted for the major share of the conservation accomplishments credited to NRMP. The rock walls were well-built but poorly maintained in the years immediately after they were installed. A decade later, however, follow-up interviews (Santos 1999) indicated that many NRMP collaborators eventually realized the benefits of soil saved from rock walls and, accordingly, many of their rock walls are working today and are well maintained.

NRMP evolved into the LUPE in 1990. Three changes re-focused its extension programming and philosophy: first, there was a change from incentive-based (food for work) to education-based programming. LUPE employed a teaching-and-visit extension methodology which emphasized the delivery of education and technical assistance. Farmers who worked with LUPE adopted conservation technologies after becoming convinced that they were worth the investment. rather than being motivated primarily by payments for conservation practices installed. Second, the new primary agents were trained farmers who were back-stopped by technical experts. Finally, the extent and the intensity of programming was increased.

LUPE's goals and accomplishments regarding conservation differed from NRMP's. Whereas NRMP emphasized getting rock walls built. the major success claimed by LUPE was to convince large numbers of farmers to cease burning and begin using mulch. LUPE agents considered adoption of mulch the first step in a two-stage conservation education process: in principle, after adopting mulch and seeing the associated improvements in productivity and reductions in erosion, then those interested in further curtailing erosion were open-minded to information about either VGLB or rock walls.

Because LUPE was a continuation of NRMP. the local extension offices never closed and personnel never stopped working. For the period 1990-1992, however, there were no tangible changes in extension delivery methods. For LUPE's first three years, the primary contacts with farmers were still made by professional (university-trained) extension agents who had worked with NRMP. Since these extension agents were accustomed to offering incentives for participation, they resisted switching to an education-based methodology which they did not understand and, therefore, did not believe in. This resistance was reinforced by farmers' reactions. Old collaborators were less interested in meeting with LUPE agents because they were accustomed to receiving payments for installing conservation practices, also few new farmers were recruited. Accordingly, through late 1992, LUPE can claim few tangible accomplishments.

Furthermore, administrative controls were weak. Existing regulations were not enforced, and LUPE resources were abused (e.g., vehicles

were destroyed by inexperienced drivers). In 1992, evaluators deemed LUPE a failure and USAID nearly terminated the project prematurely.

In lieu of closing the project, in late 1992 and in 1993 LUPE underwent systemic changes. The administration was carefully reviewed and reorganized. Key personnel, including the director, were replaced, all activities were reviewed, and there was close oversight by USAID. All new and old personnel were required to complete a training program to learn the teaching-and-visit extension methodology. The new training-and-visit strategy became fully operational in 1993 or 1994, depending on the locality and its staffing. Roles and responsibilities of the personnel were redefined, and vehicle use and maintenance was regulated and strictly enforced. Many of the appropriate policies had existed prior to 1993, but enforcement and oversight was strengthened.

Another result of the review team's feedback was that LUPE was encouraged to try to document impact. For example, NRMP, like most extension programs worldwide, was accustomed to reporting activity instead of impact (e.g., number of kilometers of rock walls built). The response of some of the project reviewers to this type of data can be paraphrased as "so what?" and "who cares?". This review input provided the opening for the SM/CRSP to become involved with LUPE: the SM/CRSP provided the funds and technical expertise for long-term research necessary to document impacts of the programs, and LUPE provided the logistic collaboration for the SM/CRSP to tie into. Neither SM/CRSP nor LUPE would have been able to accomplish their objectives alone. In summary, as a result of numerous simultaneous strategic changes, LUPE's effectiveness increased. From 1994 to 1998, LUPE was considered one of the most successful conservation extension projects funded by USAID worldwide.

Calculation of LUPE's extension costs

LUPE records were the primary data source used to estimate the extension costs associated with convincing steepland farmers in southern Honduras to install and maintain conservation practices. Because of major differences in approach between NRMP and LUPE, and the lack of consistency in data collection over time, compilation of an 18-year data series was deemed impractical. Among publicly-funded conservation projects, however, LUPE's record-keeping was unusually thorough, in particular for the period 1993 to 1998.

To support locally-based extension programming from an average of 37 offices (46 at its peak) spread across central and southern Honduras, the centralized organizational structure of LUPE was divided into a technical section (oriented to field work) and an administrative section. In 1990, there were three geographic regions in the technical section. Three were merged into two in 1993. Each geographic region had independent authority. Each geographic region was divided into several areas of influence with four to five local offices.

The administrative section was centralized and provided services to all local offices. Given this structure, in order to disaggregate costs, it would have been optimal to have data which identified the share of time or costs for project level departments (e.g., the car repair shop) to correspond with individual local offices (i.e., Namasigüe and El Triunfo). Unfortunately, no such data were collected by LUPE. Accordingly, average costs (the year's expenses in a particular category, divided by the number of offices in operation) were reported rather than an actual cost per individual local office.

The two most important data sources on a local office's background and performance were the trimester report form sent to the LUPE monitoring department by the local extension offices and the narrative reports turned in by the head of each local office to the centralized administrative section. The narrative reports provided particular and qualitative information concerning activities in individual local offices. The trimester reports consistently reported the data required for this study from 1993 to 1997.

Furthermore, beginning in 1993, data quality was assured by a monitoring unit which audited a sample of the reports with field visits, thus assuring accuracy.

Indicators used to measure accomplishment were clear, specific, and consistent. From 1990 to 1992, however, some local offices submitted reports every six months, others every trimester, others every month. In 1992 reporting was almost non-existent. Extension agents recalled that one explanation for the erratic reporting was that little was being accomplished in the field.

To supplement trimester reports and narrative reports, other LUPE records such as work plans and evaluation documents were consulted to glean complimentary information. The diversity and quantity of records made it challenging to obtain the time series data required to estimate the costs of extension programming for the period 1990-1992, but the advantage of consulting multiple data sources was the opportunity to verify data accuracy. Data consistency and quality for the period 1993-1997, confirmed through cross-checking, was deemed excellent.

During the summer of 1998, group and individual interviews with LUPE personnel were conducted to collect information not formally documented in LUPE reports (Santos 1999). A panel discussion was held with those who had worked in the Namasigüe and El Triunfo offices between 1990 and 1998. Little personnel turnover had occurred, which made it possible to reconstruct quite accurately important operational details. The most important data from this panel discussion was an estimate of how extension agents allocated their time (Table 1).

Table 1. Typical time allocation by a local extension office, LUPE program, Honduras

	1990	1991	1992	1993	1994	1995	1996	1997
Field extension tasks								
Assistance to PEC*			35%	67%	67%	67%	60%	60%
Training of PEC*			10%	15%	15%	15%	15%	15%
Direct assistance to farmers	70%	70%	15%	3%	3%	3%	0%	0%
Micro watersheds			10%	5%	5%	5%	10%	10%
Environmental education in rural schools			10%	3%	3%	3%	8%	8%
SUBTOTAL	70%	70%	80%	93%	93%	93%	93%	93%
Administrative activities			5%	2%	2%	2%	2%	2%
Planning/evaluation/monitoring			15%	5%	5%	5%	5%	5%
SUBTOTAL			20%	7%	7%	7%	7%	7%
TIME SPENT on ag activities (as a percentage of total time)								
Vetiver grass live barriers	5%	5%	2%	3%	22%	22%	21%	21%
Rock walls	39%	39%	19%	25%	18%	18%	17%	17%
Other ag. practices (including mulch)	48%	48%	24%	31%	19%	19%	18%	18%
TOTAL	91%	91%	45%	60%	60%	60%	56%	56%

* PEC = Productores Enlace Colaboradores, i.e. farmers trained and working as local extension agents

Subsequently, individual interviews were conducted with sixteen LUPE employees, including Operations Director, Finance Director, Head of the monitoring unit, field extension agents, and administrative assistants. In individual interviews, interpretation of LUPE report forms, interpretation of financial information, and subtleties of extension methodology were discussed.

