Stymieing Soil Erosion on Hillsides in Honduras
A New Rural Agenda

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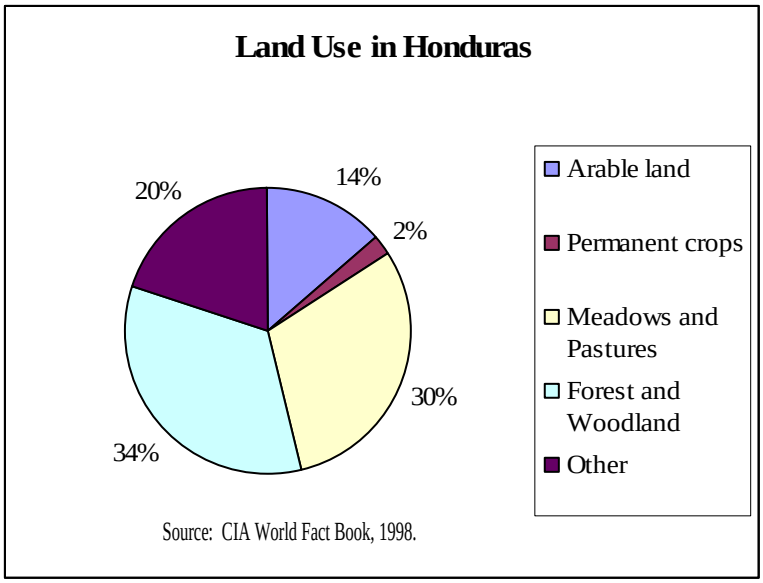
> *"It used to be really good land, for everything…We planted rice, corn, beans, yucca, whatever touched the ground grew. But not anymore…Whatever you plant dies, the leaves turn yellow and they die. The soil is no good now, it's salty and bitter."* - Maria Elena Filde, Atlantic Coast of Honduras (Lobet 1999).

BACKGROUND AND SERIOUSNESS OF THE PROBLEM

If you ask any campesino, *catracho*, or citizen of this Central American country, they will tell you that Honduras, translated into Spanish, means "depths" or was named for its extensive mountain geography. Looking at a topographic map of the country confirms this. A country approximately the size of Tennessee, Honduras is characterized by steep interior slopes, narrow coastal plains, and rural communities carving meager livelihoods from the sides of mountains. Hillside farming is commonplace and has contributed to severely degraded agricultural soils and annual soil loss per hectare is estimated to exceed 300 tons per year on steep hillsides throughout Honduras (Cárcamo 1994). Erosion rates of 100 tons per hectare will remove topsoil completely in 20 years (Cook 1987, from Moldenhauer 1988). Given Honduras' rate of erosion, steep hillsides are losing topsoil in less than 7 years!

Honduras is not alone in the process of soil degradation. Soil degradation, caused mainly by poor land husbandry and unsustainable agriculture practices, may affect 21% of the world's land and 75% of the agricultural land in Central America (Oldeman 1994, cited in Hellin and Haigh 2002). Honduras lays claim to approximately 111,890 sq km of land, and more than 80% of this total land area is occupied by steeplands, those lands with slopes exceeding 20% (Thurow 1998). Approximately 2.4 million hectares of land in Honduras (or 66 percent) is labeled



agricultural land and most of the land under cultivation in 1993 was planted to maize, coffee, beans, gama grass (maicillo), sugarcane, and bananas/plantains. For a detailed reporting of land use and crop acreages planted in Honduras, please refer to Appendix A - data from the 1993 Agricultural Census (FAO 1993).

Agriculture is no longer one of growing sectors of the Honduran economy; agriculture has declined from 21.6% of GDP in 1982 to 13.7% of GDP in 2001, and the annual growth rate has declined from 3.5% growth per year in 1982 to -0.9% growth in 2001, while the service and industry sectors have increased (World Bank 2003). While the Honduran economy is dependent on exports of primary products like bananas, coffee, beef, lobsters and prawns, as well as products from the forestry sector (CIA 2003), many of these commodities (especially coffee and bananas) are affected by the volatility of international markets. Coupling this with a declining natural resource base caused by deforestation and losses in soil productivity, Honduras, similar to its Central American neighbors, has placed more emphasis on its industrial economy in the

last decade and has lured foreign investors, such as Asian clothing assembly firms, to set up local *maquilladores* (factories) in the hopes of generating sustainable revenue sources (CIA 2003).

Honduras' population of 6.6 million is growing at a rate of 3.1% each year. It is estimated that this is closer to 4.5% in rural areas (Ruben 1991). Over 60% of the population lives in rural areas and this tremendous population growth is leading to increased cultivation and intensification of marginal, steep mountain lands. The US Agency for International Development (USAID) documented that steepland farms produced 75% of the basic grains in Honduras (Thurow & Smith1998), indicating that soil productivity on these hillside farms is a vital component of food security for the rural poor.

Honduras is one of the poorest countries in the Western Hemisphere. Over 53% of the Honduran population falls below the poverty line (Merrill 1993). Often, poverty and ecological degradation are linked in developing countries. In Honduras, rural residents are farmers who till their own plots or laborers who work for low wages on estates (often coffee *fincas*) or smaller farms. Extreme poverty and growing population pressure in these rural areas, two systemic conditions, are leading to increased cultivation of steep, fragile lands and erosion of the nation's soil resource base. In the southern and western parts of Honduras (the country's poorest regions), the rural population often resorts to non-sustainable agricultural practices, which in turn leads to further deterioration of their means of subsistence.

Soil erosion in Honduras is a serious concern. With the majority of rural residents subsisting on basic grain production (namely corn and beans[1]), maintaining land productivity is a "life-and-livelihood" endeavor. Resource poor farmers are intimately dependent on the maintenance of the land's productivity (Hellin 2002). Soil erosion affects productivity and crop

[1] In Honduras, corn, rice, and beans are referred to as *los granos basicos* or "basic grains." Although beans are not typically considered a grain, in Honduras, beans are a staple food item often cultivated in tandem with corn, the two foods traditionally consumed at Honduran meals (*frijoles y tortillas*). Rice is not as widely cultivated.

yields in several ways: it reduces soil depth; it causes losses of soil organic matter, declines in soil aggregate stability, and decreases soil moisture retention; and it causes a decline in the cation exchange capacity thereby reducing the amount of nutrients available to plants. Additionally, soil erosion can influence crop productivity depending on local soil types and the shape, aspect, and position of the slope (USDA 1998). Reduced crop yields further marginalize subsistence farmers who depend on these basic grains as household food staples and the sales of the harvest for income. Soil erosion and its long-term effects on crop productivity perpetuate a vicious and negative "rural poverty" feedback loop. Farmers and policymakers alike are increasingly aware that declines in soil fertility are a primary cause of food insecurity and malnutrition, and the migration of rural people to urban areas in search of other income opportunities (FAO 2003).

Not only do rural populations expanding agricultural production on marginal, highly erosive lands affect soil productivity and the food security of rural communities; the resulting soil erosion increases sedimentation of streams and rivers. This can result in flooding, reduced water quality, and diminished reservoir capacity (Cárcamo 1994). Additionally, in the upland areas of southern Honduras, soil erosion increases sedimentation in local water channels affecting downstream coastal estuaries where commercial shrimp industries are located. To assess effects of soil erosion from hillsides down to the coastal estuaries, an economic study was initiated by The Steeplands Project (a program at Texas A&M University's Department of Rangeland Ecology and Management). The study revealed that the majority of the shrimp farming areas in southern Honduras are affected by sedimentation (an estimated 9,000 hectares or 65% of the total area in production) (Thurow 1998). It also noted that managing sediment increases the cost of producing shrimp by about $0.50 per pound of tail produced. This increased cost is, in part, due to weekly removal (dredging) of tens of thousands of cubic meters

of sludge from water supply channels and pumping stations related to the operations. The study predicts that at current sedimentation rates, storage of the dredged sediments within farm boundaries would eventually reduce the productive area by 40% in 50 years (Thurow 1998).

CONDITIONS THAT CONTRIBUTE TO THE SOIL EROSION IN HONDURAS

Constraints to agricultural production and the systemic conditions that contribute to increasing rates of soil erosion in Honduras include population growth and development coupled with inadequate human capital, land use practices, lack of secure land tenure, deforestation, new technologies, government economic development policies, and recurrent natural disasters.

Population Growth and Regional Development: Increasing population pressure means more mouths to feed. Population growth in both rural and urban areas has led to increased community development and infrastructure needs. To address these growing demands, rural residents with few prospects for secure employment typically expand agricultural production onto increasingly marginal and sloping lands. As less land becomes available for expanded production, a common response by farmers is to continue to cultivate lands previously rotated and fallowed (Thurow 1998),[2] rather than shifting cultivation to additional land. Farmers then "push" the land for continued, intensive production due to increasing difficulty in expansion and acquisition of new lands. This "push" reduces the amount of time soils are protected by vegetative cover, which increases the potential for soil erosion and reduces the fertility and productive capacity of the soil. This response becomes a short-term solution as the highly erodible lands quickly become less productive. In many cases, returns to production become zero within four to ten years after cultivating without the application of soil conservation

[2] Rotation and fallowing of cropland is used to combat increased pest pressures that result from mono-cropping in one location year after year.

measures (Cuesta, 1994; Valdes P., 1994; Rosado P., Barrientos C., and Lima L. 1994; from Morera 1999).

Additionally, trends in Honduran rural communities are revealing that more and more families are settling in villages to facilitate children's school attendance rather than establishing isolated homesteads (Southworth 2001). The population concentrations that result exacerbate additional clearing of land for agricultural purposes and deforestation (more on this below) as people must search farther out for new development opportunities and cause further land degradation and soil erosion.

Land Use Practices: Traditional land use practices in Honduras often contributed to soil erosion and centered around migratory agriculture and reliance on "slash and burn" techniques for land preparation. Slash-and-burn can quickly become an environmentally unsustainable method of farming that involves cutting a patch of forest and "burning off" the underbrush to clear space for agricultural production. Ash from the fire acts as an initial application of fertilizer, but without a sufficient fallow period, continued vegetative burning eventually depletes the soil of nutrients and soil organic matter (usually after two harvests). The farmer then moves to another plot of land on another hillside, beginning the process again and leaving bare soil subject to erosion. Slash and burn agriculture has been greatly reduced over the past two decades largely due to governmental education efforts and a trend toward agricultural intensification (Southworth 2001). The trend toward intensification has also replaced a traditional practice of abandonment of marginal agricultural fields. Abandonment is different than "shifting cultivation." Shifting cultivation, or migratory agriculture may result in the transitory regrowth of recently deforested areas, but abandonment results in more permanent secondary vegetative succession (Aguilar 2003). Abandonment has become a relatively

temporary situation likely to be reversed as population pressures limit options for producers to acquire additional lands.

Road expansion and construction has encouraged additional community settlements leading to increased forest clearing and greater accessibility to steeper slopes at higher elevations (Southworth 2001). This accessibility to new tracts of land at steeper slopes contributes to increased levels of soil erosion as these new lands at higher elevations are converted to agricultural use, such as coffee production.

The case of coffee production in Honduras: Coffee is the second largest commodity traded after oil and its production involves some 25 million farmers around the world. Honduras' claim to fame has traditionally been its export of tropical fruit (namely bananas) from large plantations. Coffee, on the other hand, has always been produced by small farmers in the highlands. In the 1870s, government granted free land to coffee producers to maintain the quality and production Honduras had become known for on the global market. Coffee production has grown since the 1950's to overtake bananas as one of Honduras' main exports. Honduras is now the second largest coffee producer in Central America (after Guatemala), and coffee is a major source of local employment and international revenue for the Honduran economy. Coffee land is currently worth about $13,500(US) per hectare. The government encourages the continued expansion and support of coffee production through national policies that provide municipalities with funds to build roads in coffee producing areas. One of the most important elements determining coffee quality is altitude. If coffee is planted too low, the plant will not survive due to the heat; if planted too high, the cold will kill it. In general, the higher quality Arabica beans grow in a band from 600 to 1,600 meters in Honduras. In areas suitable for coffee, deforestation and community development increases as farmers plant coffee in advance of road building.

Traditionally, coffee is grown in a sustainable agroforestry system (shade-grown, often organically), but the rapid expansion of "sun-coffee" production in Honduras is characterized by clear-cut and open-field plantations requiring chemical-intensive production practices. Over 35% of Honduras' coffee production is now "sun-coffee." The result is a higher quantity but inferior coffee quality. These full-sun plantations create an oversupply and lower quality product that drives price volatility on the world market and destroys the profit margins and reliable planning horizons farmers need to survive. As a result, many growers – large and small – have had to abandon their farms, and revenue from coffee exports worldwide has sharply declined. However, there is a rising demand for "bird-friendly," "organic," and "fair trade," coffee and many environmental/consumer groups are now working with small farmers to produce sustainably grown coffee in Honduras.

Sources: Sorby 2002; Rainforest Alliance 2003; Watson 2003; Partners of the Americas 2003.

Land tenure: In the 1960s, Honduras' policies on land tenure focused on organizing rural cooperatives to distribute government-owned land through the National Agrarian Insitute. This effort was halted by a military coup in 1963 and illegal squatting became the primary means for poor people to gain land throughout the early 1970s (Merrill 1993). This led to new agrarian reforms in 1972 and 1975, but illegal occupations of unused land increased once again from 1975 through the 1980s. Land reform was needed to grant title to squatters and other landholders so they could sell the land or to use it as collateral for loans. Land reform between 1989 and 1992 was directed primarily at large agricultural landowners. Despite periodic efforts to address property rights in Honduras, land tenure still remains insecure throughout the country.