LUPE total expenditures for the period 1990-1997 totaled almost US$13 million. For a detailed description of annual operating expenditures in nineteen categories, see Santos (1999, p. 37). The average cost of operating a local LUPE office for this period was US$ 615,670; for a detailed breakdown of these average cost figures, see Santos (1999, p. 40).

To estimate adoption rates, two statistics were crucial from trimester reports at the beginning of 1993: the cumulative number of farmers receiving assistance and adopting new technologies and the area under SWCPs. These cumulative total statistics reflected only the accomplishments that could be attributed to LUPE and that could be verified in the field. Though adoption data were collected and reported for each year from 1990 through 1997, the annual estimates for 1990, 1991, and 1992 were not reliable. For purposes of this study, the arithmetic mean of the cumulative total reported in 1993 was used to represent accomplishments for the years 1990, 1991, and 1992.

Interviews with steepland farmers regarding their perceptions of LUPE's extension programs

To learn more about steepland farmers' responsiveness to LUPE's extension programming, in July, 1998, 163 farmers in the Namasigüe watershed were interviewed. Interviews with 160 farmers had been planned, stratified two ways: half were from the locality of Namasigüe and half from the locality of El Triunfo, and half had used SWCPs for at least three years and half were non-adopters. The SWCPs used by adopters were rock walls or VGLB or both. All farmers interviewed had been visited by a PEC (Productor Enlace Colaborador -- farmers trained by LUPE to aid the local extension effort) previously, thus all had considered whether or not to adopt SWCPs. Only farmers who had used a SWCP for over three years were interviewed because, in general, it is two to three years after installing them when farmers report that they fully appreciate the benefits from SWCPs. Interviews with 163 farmers were actually conducted, but ten were discarded because of contradictory responses or because they operated farms substantially larger than normal LUPE standards (suggesting farmers wealthier than the norm). The final sample analyzed was 153, representing 77 farmers from El Triunfo and 76 farmers from Namasigüe.

Interviews were conducted as a conversation rather than as a question-and-answer session, in order to elicit candid opinions. This permitted the farmer to explain in his own words his experience with soil conservation on his farm, and his impressions of LUPE programming, rather than the farmer providing the response which he thought the interviewer was seeking. Interviews were often lengthy; sometimes only four farmers were interviewed in a day of work. Four interviewers were needed to conduct the survey within the month of July, 1998. LUPE's PEC farmer agents recommended which farmers met the criteria for inclusion in the research project and guided the interviewers to the prospective interviewees' farms.

RESULTS OF LUPE'S SOIL CONSERVATION EXTENSION PROGRAMS

The three conservation technologies which LUPE promoted were mulching, vetiver grass live barriers (VGLB), and rock walls. LUPE had their greatest successes in promoting VGLB and rock walls with farmers who had already made the transition to mulching, for whom VGLB and rock walls were the second step in their adoption process. For the local offices operated in the localities of Namasigüe and El Triunfo, the average area under these three SWCPs was estimated. The average area under SWCPs as a result of LUPE extension efforts in 1997 was 326.5 ha/locality. The use of mulch cover accounted for most of the protected cropland (291 ha/locality) and smaller areas were protected with

rock-walls (1.3 ha/locality) and vetiver grass live barriers (23.8 ha/locality).

Analysis of extension activities relative to results

Four factors were helpful in understanding differences between the El Triunfo and Namasigüe extension effort and results: the number of extension agents in the field, the availability of vehicles, the number of farmers assisted, and the number of hectares where SWCPs were installed.

Number of extension agents

The LUPE office in El Triunfo had more manpower to provide extension services than did the Namasigüe office. The team of professional extension agents in El Triunfo was fully staffed, in accord with what LUPE considered optimal, and there were no personnel changes during the period 1990-1997. The number of PEC farmer agents was also consistently higher in El Triunfo than in Namasigüe. There was an average ratio of 3.5 PEC farmer agents per professional extension agent in El Triunfo, while in Namasigüe the ratio was 4.6.

This means that the El Triunfo office had more capacity to train, supervise, assist, and support farmer agents than did the Namasigüe office. LUPE had a sufficient budget and administrative authority to hire additional personnel for the Namasigüe agency, but none were hired. None of the LUPE personnel interviewed in July, 1998, could explain this under-staffing phenomenon.

Availability of vehicles

The Namasigüe office struggled with transportation problems throughout much of the period 1990-1997. The vehicle assigned to the agency was broken for most of the period of 1993-1995, forcing the extension agents to rely on occasional support from other agencies or other headquarter-borrowed cars. The lack of reliable transportation hindered the operational efficacy of all Namasigüe's field-related activities, in particular during the critical transition years of 1994 and 1996. This had a direct effect on the supervision and monitoring activities, training, and the production and distribution of vetiver grass planting material. The vehicle assigned to the agency of El Triunfo was broken only once, during half of 1994.

Number of farmers receiving assistance

In the two localities in the Namasigüe subwatershed, 743 farmers received LUPE assistance with the adoption of SWCPs. The El Triunfo office had more personnel and more reliable vehicles than did Namasigüe; accordingly, LUPE in El Triunfo assisted more farmers than did Namasigüe. In El Triunfo, 460 farmers worked with LUPE, 42% of the prospective population. In Namasigüe, 283 farmers worked with LUPE, 32.5% of the prospective population. Figure 2 shows that the number of newly enrolled farmers each year, 1993 through 1997, was lower in Namasigüe than in El Triunfo, except in 1994.

Both agencies experienced significant gains in the numbers of new farmers working with LUPE in 1994 when the PEC farmer extension agents entered the field. Figure 3 shows the total number of farmers assisted by LUPE in Namasigüe and El Triunfo. Consistent with Rogers' model of the diffusion of new technologies (1995), the cumulative number of farmers working with LUPE plots to a logistic curve. For the decade of the 1990s, farmer participation in LUPE activities in Namasigüe was consistently lower than in El Triunfo. For LUPE as a whole, 40 was the average number of farmers whom one extension agent could effectively assist. Staff numbers were not only consistently higher in El Triunfo, but also increased at a faster pace than in Namasigüe. More personnel allowed the local office in El Triunfo to work with more new farmers, while continuing to follow up with existing clientele.