Lack of secure land tenure discourages limited-resource farmers from investing in soil conservation practices. Several factors account for insecure land tenure in Latin America: farmers' lack of legal title, inappropriate legislation, institutions' lack of technical capacity to handle a proper registration system[3], lack of enforcement, and complicated procedures that unduly increase the cost of land registration (World Bank 2003). Rural farmers with no title to their land are less likely to adopt labor-intensive soil conservation practices because soil erosion can take many years to have a significant impact on agricultural productivity and farmers often place a higher premium on the use of soil resources today than at some point in the future (Cárcamo 1994). A USAID-funded land titling project conducted a baseline study of 1,500 farm households from 1983-85 and again in 1987-88. In 1994, 437 of these households were resurveyed to obtain data on farm income, investments, assets, land transactions, and the use of

[3] In a recent press release, the Inter-Development Bank pledged $17.5 million to Honduras to implement a "Pro-*Bosque*" initiative (bosque translates to forest in Spanish), and some of the objectives of this initiative are to "finance the establishment of land tenure regularization boards with the participation of municipalities, provide training for municipal cadastre units, and teaching conflict resolution mechanisms" (IADB 2003).

credit. The analysis of these data indicates that titling is strongly associated with higher yields and farm incomes (which are in turn closely associated with greater use of credit and inputs) and with increased investment on titled land (World Bank 2003). Other studies show that neither possession of a title nor perceived ownership was found to be related to improved soil management practices in Honduras (Neill & Lee 2001).

Deforestation: Forest resource depletion is a result of major lumber and pulp cutting projects and the increased use of timber among rural populations for fuel is contributing significantly to soil erosion in Honduras. Communal forests are shrinking (Southworth 2001) and accelerated clearings for agricultural development (as mentioned above) of high-value, market-oriented production cash-crops such as coffee is focused in higher elevations more prone to erosion. As a result, Honduran coffee yields have been only about half those of Costa Rica (Lobet 1999). Instead of using improved techniques to increase the productivity of the land, Honduran farmers have merely expanded the acreage under cultivation to produce more crops--pushing their fields farther into the forests and marginal steeplands. Forests play a critical role in stabilizing soil and storing water. When a forest is cleared, the forest canopy is opened, exposing the forest floor, and reducing rainfall interception and infiltration into the soil. This results in an increase in surface run-off when it rains, and accelerates soil erosion and land degradation. Soil erosion due to deforestation can increases the risk of landslides or mudslides on hills and in valleys as tree roots are removed and vegetation is cleared.

Technology: New technology advances such as improved seed varieties, seed treatment, and chemical fertilizers and pesticides have the potential to positively affect crop productivity and thereby increase crop cover and slow rates of erosion. Blaikie (1985, cited in Morera 1999) notes that "…it was not the demand signals of the small farmer and landless that generated the

research development and diffusion of the Green Revolution technology but the interests of large multinational companies and the strategic considerations of the US." This certainly rings true in rural Honduras as most poor, rural farmers cultivating marginal lands have limited access to these agricultural inputs that could enhance productivity. Even if farmers are able to afford expensive inputs, the likelihood of the effectiveness of the input depends on the effort the farmer makes in conserving his/her soil. Other technology innovations that are within the economic reach of limited resource farmers and that can positively affect soil quality include new techniques in soil conservation, such as mechanical barriers, live barriers, reduced tillage, mulching, contour planting, or agroforestry. Farmers who practice these soil conservation technologies can effectively increase their soil moisture retention, making application of fertilizer more effective and profitable (and less risky to their investment). The same would be true for the added investment in new crop varieties. A lengthier discussion of the benefits of these soil conservation technologies follows in subsequent sections of this paper, therefore they will not be discussed here.

Governmental Economic Development Policies: Honduran government policies and international lenders have long encouraged growing lowland crops that Honduras can sell on the international market such as bananas, sugarcane, and melons (Lobet 1999). This fits naturally with Honduras' history of encouraging state and large multi-national corporations to set up shop in the most fertile, productive regions of the country. For example, the Honduran government and two banana companies, Chiquita Brands International and Dole Food Company, owned approximately 60 percent of Honduras' arable land in 1993 (Merrill 1993). There is an additional tendency for the agricultural industry to use alluvial and lowland valley soils for pastureland and given limited amounts of accessible and quality agricultural land to begin with,

these policies and traditional land use patterns have resulted in relegating intensive vegetable production to steeplands prone to severe soil erosion and continued deforestation.

Additionally, Honduras has implemented structural adjustment policies to control its fiscal deficit and remain eligible for multilateral and bilateral loans and aid (Morera 1999). These policies have resulted in decreased government spending, privatizing public services, increasing exports, and decreasing imports. At the same time, Honduras also increased emphasis on agricultural exports which favor cash crop production over food crop production to generate larger amounts of foreign exchange and to repay loans (Stonich 1993; Farnsworth, et al. 1996, from Morera 1999). While growth of commercial agriculture created a demand for labor and an improved cash economy, the government naturally channeled what little extension, education and research, and credit programs existed to cash crop producers, continuing to ignore the needs of smaller, subsistence producers cultivating the most erosion prone lands. Ruben (1991) noted that in 1988, basic grain production received 11.6 percent of all agricultural credit, while the export sector received 51.8%. Unfortunately, regardless of where credit opportunities are directed, small, rural producers often cannot take advantage of these cash crop markets due to a lack of infrastructure (roads, distribution facilities), a lack of regional markets, and the emphasis on quality that the export market requires.

Monetary devaluation is another factor that affects rural hillside farmers. The lack of buying power of local currency causes the price of agricultural inputs to increase thus making them unaffordable and not allowing farmers to alleviate the continued decrease in soil productivity. Adding to this, Honduras has instituted basic grain price ceilings that artificially keep the prices of basic grains low. Morera contends this is a strategy governments use to "keep the urban voting constituency content, and the government political parties in power." Cheap

imports and food aid have also lowered the prices of basic grains in Honduras. Lack of government policies to support basic grain prices during good rainfall years (thus resulting in higher production) also impacts small-scale farmers. Many of these rural hillside farmers are "net purchasers" of basic grains – selling at the time of lowest market prices and having to purchase grain back at high prices (Lopez-Pereira, et al 1994). Without price supports for basic grains, high production in a good year results in depressed basic grain prices. To make matters worse, many of the more remote hillside farmers are usually unable to access official guaranteed prices even if they do exist due to the lack of appropriate infrastructure discussed above. Thus, Honduras' economic policies have, to some extent, contributed toward farmers' decisions to focus their efforts on seeking off-farm income opportunities and away from soil conservation practices. Off-farm income comprises more than 52% of total household income for farms with less than 2 hectares (Ruben 1991). When an economy is favorable and there are greater opportunities for earning income off-farm, farmers will have an economic incentive (cost-benefit) to plant with a minimal use of agricultural inputs and labor rather than invest in soils conservation measures, agricultural inputs, and hired or household labor.