Area on which mulch system was adopted

LUPE considered a farmer to have adopted a mulch system if two conditions were satisfied: first, if burning was eliminated and,

Figure 2. Newly enrolled farmers in LUPE soil and water conservation activities in Namasigue and El Triunfo, southern Honduras

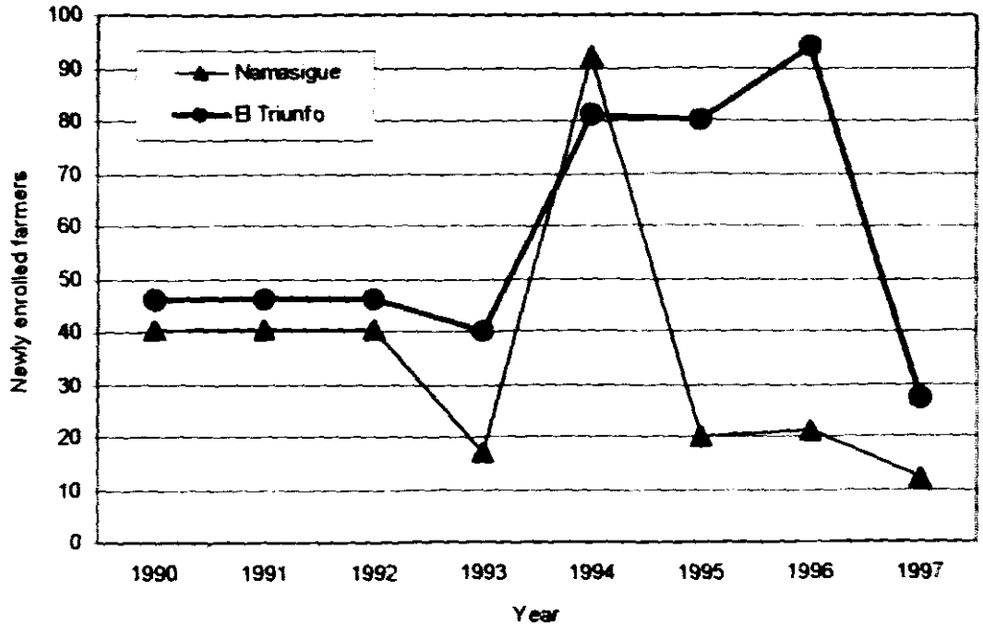


Figure 3. Total number of farmers assisted by LUPE with adoption of soil and water conservation practices in the Namasigue and El Triunfo local offices, southern Honduras

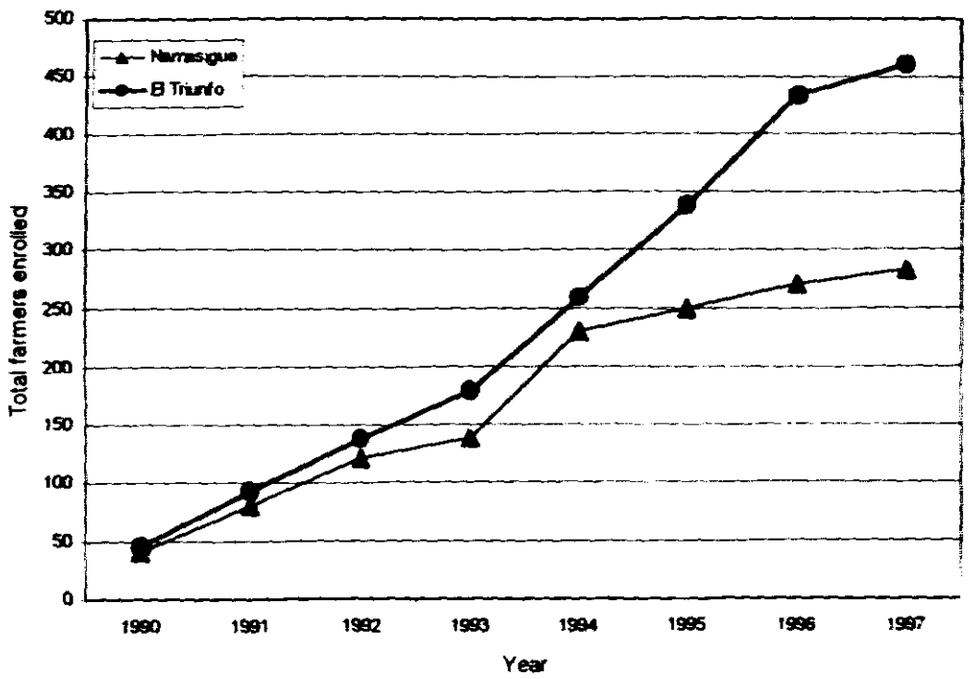
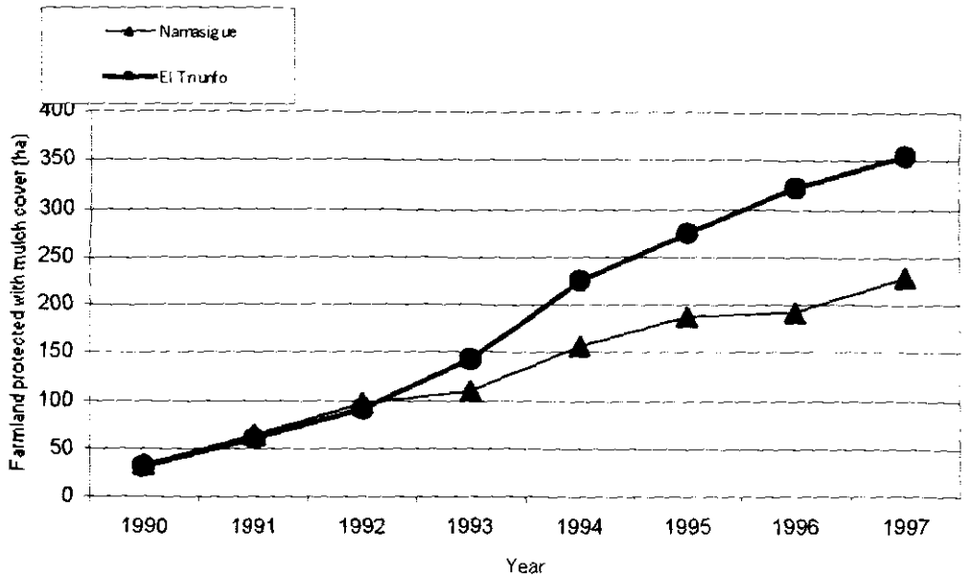


Figure 4. Total hectares protected with mulch cover by farmers assisted by LUPE in Namasigüe and El Triunfo, southern Honduras



also, if crop residues were left on the field (i.e., no harvesting of crop residue, including no grazing by livestock). Due to LUPE initiatives in Namasigüe, 227.9 ha were protected by mulch; in El Triunfo 354.9 ha were protected by mulch. Figure 4 depicts farmers' cumulative adoption of mulching. For both local offices there was steady growth in adoption of mulch. Adoption levels in El Triunfo, however, were consistently higher than in Namasigüe, reaching a higher level, and occurring at a faster-increasing rate.

Area on which VGLB & rock walls were installed

Adoption of VGLB and rock walls occurred at a slower rate than adoption of mulch. In Namasigüe 14.6 ha were protected by VGLB due to LUPE's efforts, and 33.1 ha were protected in El Triunfo. The area under rock walls was 12.6 ha in Namasigüe and 10.0 ha in El Triunfo. VGLB were implemented at a more rapid rate than were rock walls (Figure 5 and Figure 6).

Discussion of observed adoption patterns

Farmers tend to be most responsive to technologies that require the least commitment, in both economic terms and physical terms. For steepland farmers in southern Honduras, switching from traditional slash-and-burn farming system to mulch practices required little economic commitment as compared with installing either rock walls or VGLB. Observed farmer participation in LUPE programming follows patterns consistent with Rogers' (1983) general observation that people are reluctant to adopt innovations if their investments cannot be reversed in the future with only minor losses.