Natural Disasters Central America is a disaster prone region of the world. It lies above active tectonic faults; is home to over 27 active volcanoes; is located in the western extreme of the Caribbean hurricane belt; and is characterized by mountainous terrain with complex river basins prone to flooding and landslides (IADB 1999). Honduras was hit by Hurricane Fifi in 1974, destroying 80 per cent of the 1974 banana crop, most of the Honduran fishing fleet, and the main facilities of Puerto Cortes, Honduras' most important port. It also drowned two-fifths of the country's cattle and the total damage, estimated at about $900 million, was devastating (Merril 1993). Hurricane Mitch hit 24 years later in October 1998. Mitch will be remembered

as one of the most deadly hurricanes to strike the Western Hemisphere in the last two centuries. It caused over 5,000 deaths, over 12,000 injuries, and over 8,000 missing persons. There were multiple human health epidemics and critical shortages of food, water, and medicine. Infrastructure throughout the country was devastated; whole villages washed away. It is estimated that 70-80% of the transportation infrastructure was destroyed and the majority of the country`s bridges and secondary roads were washed away. Crop losses alone were estimated at $900 million; at least 70% of agricultural crops were destroyed, including 80% of the banana crop. Large warehouses and storage rooms for coffee flooded and maize and corn crops were devastated. The international development community pledged billions of dollars to aid in the reconstruction of the country, but it is estimated the damage by to Honduran agricultural production and the region's infrastructure will take years to recover.

Natural hazards such as hurricanes and earthquakes do not have to become natural disasters and it is estimated that 50-75% of the economic losses associated with Hurricane Mitch resulted from inadequate design and siting of housing, roads, bridges, and industry (IADB 1999). A study conducted in 1999 by World Neighbors compared "conventional" farming practices with "agroforestry" practices and found that those farmers who used techniques like tree-planting and terracing survived Hurricane Mitch with 20-40 percent more topsoil and 2-3 times less erosion than neighboring "conventional" farmers (Krajick 2001). Sound environmental management, such as land use planning and natural resource management (particularly water resource management) go a long way toward risk reduction. So what has Honduras done over the last several decades to address the widespread social, physical, and environmental causes of soil degradation?

CURRENT POLICIES ADDRESSING SOIL EROSION IN HONDURAS

In the early 1980s, soil conservation programs (largely education and extension efforts) by NGOs and government/extension were initiated to educate and involve uninformed farming communities about the adoption of soil conservation practices (Southworth 2001). These efforts were endorsed by the U.S. Agency for International Development (USAID) and the Honduran Ministry of Natural Resources and together they began the Natural Resource Management Project (NRMP).

The main goals of the NRMP were: to increase the effectiveness of the Honduran government in managing its natural resources; to improve the government's data collection and analysis; and to pilot test policies and approaches in a watershed before implementing on a national scale (Thompson 1992). Soil conservation techniques promoted through NRMP focused on slopes greater than 15% and included planting live barriers and constructing hillside ditches and stone retention walls. These techniques were presented with other production practices such as contour planting and improved plant spacing. Fertilizer subsidies or loans were paid to farmers for construction of the soil conservation measures,[4] and farmers were organized into community groups to form a labor pool that would then construct the soil conservation measures on each of its' members farms. An interesting outcome of this project was that the farmers voluntarily maintained the rock walls without further project subsidies[5] despite the relatively demanding labor requirements. This is likely due to the benefits perceived by the farmers almost immediately, mainly in the form of increased and more stable crop yields. These

[4] Farmers with less than 5 ha were given fertilizer grants of up to $90/ha based on the number of meters of stone walls or ditches constructed. Farmers owning between 5 and 50 ha were offered 15-year loans with a repayment waiver for the first 5 yrs. This subsidy program was later referred to as a "massive giveaway" in an attempt to save the struggling project from withdrawal of USAID funding (Thompson 1992).

[5] The subsidy program associated with NRMP was reorganized in 1986 and shifted toward providing farmers with material help in the form of free fertilizer, seeds, and loaned tools (Morera 1999).

soil conservation technologies are estimated to provide a 20% yield gain during the first year (Lopez-Pereira 1994). However, the capital and labor costs associated with the initial construction of rock walls is largely beyond the economic (or labor) capacity of most subsistence farmers, therefore very few farmers built rock walls without project funds.

The NRMP ended in 1990, and a follow-up project, the Land Use and Productivity Enhancement Project (LUPE), (again supported by the Honduran Ministry of Natural Resources and USAID) shifted emphasis away from mechanical soil conservation techniques toward establishment of cheaper soil and water conservation practices that relied on local materials, farmer labor and small cash investments such as convincing farmers not to slash-and-burn, establishing live barriers and grass contour strips, minimum tillage and green manures (emphasizing field surface management and productivity enhancement), and encouraging adoption of improved fallow systems such as planting nitrogen-fixing trees as part of the fallow (Thurow 1998). LUPE focused on technological adoption at the individual level through use of participatory and educational methods of extension, thus with this shift in emphasis, the program also discontinued providing financial incentives to farmers (Lopez-Pereira, et al 1994). USAID withdrew its assistance for LUPE in 1997, but the participatory methodologies used are still continued today in the work of other NGOs and Farmer-to-Farmer empowerment and technology transfer programs.

From 1992 to 1998, the Soil Management Collaborative Research Support Program (SM-CRSP) at Texas A&M University worked with LUPE to address soil and water conservation problems originating in the upland portions of key watersheds. In 1995, the International Center for Tropical Agriculture's (CIAT) Hillside Project began working to collect and systematize soil

information in order to develop soil databases[6] that could be interfaced with GIS as a way for organizations and local institutions to collaborate and identify areas with similar resource problems. Eventually, the goal is to link the soil database with socioeconomic and agricultural productivity databases to develop coordinated solutions to these problems (Ayarza 2002).

Today, researchers continue their work studying the soils of the Central America Tropical Steeplands that are "subject to catastrophic mass movement and slumping leading to loss of sustainable production, increased land degradation, erosion and nutrient depletion" (The Steepland Project 2003). This is vitally important work because in order to make sound resource management decisions, it is useful to have reliable information[7]. Lack of quantifiable data on run-off and erosion losses in Honduras has prevented an evaluation of the effectiveness of the technologies and practices implemented by the NRMP, LUPE and countless NGOs. Lack of a coordinated national policy to systematically research, quantify, and address soil erosion in Honduras complicates decision-making as NGOs and local institutions are left to independently implement short-term projects fragmented in various regions of the country. Interestingly, in the aftermath of Hurricane Mitch, soil erosion and conservation practices grabbed the attention of many NGOs and farm groups who recognized that farmers who *had* practiced many of the soil conservation technologies that have been promoted over the past several decades fared far better during the tragedy than their neighbors who had not. This prompted a study coordinated by World Neighbors,[8] to compare the impact of the disaster on agroecological farms (those that had

[6] The database developed includes analytical soil data and field descriptions of more than 2,000 soil profiles. The field data includes profile descriptions and classification according to the Soil Taxonomy System developed in 1975. The systematization work is complete and field verification is in progress (Ayarza 2002).
[7] Over the last forty years, more than 50 soil survey studies have been carried out in Honduras, but the results of these studies is scattered among many reports and is difficult to access.
[8] This study was organized quickly, only 3 months after Mitch, in order to capture valid data before the next rainy season would destroy the evidence. The study was make possible with funding from the Ford, Rockefeller, Summit and Inter-American foundations and over 40 local and international NGOs (Krajick 2001).

adopted integrated soil conservation innovations) with conventional farms. The study spanned 3 countries (Honduras, Nicaragua, and Guatemala) and data demonstrate that plots farmed with sustainable methods survived the force of the hurricane better than conventionally farmed plots on factors such as topsoil thickness, depth at which subsoil began, moisture content, soil texture and color, vegetation covers (at 3 height levels), organic matter, agroecological methods used, crop losses and yields, surface erosion, gully erosion and landslides (World Neighbors 2000). The sustainably farmed plots had 28-38% more topsoil and 3-15% more soil moisture than their conventional neighbors, and surface erosion was 2-3 times greater on conventional plots. The Honduran data from this study is presented below.

Comparison of Honduran Farms practicing Soil Conservation Technologies (Agroecology) with Conventional Plots

Factor	Agroecological Plot	Conventional Plot	Difference	Percentage
Avg depth of topsoil (cm)	9.03 cm	6.52 cm	2.51 cm	38.5%*
Avg depth of soil moisture (cm)	9.98 cm	10.28 cm	-0.30 cm	-2.9%*
Vegetative cover (%):				
- ground	56.11%	96.63%	-40.52%	
- bush	11.61%	25.11%	-13.5%	
- tree	14.07%	9.21%	4.86%	
Vegetative density:				
- ground (cm)	18.00 cm	17.05 cm	0.95 cm	5.6%*
- bush (cm)	62.62 cm	59.05 cm	3.57 cm	6.0%*
- tree (mt)	3.35 cm	2.88 cm	0.47cm	16.3%*
Avg area surface erosion (m^2 per plot)	7.85 m^2	18.95 m^2	11.1 m^2	58.6%**
Avg vol gullies (m^3 per plot)	31.80 m^3	102.26 m^3	70.46 m^3	221.6%**
Avg area landslides (m^2 per plot)	102.17 m^2	221.93 m^2	119.76 m^2	117.2%**

*Percentage of additional [factor] in agroecological vs conventional plots
** Percentage of additional [factor] on conventional vs. agroecological plots
Source: World Neighbors 2000.

Other policies that prevent or contribute toward soil erosion in Honduras include policies addressing land tenure, market liberalization, infrastructure development, and the prohibition of logging.

Land Tenure. In Honduras, 90% of prime farmland belongs to 10% of the population (World Neighbors 2000). As discussed above, land tenure policies have largely been a reaction to rural populations "squatting" on the land and claiming it as their own. The Latin America and Caribbean (LAC) Regional Office of the World Bank created a "land policy and administration portfolio" and the outcome of that effort is a Rural Lands Administration Project (PAAR) in Honduras that includes registry modernization, adjudication of lands to small farmers, and efforts toward indigenous land titling (World Bank 2003). The "Pro-Bosque" Initiative recently funded by the IADB will also assist in this effort. Land tenure policies can assist small scale farmers to purchase title to their agricultural lands and therefore create incentives and value for the farmer to invest in soil conservation practices.

Market Liberalization. Since 1976, Honduras has been a net importer of basic grains (Thompson 1992), and until 1990, import substitution served as the foundation of Honduran economic policy. Honduran government promoted industrialization by reducing agricultural production costs and lowering consumer food prices. Then they began to subsidize agricultural inputs, enact import controls of agricultural produce, and expand extension and technical assistance programs to promote high-value export production. The result of these policies was farmer intensification and a diversified agricultural production, at least for those with access to and who were affected by these programs. As new crop varieties were introduced, crop yields increased. In the 1990s, there was again a shift in national economic policies. The government removed many of the price control mechanisms and opened its doors to the "free market

system." By not keeping prices at specific levels and letting the market determine prices for crops, wild variations in price and the rate of return to the farmer began to fluctuate. Some years prices may have been good, other years, everyone suffered. In the good years, the profitability of growing vegetables encourages people to stay on the farm and reduces their need to participate in wage labor. It also encourages either the intensification of production or the expansion of production on additional acres, potentially increasing soil erosion if conservation measures do not keep pace with the expansion. In lean years, low market prices often result in farmers reducing their inputs (labor, chemicals) and lower inputs often equates to decreases in soil cover and biomass production and increases in soil erosion. Additionally, with lower yields, farmers bring more land under cultivation to compensate for their yield losses. Low market prices also create disincentives for small, subsistence farmers to invest in soil conservation technologies, as they shift their labor to off-farm work (Morera 1999). Farmers generally try to buffer themselves against price fluctuation risks, shifting labor to off-farm work (disinvesting in soil conservation practices) or reducing their on-farm inputs when prices are low.

Infrastructure Construction (roads and irrigation systems). Road construction improves access to local markets. Better access to regional markets allows farmers to benefit from the higher prices offered for nontraditional crops. This can increase per capita income, but does not necessarily promote soil conservation. As farmers can access new market opportunities, this influences crop choice – now crops can be grown that previously had to be transported by mules (a tomato did not generally survive the pack mule scenario). Several studies pointed to increased soil erosion as farmers switched to more erosion-prone crops, such as potatoes, onions, tomatoes, cabbage, and other horticultural crops (Barbier & Bergeron 1999; Kammerbauer & Ardon 1999). One of the benefits of road construction was that it increased production efficiencies; farmers

were more willing to invest in soil conservation strategies to improve their production and capture more profits. By being able to produce a wider range of higher value crops and positively influencing income, this also reduced the demand for continued expansion onto new agricultural land as they *intensified* rather than *extensified* production (Morera 1999).

Access to irrigation infrastructure also affects rates of soil erosion. Because Honduras' rainfall pattern is "bi-modal," it rains six months of the year and is dry six months of the year. Without irrigation, no vegetables are produced during the dry season. This means that most of the cultivation of hillside farms occurs just prior to the rainy season when slopes are more subject to runoff. Additionally, without irrigation, farmers attempt to compensate for the loss of income in the dry season by producing more crops in rainy season (Barbier & Bergeron 1999). As farmers gain access to the capacity to produce year-round by installing irrigation infrastructure, periods of fallow also decrease and can more rapidly cause declines in soil productivity unless conservation measures are employed at the same time.