A related issue is that technology diffusion is most rapid on technologies which are easy to try, which Rogers (1995) dubbed good "triability." Before farmers adopt a new technology, they collect their own evidence about it. Use of mulch cover can be tried easily, with

Figure 5. Total farmland protected by vetiver grass live barriers by farmers receiving LUPE assistance in Namasigue and El Triunfo, southern Honduras

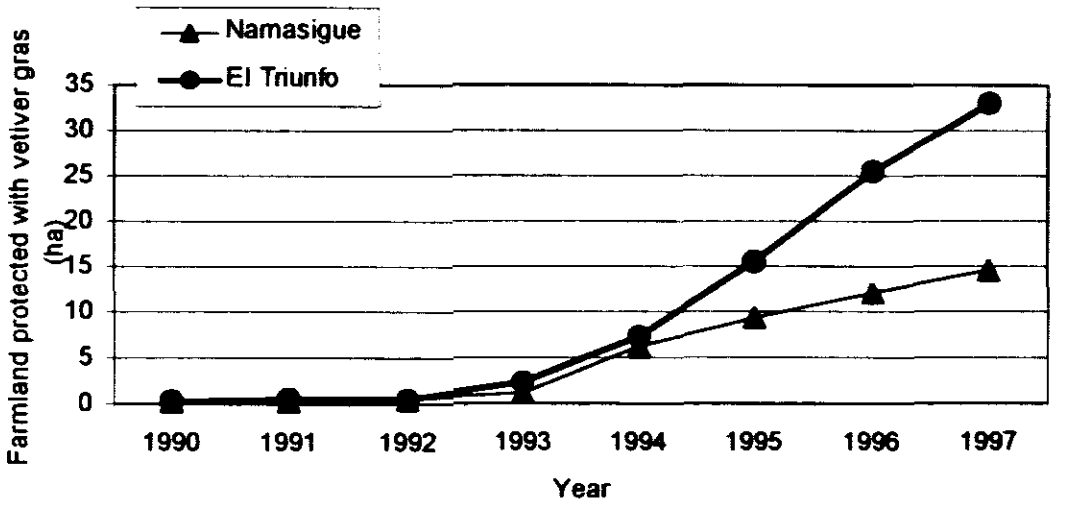


Figure 6. Total farmland protected by rock walls by farmers receiving LUPE assistance in Namasigue and El Triunfo, southern Honduras

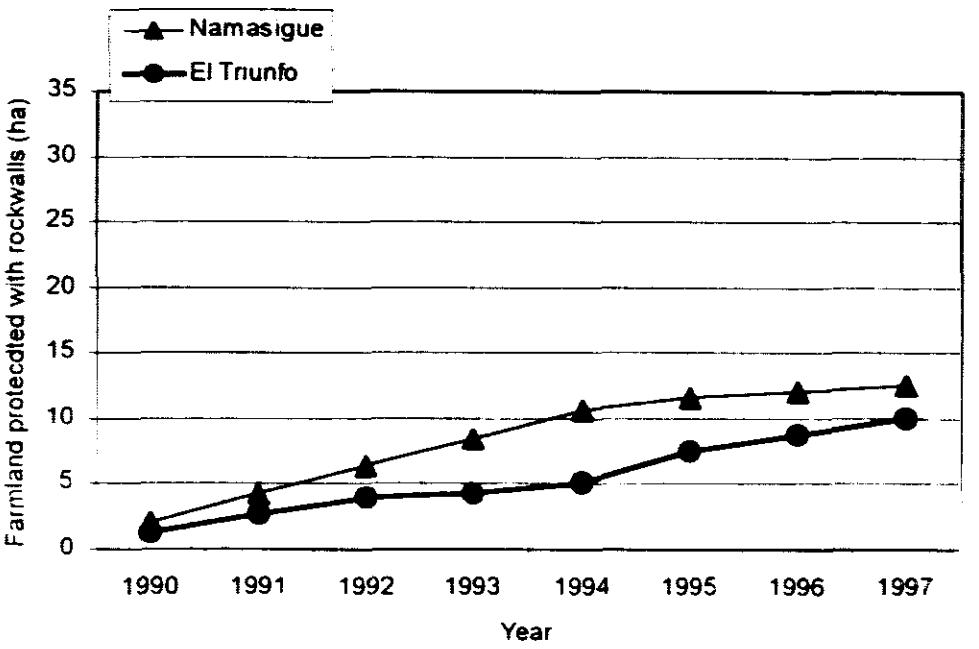


Plate 5. The better soil/water/nutrient storage enabled by rock terraces enabled more reliable crop production behind the terraces. The more reliable crop production (reduction of risk) was was very important to the farmers.

Plate 6. Maize, sorghum and beans are important staples of the diet, but command a very low market price. The better water and nutrient characteristics behind the rock terraces enabled farmers to plant fruit crops with greater market value (banana, coffee, papaya, etc. planted in a diverse mix). This picture was taken in 1999 at the same location as in Plate 5 (taken in 1993).

Plate 7. A landscape view of the phenomenon discussed in Plate 5 and 6. This is a 1993 photo of a rock terraced landscape established in 1985.

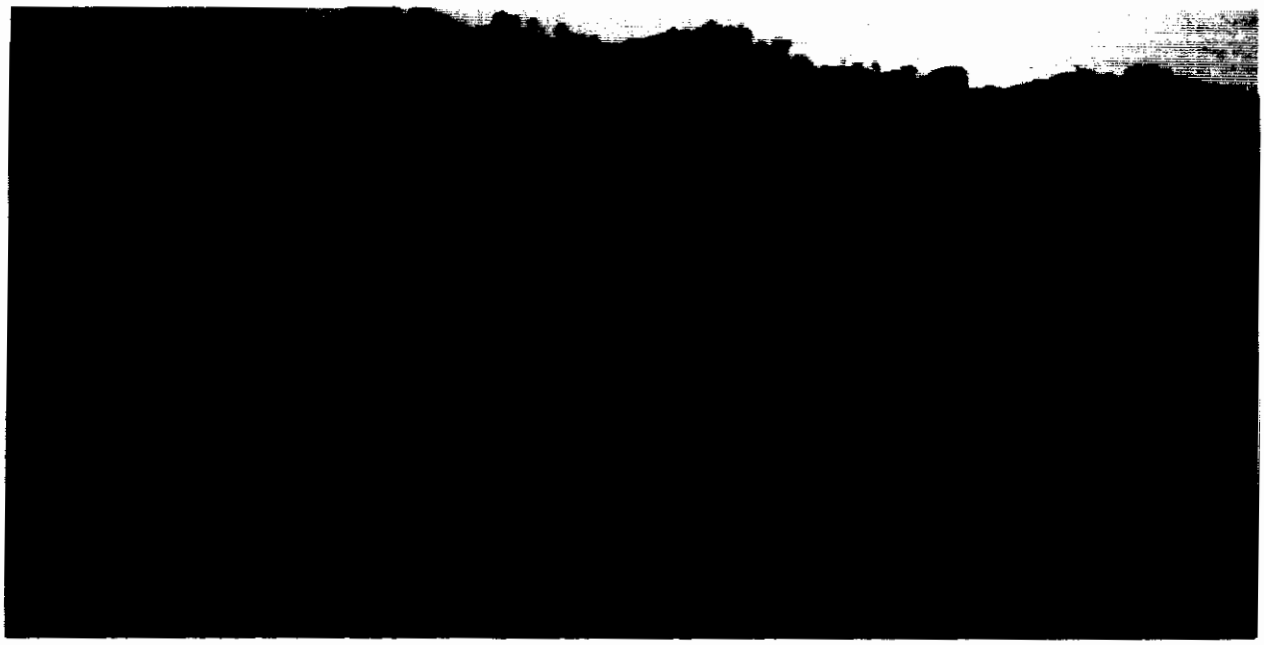


Plate 8. A landscape view of the same hillside in 1999 (the roofs of the houses are visible but mostly hidden by trees - orient your view by the hills on the skyline). This shift in land use associated with terraces was a phenomenon driven by individual farmer decisions: this step in the evolution of terraced field use was not directly associated with a LUPE extension objective. Thus, after about 40 years this hillside has returned to forest cover (albeit fruit trees instead of native forest). Tree cover affords the best protection of the steepland watershed.

nominal cost. If performance of the new system is not consistent with expectations, then it is easy to revert to the traditional system at a low cost. Rock walls and VGLB, in contrast, are both more expensive and more permanent. Once implemented, they are costly to remove. If dissatisfied, the farmer will not only have squandered the physical and economic effort expended to implement the practice, but also must commit additional resources to remove them or work around them. VGLB are easier to try than are rock walls, a partial explanation for more hectares under VGLB than rock walls in both Namasigüe and El Triunfo. Moreover, mulch has significantly better triability mulch than either VGLB or rock walls. Triability is an important component of LUPE's framing of their technologies as part of a two-stage education process, first mulch and then VGLB or rock walls.

Diffusion of VGLB

Before 1993, LUPE emphasized rock walls and mulch practices; VGLB were first introduced in 1993 when nurseries were established to provide all LUPE local offices with a stock of vetiver grass.

Prior to 1993, the only locally-available grasses were King grass (*Pennisetum purpureum* x *Pennisetum typhoides*) or elephant grass (*Pennisetum purpureum*) which most farmers considered to be too competitive with their crops for water and nutrients and too invasive (requiring intensive control) to use as live barriers. The limiting factor in 1993 and 1994 for LUPE's promotion of VGLB was availability of planting materials; only after two years (i.e., 1995 or 1996) could vetiver slips from VGLB planted in a farmer's field be used as a source for planting materials for other farmers. Both the quantity of vetiver plants available and access to reliable transportation made a difference in local offices' effectiveness in helping farmers to adopt VGLB.

In 1993 both of the local LUPE offices, in El Triunfo and in Namasigüe, were given an initial nursery stock from which to produce vetiver plants. Distribution, however, was limited in Namasigüe because they had no working vehicle for 83% of the time during the period 1993 - 1995. Because the Namasigüe LUPE office was not able to distribute planting material to potential adopters, production of vetiver slips was limited to the initial sites where it had been established, thus constraining the span and rate of diffusion of VGLB in subsequent years.

Diffusion of rock walls

The number of hectares enrolled in rock walls were consistently higher in Namasigüe than in El Triunfo, a reversal of patterns observed for mulch and VGLB. Higher adoption levels in Namasigüe may be partially explained because less effort was being expended to disseminate VGLB than in El Triunfo, since Namasigüe personnel had no transportation to disseminate vetiver slips.

A more fundamental issue – according to anecdotes related in interviews with LUPE personnel familiar with activities in the Namasigüe subwatershed – was that the extension agent in the local office in Namasigüe had several years of experience with farmers who had successfully adopted rock walls and harbored a strong bias in favor of them. Rock wall adoption rates were consistently high in Namasigüe until 1995, when this experienced extension agent was moved to another local office. When a new agent arrived in Namasigüe, adoption rates for rock walls plateaued. Rogers (1995) corroborated the general observation that an experienced extension agent's beliefs and preferences often exert an influence on the content of educational messages, both directly and more insidiously.

COST OF THE LUPE EXTENSION PROGRAM

The total costs of LUPE programming, involving over 40 local offices plus its centralized administrative support division, were estimated at US$ 12,969,513 for the nine-year period, from 1989 through 1997. This estimate includes salaries and labor for extension agents,

administrators, and PEC farmer agents; pensions, insurance, and accident compensation; rental of facilities, vehicle maintenance and fuel; technical training and per-diems. The capital costs of purchasing vehicles is not included in this total cost figure. For a detailed description and breakdown of these costs, please refer to Santos (1999).

For the period 1990 to 1997, the average cost of operating each local office was US$ 615,670. Dividing this figure to match the time allocation of LUPE local office personnel (as described in Table 1), the share of this cost attributable to the transfer of agricultural practices was US$ 229,963. (The definition of "agricultural practices" includes mulch as well as other productivity-oriented agricultural practices adopted simultaneously.) The average cost per local office of transferring rock walls for the period 1990-1997 was US$ 155,553. The average cost per local office of transferring VGLB for the period 1990-1997 was US$ 13,787).

For the two local offices in Namasigüe and El Triunfo for the period 1990-1997, the average per-hectare cost of LUPE's programming to promote the adoption of mulch was US$ 663/ha. On average it cost US$ 2,458/ha to transfer the VGLB technology to steepland farmers. The average per-hectare cost of transferring rock wall technologies was US$ 13,787/ha. Figure 7 depicts how the annual costs of technology transfer decline over time for these three conservation practices. The marginal reduction in costs over time is most dramatic for the technologies which are most expensive to transfer, rock walls and VGLB.

COSTS OF LUPE IN SOIL SAVED

The largest marginal reduction in soil loss occurs when a farmer initially adopts mulching. Thurow and Smith (1998) documented that traditional slash and burn practices averaged 92 tons/ha/yr soil loss and mulch-managed fields averaged 39 tons/ha/yr soil loss, thereby resulting in a 53 ton/ha/yr reduction in soil loss when mulching was adopted. The substantial extra effort and cost required to encourage adoption of rock walls or VGLB after mulching has already been adopted results in an incrementally smaller decrease (i.e., a reduction of an additional 38 tons/ha/yr soil loss). Figure 8 shows the average costs of soil saved, attributable to LUPE programming, on an annual basis.

The initial costs of transferring VGLB and rock walls technologies to farmers, in the first years of programming, were substantial. After the LUPE program was well established, however – by the mid-1990s – the cost per ton of soil saved was similar for the three practices. This corroborates the notion that programming to promote these technologies is indeed framed appropriately as a two-stage educational process (mulch, then VGLB or rock walls). More importantly, these average annual costs of soil savings take into account the fact that most of the benefits associated with adoption of mulching accrue soon after they are adopted. In contrast, the per-hectare benefits associated with adoption of VGLB and rock walls are sustained over time. Because the initial costs of working with a farmer to establish VGLB and rock walls are relatively high, the average annual costs of extension programming to support adoption of VGLB and rock walls plateau in the third year after they are adopted, and are low thereafter.