Bans on Logging. In 1974, forest land in Honduras was de facto nationalized and under the control of the National Forestry Administration requiring official permission to cut down trees (Kammerbauer & Ardon 1999). The high cost of receiving official permissions reduced the rate of clear-cutting, but led to dense forest becoming more sparse. A common practice to circumvent the regulations was to set fire to forest plots so that the dead trees could be legally cut and pasture established. In 1992, the Agricultural Modernization Law was passed which privatized forest land and introduced forest management planning (Kammerbauer & Ardon 1999). Some communities then adopted local (county-wide) bans on logging. In the study by Southworth and Tucker, they report that communities strongly supported logging bans since they perceive it as necessary to protect forests from exploitation by outsiders and to preserve forest

resources for subsistence users. In some cases, even private forest owners have complied with the ban (Southworth and Tucker 2001). This ultimately reduces deforestation in area watersheds and reduces the potential for soil erosion.

In sum, behavior change is not an easy process to regulate. Some of the more effective soil conservation programs in Honduras manage to change a few individuals at a time. While this is a fantastic beginning, "macro-level" behavior change is necessary to truly address the crisis that washes hundreds of tons of valuable Honduran topsoil into rivers and oceans at an alarming rate. In the table below, the most plausible and effective physical and technical soil strategies that have been employed are contrasted with prevailing practices in Honduras. These early adopters or "innovators" forge ahead despite government policies encouraging efficiencies on larger, export-oriented farms; lacking financial support; devoid of clear land titles; and absent consistent and reliable income opportunities from agriculture. The real challenge faced by government is how to economically and efficiency replicate this tenacity on a national scale.

Comparison between Adopters and Non-adopters of Soil Conservation Technologies in Honduras*

"Innovators" in Honduras	Prevailing Practices
Use deep mulching techniques to retain soil moisture and introduce organic matter	Slash and burn; seasonal clearing and burning to maintain fields free of vegetation and regrowth
Maintain a wide biological diversity to help keep specialized pests and diseases in check	Mono-cropping; planting corn and beans in same fields year after year (no rotation); increased use of chemical pesticides and herbicides to address pest problems
Interplant trees among food crops (agroforestry)	Clear-cutting of forests for timber, ranching, and farming (especially sun-coffee production)
Concentrate cattle in holding pens to prevent widespread soil compaction and facilitate mature collection (to assist soil fertility)	Cattle are turned loose on agricultural fields to "harvest" crop residues, causing widespread soil compaction and denuding ground cover; overgrazing of marginal range lands
Plant nitrogen-fixing cover crops and green manures	Bare soil; extended fallow; or abandoning fields as productivity declines
Practice conservation or minimum tillage	Cultivation with animal traction, *piocha* (pick axe), or hoe on steep slopes; excess cultivation and pulverization of soil structure
Plant along the contour; construct live or physical barriers	Planting across slope; no barriers constructed or planted

Source: personal observation, Hashley 1999-2001.

POLICY GOALS

Hellin and Haigh conducted an extensive literature review and research on farmer adoption of soil conservation technologies. The article is an interesting revelation into why some policies and program goals are not adopted by a target audience, i.e., why there aren't more "innovators" in Honduras. Much of this has to do with the compatibility of conventional soil conservation approaches with Honduran farmers' resources, needs, and priorities. The literature suggests that the sustainability of conservation technology adoption is determined not only by fundamental agronomic characteristics, but also by the *economic context* framing household decision making and the knowledge and understanding of the decision makers (Lopez-Pereira, et al 1994; Morera 1999; Neill & Lee 2001). The table below articulates the key points of Hellin and Haigh's research and serves as a foundation for considering future policy goals for the government of Honduras.

Reasons for non-adoption and adaptation of soil conserving technologies

- lack of education reaching target audience
- lack of perceived benefits due to insecure land tenure
- labor costs in implementing technologies (especially if farmers work off-farm)
- technology does not reliably reduce soil loss or immediately raise yields or improve productivity
- technology requires farmers to take land out of production (unwilling to do so)
- soil erosion is not as a major concern (compared to pests, diseases, lack of resources), therefore soil conservation is seen as a waste of time and effort
- resistance to "top-down" programs; conservatism
- technologies exacerbate other problems (weeds, pests, diseases, water-logging)
- farmers do not feel empowered due to the 'transfer-of-technology' extension practices
- technologies do not address [financial] risks of agricultural production, especially if they require additional debt
- practices require changes in farming systems not suitable for economic or cultural realities of that system

Refer to Hellin & Haigh 2002 for literature review sources

With an opportunity to design an institutional framework for the government of Honduras to address severe natural resource degradation, it is important to design a framework that is participatory, relevant, and valuable to all sectors of society. In order to achieve true effectiveness, policies or programs must: fit within the current agronomic and economic culture; show short-term benefits; exhibit flexibility; expand gradually and systematically building on cumulative successes; be feasible within existing units of government and land tenure systems; incorporate follow up and evaluation mechanisms; and avoid political antagonism (Harper & El-Swaify 1998). An effective natural resource conservation policy must be based in realism versus idealism and consider:

- Who are the clients?
- What need is there for the conservation program and policy?
- Who is the conservation effort designed to protect?
- Are the conservation programs protecting farmers from long term productivity losses?
- Are the conservation efforts protecting consumers from future food shortages?
- Are the conservation policies protecting non-farm users of water quality?
- Are the conservation programs protecting government infrastructure investments from sediment damage? (Lovejoy and Napier 1999).

Although it is unlikely that all national goals will be consistent with conservation priorities, the following policy goals attempt to consider the criteria above in addressing severe soil erosion in Honduras. The resounding advice in the literature recommends designing bottom-up approaches focusing on prevention rather than mitigation, therefore, in order to combat declining agricultural productivity and devastating annual soil erosion losses, it is recommended that Honduras strive to: (1) reduce soil erosion by 20% per year on a hillside or watershed basis through prevention *and* mitigation to protect all land use within the watershed[9]; (2) retire marginal lands from

[9] *Baseline Data Collection.* Honduras should institute a regular comprehensive inventory of its natural resources (similar to the NRI of the US) in order to establish a baseline against which all future policy actions and interventions are measured.

production; (3) increase incentives for soil conservation practices; and (4) reform macro-level economic policies to enable farmers to earn a greater portion of their livelihood from farming and create greater consistencies between conservation, international trade policies, and other agricultural / environmental programs.