In summary, large numbers farmers in Namasigüe and El Triunfo during the 1990s were responsive to efforts by LUPE to promote mulch. The minority of farmers who also adopted VGLB and rock walls, however, achieved soil savings at per-ton costs quite similar to the costs to LUPE of promoting mulch. Costs and benefits and trade-offs associated with extension programming to promote these three SWCPs will be discussed, in formulating policy implications from this study in the final section of this publication. To set the stage for this interpretative discussion, more detailed analysis of whether and when steepland farmers in southern Honduras were responsive to LUPE's educational messages is presented in the following section. Data from interviews with farmers in Namasigüe and El Triunfo are summarized and discussed.

Figure 7. Average annual cost of a LUPE local office to work with new farmers adopting SWCPs in Namasigüe and El Triunfo, southern Honduras

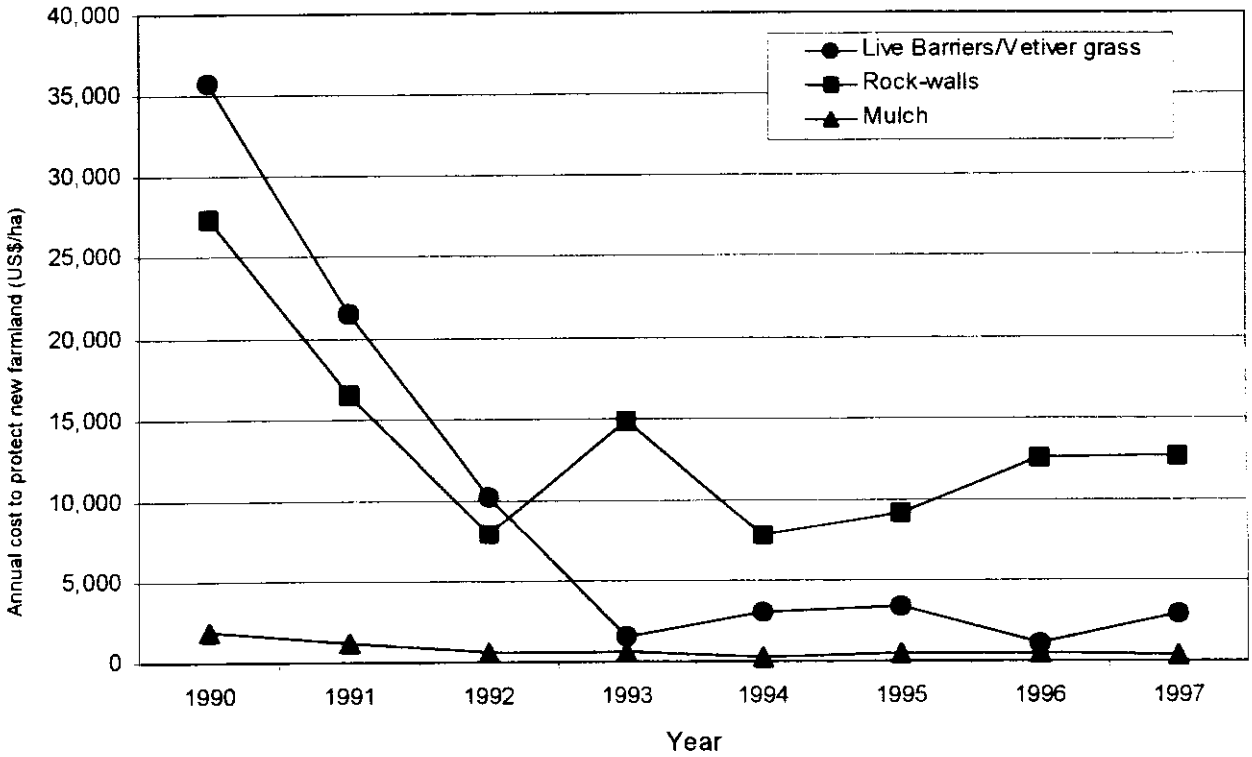


Figure 8. Average annual costs of soil saved due to adoption of mulching, vetiver grass live barriers, and rock walls in response to LUPE programming in local offices in Namasigüe and El Triunfo, southern Honduras

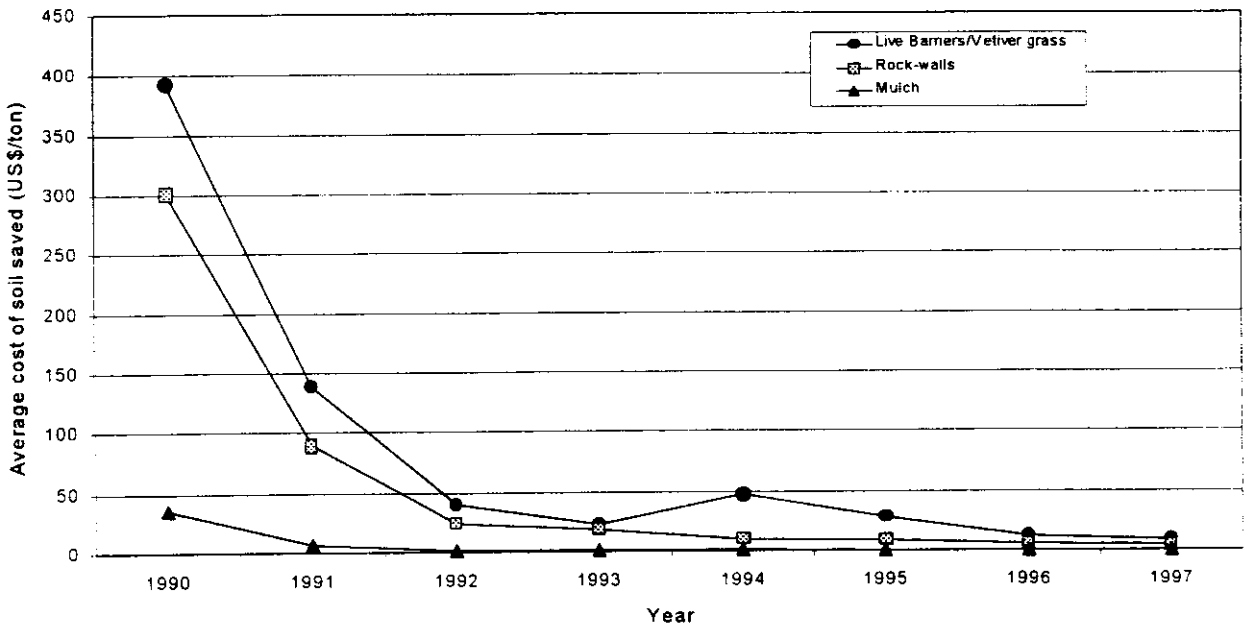
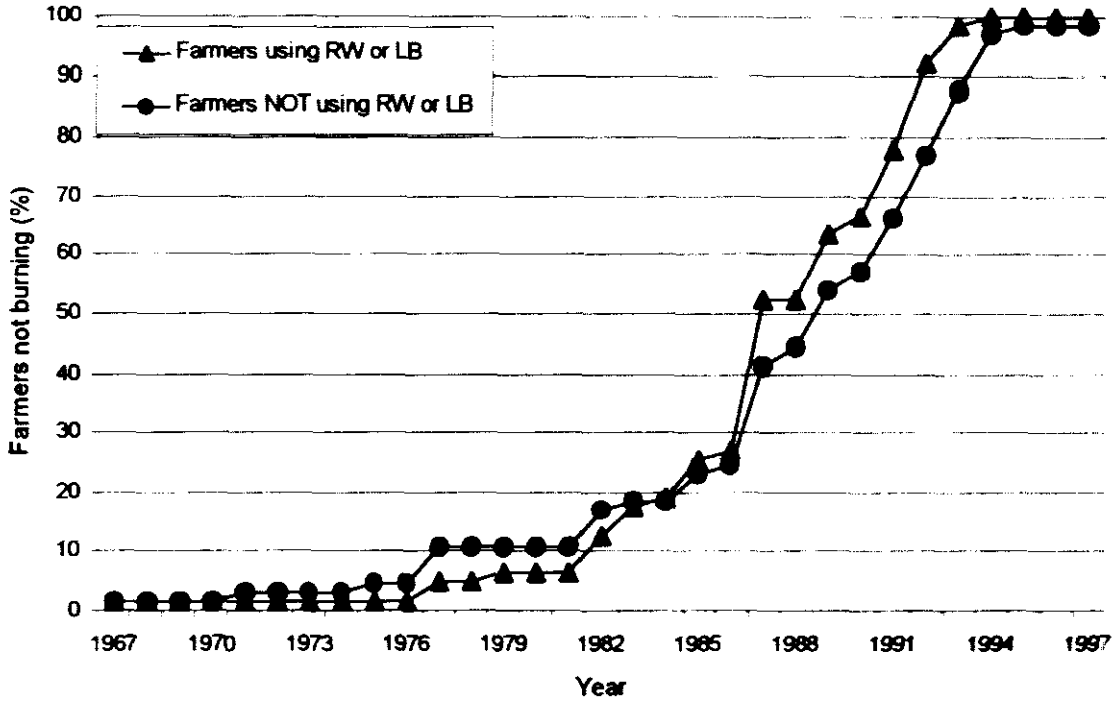


Figure 9. Percentage of farmers not burning their cropland in Namasigue and El Triunfo, 1967 to 1997, grouped by adoption and non-adoption of rock walls (RW) or vetiver grass live barriers (LB)



FARMERS' DECISIONS WHETHER OR NOT TO ADOPT CONSERVATION PRACTICES

Characteristics of the farmers interviewed

Interview data collected in July, 1998 for 153 farmers in the Namasigüe watershed were analyzed. Seventy-seven of the respondents worked with LUPE's El Triunfo office and 76 worked with the local office in Namasigüe. The average farmer interviewed was 47 years old. Average farm size was 4.6 hectares. Seventy-four percent of the farmers interviewed expressed the belief that they have an erosion problem on their farm.

Shift from slash and burn to mulch management

Only one of the 153 farmers interviewed still uses fire to prepare his fields for planting. On average, the farmers interviewed had farmed for nine years without burning their fields. Figure 9 shows the percentage of farmers who had ceased to burn for the period 1967 to 1997, in Namasigüe and El Triunfo. Before 1982, 90% of these farmers used slash-and-burn farming techniques. By 1990, those burning had dropped to 40%. Virtually all burning had ceased by 1994. This upswing in the adoption of mulch management (i.e., elimination of burning) corresponds with the early activities of the NRDP and LUPE programs in the region. The results should not be interpolated to suggest that slash-and-burn

techniques have died out in southern Honduras. During the summer of 1998, numerous observations of burning cropland were reported in the Departments of Choluteca and Valle. The extent of burning appears to differ between areas influenced by LUPE programming and those without active conservation extension initiatives.

Technology choice of VGLB & rock wall adopters

The population of 153 farmers surveyed were stratified to represent half farmers who had adopted either rock walls or VGLB at least three years before ("adopters," N = 75) and half farmers who had been visited by a PEC farmer agent but had not installed either ("non-adopters," N = 78). Among the 75 adopters interviewed, 38 were using both rock walls and VGLB (15 in Namasigüe and 23 in El Triunfo). Thirty adopters had installed rock walls only (17 in Namasigüe, 13 in El Triunfo). Six adopters in Namasigüe and one in El Triunfo were using VGLB only. Among the adopters interviewed, 41% used rock walls only and only 9% used VGLBs only. Fifty percent used both SWCPs. This sampling reflects a significantly larger proportion of farmers using rock walls than in the general population of adopters in Namasigüe and El Triunfo.

Rock wall adopters were over-sampled because the PEC farmer agents who directed interviewers to interviewees was instructed to select only farmers who had used a permanent SWCP for at least three years (i.e., before 1995). Adoption of VGLB began in 1993 but was strongest after 1995. Farmers started using rock walls in the 1980s. To make sure that they selected farmers who had adopted a SWCP before 1995, they inadvertently over-sampled early adopters, which meant mainly those who had installed rock walls. The farmers interviewed had been using SWCPs for an average of seven years in Namasigüe and six years in El Triunfo.

Perceptions of crop yield differences between conservation treatments

Adopters reported an average 70% increase in their crop yields after installing rock walls and/or VGLB, comparing 1998 yields with yields six to ten years earlier. Non-adopters in Namasigüe reported production declining by 12%, on average, comparing current yields with yields from six to ten years before; non-adopters in El Triunfo reported a 23% increase in production for the same comparison. Differences in fertilizer use are a partial explanation for this discrepancy among non-adopters in the two localities: in El Triunfo, 78% of non-adopters use fertilizer whereas in Namasigüe only 55% use it.

Motivators and obstacles to adoption

Statistical analysis was conducted to identify factors which made a difference in this group of farmers' decisions about whether to adopt rock walls and/or VGLB. In fitting a logit model to predict adoption, five explanatory variables were used: the farmer's locality (i.e., Namasigüe or El Triunfo, age, farm size, how much the farmer believes erosion is likely to be reduced if a SWCP is installed, and whether the farmer perceives an erosion problem on his own cropland. The two explanatory variables which were statistically important were perception of an erosion problem and the expected improvement in crop yields associated with adoption. The logit model predicted that for the average participant in this research project – a 46-year-old farmer whose farm is 4.6 hectares – the likelihood of adoption increases by 0.94% for every kilogram increase in production expected in conjunction with adoption. An average respondent is 95% more likely to adopt if he perceives an erosion problem on his own cropland than if not.

In an open-ended discussion format, adopters were asked to identify the factors which made a difference in their decision to adopt a SWCP. The most prevalent response was that they perceived an erosion problem, indicated by 89% of Namasigüe respondents and all of the El Triunfo respondents (e.g. "My cropland was too deteriorated." "Sloughing washed away my soil." "Fertility and crop production was in decline."). The second most important, and consistent, response from adopters was that they received technical advice from LUPE (55% of adopters in

Namasigüe, 70% in El Triunfo). Only 24% of Namasigüe adopters and 16% of El Triunfo adopters mentioned other factors.

Responding to a similar open-ended question, non-adopters named diverse obstacles to adoption, listed in Table 2. The percentages do not sum to 100% because each respondent was encouraged to offer multiple explanations for non-adoption. Most prevalent responses were the cost of installation, labor constraints, the need for crop residues for livestock, and lack of technical assistance or materials. Drawing on their experience with rock walls and/or VGLB, adopters were asked to describe their experience in adopting and working with SWCPs. Each respondent listed multiple advantages and disadvantages associated with adoption, as listed in Table 3. The most commonly cited disadvantages were the expense of initial installation and the loss of crop residues used as livestock fodder during the dry season.