SPECIFIC GOVERNMENT ACTIONS TO REACH GOALS

In order to achieve these goals, the government of Honduras needs to take swift, specific, and concrete actions to address the underlying causes of soil degradation. Many of these causes are systemic: severe poverty, rapid population growth, a geography ill-suited for expansive agricultural production, a propensity for natural hazards, and other myriad causes that have been documented earlier in this paper. What then should Honduras do to truly impact and reduce soil degradation? Is it a hopeless situation devoid of possible corrective action? The answer is no, but a comprehensive set of policies and actions with the continued input of beneficiaries is necessary to engage individuals and communities to change behavior on a regional and national scale.

Population Control. One of the most difficult, but effective actions the government of Honduras could take to address natural resource degradation would be to control the rapidly increasing population. Steps to accomplish this (both "carrot and stick" incentives - reproductive education campaigns, establishing family planning targets, child health and survival programs, etc.) are beyond the scope of this paper, but it would certainly impact the rate of deforestation and the rapid expansion of farmland, two key causes of soil erosion in Honduras.

Zoning and Land Use Enforcement. A more plausible action the Honduran government could take is to continue to equitably distribute land resources and focus on land titlement

programs. Coupling land distribution and tenure policies with zoning and land use management plans (and effective enforcement) would discourage farming on highly erodible lands. Each Department (or state) should establish "zones" within a watershed where crop production and other infrastructure development can occur. Production of more erosive vegetable crops could be zoned for flatter lands (no more than 10% slopes), corn and bean production on medium-slope lands (no more than 20%), and corn-beans intercropped and possibly shade-grown coffee, or agroforestry systems for the steepest slopes (Ca'rcamo 1992). Local ordinances could specify that on the steepest slopes, minimum tillage is required or that the steepest slopes are simply banned from agricultural production. Steep fines or consequences for non-compliance should be enforced. Many local governments in Honduras have specific drinking water source protection policies and these could be expanded to include the prohibition of cultivation on the steepest slopes. Regularly monitoring of soil losses throughout the watersheds should be mandated. This would require regional collaboration as these slopes and watersheds could cross several jurisdictions.

Subsidies. Technical assistance, outreach, and education efforts are becoming more widespread and research and demonstration is becoming more participatory and educational for an increasing number of farmers. Yet, without financial incentives (direct payments or cost-share programs), small-scale, subsistence farmers lack the resources to prioritize conservation efforts. The Honduran government needs to subsidize these soil conservation techniques, treating soil conservation as a public good rather than a private investment. The recommended soil conservation technologies are now less labor intensive and more productivity enhancing – yet they still require a substantial input of labor and, in many cases, inputs such as fertilizer and pesticides or new crop varieties and expensive cover crop seed. Farmers are unwilling to divert

their labor away from off-farm wage work because soil conservation work generates benefits over the long term whereas wage work generates immediate cash (Morera 1999). Subsidies allow farmers to hire labor or forgo off-farm wage work in order to invest in soil conservation work and intensify production. The flip side is that farmers tend to abandon these practices once the subsidies are removed. It can be argued that subsidies do not replace an internal motivation and desire by farmer to change their destructive practices. Others argue that subsidies may jeopardize other national development agendas and create a "handout" or "welfare" mentality. The reality is that time and again, economic and financial incentives are largely the driving decision behind whether or not to adopt soil conservation techniques.

Access to Credit. Subsidies or cost-share programs linked with an improved system of farmer credit at start of the growing season to purchase inputs and new technologies can give poor, subsistence farmers the jump start they need to improve their production practices. Many localized credit programs are currently being run by farmers through cooperative efforts. Funding for these programs is often sustained by international NGOs. Honduras should institutionalize these credit programs after the groundwork is laid and assist with the development of rural banking systems that facilitate credit access.

Don't sell the national soul! While it is difficult to develop a concrete action plan for stemming political corruption and the lure of foreign investment, Honduras should look internally to creatively solve its fiscal problems. Honduras should coordinate its structural economic policies to support its own internal demands for improved basic grain production and income generation. A larger percentage of farmers need to earn their livelihood from agriculture – an agriculture that they depend on for sustenance (not one wholly dedicated to export of specialty products not consumed locally). Honduras is adept at selling its soul to multinational

interests at the expense of its own people. The government should truly take a moment to listen to its people without the chatter of aid monies and influential promises of external assistance[10].

MONITORING TO ASSESS PROGRESS TOWARD GOALS

The most effective process for monitoring progress toward a stated goal is to involve change agents at the local level to assess impacts of the intervention. It is recommended that local community monitoring committees are established to continually measure progress toward the stated goals. Regional committees should meet semi-annually to review progress and share innovations across watersheds and political boundaries. The government should sponsor state-funded annual reports that can guide the revision of policies and programs and maintain the flexibility to adapt as conditions evolve. What worked well in the past, may not be appropriate in the future.

Specific outcomes to be measured in relation to the policy goals and action steps identified in this paper include:

Policy Goal	Concrete Action Steps	Outcomes to be measured and Target Dates
Reduction of Soil Erosion by 20% per yr by watershed	install monitoring stations; establish "T" for each watershed unit; continued extension/education; institute zoning and land use restrictions	Soil losses decrease by 20% per year in each watershed unit until they reach "T" tolerable levels. **Target**: funds appropriated 2004; monitoring stations in place 2005; zoning restrictions devised and implemented by 2010
Retire marginal lands from production	zoning and land use restrictions; improve land tenure options	XX acres of marginal lands per watershed are retired from production each year. Land tenure increases by 5% each year. **Target**: ongoing; 30% compliance by 2008

[10] The author needed to inject a sprinkling of idealism here and unfortunately is void of concrete suggestions for how to encourage this structural self-examination.

Policy Goal	Concrete Action Steps	Outcomes to be measured and Target Dates
Increase incentives for soil conservation practices	subsidies and access to credit programs	Banking systems are established in each community and % of farmers borrow funds annually. **Target**: 2006
Reform macro-level economic policies	revise internal structural policies	Basic grain price ceilings are removed and imports are taxed relative to local costs of production. **Target**: ongoing; changes proposed in 2005 presidential election

Long-term monitoring can integrate information about the physical attributes of localized areas and report changes in the context of local solutions. Integrating the physical changes with a broader database of demographic, legal and policy changes can aid in the establishment of cause and effect patterns (Ayarza 2002). The results can be used to inform future programs or policies and to correct weaknesses in existing mechanisms. Honduras has much to initiate in the establishment of tracking mechanisms. Constant natural disasters interrupt long-term planning horizons and shifts attention from the progress that is made. Concentrating monitoring efforts locally helps to empower and motivate individuals in local communities to continue on the path toward effective change.