Maintenance intentions and overall satisfaction with SWCPs

The farmers interviewed were unanimously positive in their response to questions about whether rock walls and/or VGLB are worth installing and whether they are worth maintaining. Asked "now that you have installed SWCPs on your farm, if you had it to do again, would you?" all 65 respondents said they would. Furthermore, 63 of the 65 respondents expressed their intention to continue maintaining their SWCPs. Only two elderly respondents were concerned that they were too old to maintain existing conservation structures. Table 4 summarizes farmers' intentions concerning expanding the area on their farms under SWCP. Eighteen percent of adopters have all their cropland under rock walls and/or VGLB; another 72% intend to install more SWCPs.

Table 2. Obstacles to adoption of soil and water conservation practices, as described by non-adopters, southern Honduras, 1998

	Namasigüe (N=38)	El Triunfo (N=40)
Too costly to establish	15 (39%)	36 (90%)
Crop residues needed as livestock fodder during the dry season	14 (37%)	16 (40%)
Do not have time	12 (32%)	19 (48%)
Do not believe they work	11 (29%)	1 (3%)
Do not have materials (rocks or vetiver slips)	11 (29%)	26 (65%)
Need technical assistance to install them	9 (24%)	31 (78%)
Loss of income from renting the land for crop residues during the dry season	8 (21%)	15 (38%)
Work off farm, cannot hire someone to install them	8 (21%)	8 (20%)
Ceasing burning is enough to maintain production	6 (16%)	1 (3%)
Do not have an erosion problem	5 (13%)	11 (28%)
Do not think I need them	3 (8%)	12 (30%)

Table 3. Adopters' perceptions of the advantages and disadvantages associated with the use of rock walls and/or VGLB, southern Honduras, 1998

	Namasigüe N=38	El Triunfo N=37
ADVANTAGES OF USING SWCP:		
Increased crop yields	32 (84%)	34 (92%)
Reduced loss of soil, fertilizer, and/or organic matter	19 (50%)	35 (95%)
Conserves soil moisture, thereby reducing consequences of drought	17 (45%)	37 (100%)
Crops are more ordered in rows, thus are easier to manage	16 (42%)	24 (65%)
It is easier to plant crops and do the weeding	15 (39%)	27 (73%)
Recovers soil fertility	11 (29%)	17 (46%)
Forms terraces	7 (18%)	1 (3%)
DISADVANTAGES OF USING SWCP:		
Cannot use the crop residues to feed livestock during the dry season	23 (61%)	12 (32%)
Too costly to establish	15 (39%)	26 (70%)
Lose cropping area occupied by the SWCP	3 (8%)	4 (11%)
More difficult to plant the crops	0 (0%)	9 (24%)

Table 4. Adopters' intent to increase the area on their farms under SWCPs, southern Honduras, 1998

	Namasigüe N=38	El Triunfo N=37
Farmers who have all their cropland under rock walls and/or VGLB	9 (24%)	4 (11%)
Farmers who have only a portion of their cropland protected with SWCP	29 (76%)	33 (89%)
Farmers who plan to protect more of their cropland with SWCP	22 (58%)	32 (86%)
"What are the obstacles to your expanding your use of SWCPs?"		
It is costly ... I don't have the money	11 (29%)	25 (68%)
I do not have time ... I also work off-farm ... I must provide food for my family	11 (29%)	16 (43%)
I do not have the materials (rocks or vetiver slips)	9 (24%)	0 (0%)
I need the crop residues to feed my livestock	3 (8%)	1 (3%)
I am too old to do it myself	2 (5%)	0 (0%)
I have not been interested	1 (3%)	1 (3%)
I am not sure of land ownership	1 (3%)	0 (0%)

SUMMARY

Based on interviews with LUPE collaborators in Namasigüe and El Triunfo, perhaps the most convincing endorsement of the value of rock walls and VGLB to steepland farmers is their willingness to maintain the structures and, furthermore, their affirmation that if they had the choice to re-consider their adoption decision they would, indeed, make the same choice again, to adopt. Most adopters intend to expand the proportion of their cropland under SWCPs, another strong indicator that they consider them worthwhile. The most important obstacles to adoption were the initial costs of installing conservation practices and farmers not perceiving a soil erosion problem on their cropland. The education and aid provided by LUPE was targeted at helping farmers overcome these obstacles.

LUPE's experience in Namasigüe and El Triunfo in the 1990s demonstrates that mulching is the least costly to promote and most readily accepted SWCP offered to steepland farmers in southern Honduras. For these two localities, on average 291 hectares per locality were protected from erosion with mulching, at an average **total** cost of US$ 663 per hectare. Promoting VGLB cost a total of US$ 2,458 per hectare, on average, and VGLB were installed on 23.8 hectares per locality. Promoting rock walls cost a total of US$ 13,787 per hectare, on average, and rock walls were installed on 1.3 hectares per locality. However, Figure 8 – a comparison of the average **annual** cost of the soil saved from adoption of these three practices – highlights an important issue: because the soil saving benefits from rock walls and VGLB are sustained over time, as the costs of LUPE programming to get them adopted are averaged over time, they become comparable with the average annual costs of promoting mulch. The cost saving differential associated with extending mulching as opposed to rock walls and VGLB is obtained in the first several years of the program, after which there is little difference in the average annual cost of soil saved by implementing any of the three technologies.

CONCLUSIONS AND POLICY IMPLICATIONS

Widespread diffusion of the mulching practice by LUPE was an effective extension strategy for two reasons. First, it was readily adopted by a large number of farmers and their use of mulch saved a significant quantity of soil. Second, it is the logical first step in a conservation education process: farmers are most open-minded to considering investment in more permanent conservation practices, such as rock walls and VGLB, after having had a positive experience with reducing erosion through the use of mulch. Indeed, mulching is the first step in a two-step conservation technology adoption-and-diffusion process necessary in southern Honduras. The second step, adoption of a technology such as rock walls or VGLB, is necessary to tie the soil onto the hillside, thereby reducing soil erosion to a rate that does not exceed estimates of soil formation rates.

The cost per amount of soil saved associated with taking the second step of installing rock walls or VGLB is initially much greater than convincing farmers to stop burning and grazing their fields. Because of this, it would make sense if these more targeted – including further extension programming, education and technical assistance – to sites where erosion hazard is greatest and/or sites where erosion is known or suspected to cause significant downstream intensive conservation investments were damages. Policy makers in the United States started discussing how to target conservation expenditures to reduce the water quality damages from cropland erosion in the 1980s (Batie 1984), and similar proposals have been raised more recently within the context of Latin American soil conservation (Scherr 1999). A rationale for these targeting decisions will be provided in the next publications in this series using a Geographic Information System (GIS) analysis of the factors that determine where erosion rates are greatest within the watershed.

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Back Cover:

Vetiver grass was one of the soil and water conservation technologies introduced into the region by LUPE. Prior efforts to encourage establishment of rock wall terraces showed that farmers maintained and valued the rock wall terraces, but the effort associated with building the terraces was a substantial barrier to self-motivated expansion of this technology. Vetiver grass was able to quickly form terraces upslope of the ridgid buchngrass lines that were planted following the contour of the slope: thereby enabling the objective of tying the soil onto the hillside without having to invest in the rigourous labor necessary to build rock terraces. Both rock or vetiver grass terraces proved to be very effective at preventing landslides, even during the extreme rainfall event (39 inches of rain {991 mm}in three days) that occurred during Hurricane Mitch.