TIMETABLE FOR ACHIEVING GOALS

The timetable for achieving these goals is multi-year, phased in over a long-term planning horizon. The table above lists outcome target dates corresponding to proposed policy goals and action steps. Although one of the criteria for effective policy development mentioned above is that constituents should quickly realize short-term benefits, however, meeting each of the proposed policy goals requires careful planning, coordination across agencies and

jurisdictions, and universal change of prevailing cultural practices and norms. One of the key frustrations in addressing conservation priorities is that sometimes good development projects come and go or only commit funding for 5-10 years depending on the whims of funders and political will. Often programs or policies fall by the wayside before they are carefully analyzed and evaluated for impact and effectiveness. Much of the momentum for the implementation of these policy goals already exists in the communities where change is occurring. Pushing forward and tapping into this motivation will speed progress and propel the adoption of these policies forward.

POSSIBLE BARRIERS TO ACHIEVING GOALS

There are many barriers in Honduras that may prevent the adoption of the proposed policies. The conditions and factors affecting the adoption of soil conservation policies have been documented extensively in this paper. The primary barrier to adopting any of the proposed policies presented in this paper is the chronic poverty driven by the economic climate of the country and its continued dependence on foreign investment. The Honduran economy experienced a period of sustained growth during the 1990's as the economy expanded and continued its evolution from an agriculture-dependant economy to a manufacturing and service-based economy. Most of the political emphasis is focused on developing full employment (not necessarily in relation to basic grain producers in the agricultural sector), economic growth, national security, and international trade at the expense of the needs of the majority of the population living below the poverty line. Much of the international development funds and aid come with strings attached and encourage the exploitation of the national resource base.

Political corruption is another compounding factor in this equation. Deals are made which inequitably favor larger landholders, multinational corporations, or the upper echelon of society.

Lack of financial resources is always a major barrier when considering the implementation of incentive programs or green payments. The case has been made that Honduras is a poor country reliant on outside debt relief and multilateral aid; debt repayment schedules and political pressure drive investments in reconstruction of downstream municipalities and industry (Thurow 2002). Government funding for encouraging conservation practices and maintaining the funding over time is unlikely.

Honduras is also plagued by frequent hurricanes, earthquakes, tropical storms, and other natural hazards that quickly destroy years of conservation efforts. Without an integrated watershed approach, even the most diligent practitioners of soil conservation technologies can be adversely affected by their upstream neighbors who fail to do the same. This makes soil conservation even more difficult to sell because the results accumulate over time, the benefits are widely dispersed and not easy to identify, and it requires that individual farmers invest heavily in soil conservation measures. Most farmers want quick, direct returns for their efforts or will turn their attention toward other methods to perpetuate their livelihood.

Additional factors to consider in implementing these policies are the lack of trained specialists and professionals who live and work in steepland areas and the lack of supporting industry. These factors compound the challenges in communicating new technology innovations. Many of the individuals who attend secondary or post-secondary institutions do not want to return to their "rural roots" for lack of opportunity. Most of the "promoters" of soil conservation practices drive in to rural villages in an NGO-funded Landcruiser and head back to a regional office, returning the next month to assess progress. There is also a general lack of

industry support required for the implementation of some of the recommended techniques. Specialized services such as soil testing, suppliers of improved seed varieties, and research and development projects are located far from remote villages where the majority of subsistence farmers reside.

DATA GAPS OR RESEARCH NEEDED

Little research has been conducted on slopes greater than 20% because they are largely considered marginal for farming. Much has been written about soil erosion, though much of this focuses on the technical causes and solutions rather than the economic and political causes and solutions (Morera 1999). This lack of socio-political research, coupled with a lack of quantifiable data on run-off and annual soil loss estimates renders it difficult to assess the effectiveness of various erosion control technologies and to assess the "true" causes of soil erosion. To date, Honduras does not have a completed land resource database and without it, it is difficult to put annual soil losses in context and hard to assess the effectiveness of strategies and technologies that have been employed over the past several decades.

Recommendations for future research include assessing "positively deviant" communities and individuals – why are some communities able to implement adequate soil conservation policies and practices where others are not? What leads some farmers to "innovate" while other farmers continue with traditional, soil degrading practices? Conducting additional research on crops that have the potential to reduce soil erosion while providing additional income to the farm will also be valuable so that farmers can continue to make economically sound cropping choices.

Further studies of the effects that different land tenure systems have on soil conservation benefits would also assist policymakers in developing appropriate land titling programs that

encourage soil conservation. Assessing why conservation is difficult without subsidies and why farmers abandon conservation practices when subsidies are removed also can inform governments of how to shape incentive packages that achieve their policy goals but do not create a "welfare" system that discourages progress.

These research agendas will be valuable to inform and shape future policy decisions. While technical studies and data aid in the understanding of physical causes of soil erosion, linking this data to feasible, broad-based socio-economic reform will go a long way toward addressing and underscoring the true underlying causes of soil erosion: the political economic structure of a nation that provides little economic incentive for soil conservation practices (Morera 1999). Steps to address these structures will go a long way toward creating positive, lasting change in Honduras.

> *"It was not just the beans that we lost here; it was the land,"* he says, pointing to a ruined hillside, "*You can see it. That was when we wept*."- Juan Cruz reflecting on his farm, jumbled with boulders and tree stumps with a giant chasm down the middle where water had run during Hurricane Mitch (Krajik 2001).

REFERENCES

Aguilar, A.L. (2003). *Is a Forest Transition Occurring in the Neotropics?* Retrieved December 13, 2003 from http://convention.allacademic.com/aag2003/view_paper_info.html?pub_id=1320&part_id1=23875.

Ayarza, M.A., Trejo M.T., Barreto, H., and Mejia, O. (2002). *Digital soil database of Honduras: a decision tool to support improved land use*. Retrieved December 13, 2003 from http://www.sfst.org/Proceedings/17WCSS_CD/papers/1426.pdf

Badger, D. D., de J Agudelo, N., Fisher, D.J. (1984). *First formulative evaluation of the Natural Resources Management Project in Honduras*. Stillwater, OK, Department of Agricultural Economics, Oklahoma State University.

Barbier, B. & Bergeron, G. (1999). Impact of policy interventions on land management in Honduras: results of a bioeconomic model. *Agricultural Systems* Vol 60(1): 1-16.

Barbier, B. & Bergeron, G. (2001). Natural Resources Management in the Hillsides of Honduras: Bioeconomic Modeling at the Microwatershed Level. *Research Report 123. International Food Policy Research Institute*. Washington, D.C.

Barrios, E. & Trejo, M.T. (2003). Implications of local soil knowledge for integrated soil management in Latin America. *Geoderma* Vol. 111(3-4): 217-231.

Blaikie, P. (1985). *The Political Economy of Soil Erosion in Developing Countries.* London: Longman Development Studies.

Ca'rcamo, J.A., Alwang, J. & Norton, J.W. (1994). On-site economic evaluation of soil conservation practices in Honduras. *Agricultural Economics* 11: 257-269.

Ca'rcamo, J.A. (1992). *Sustainable Development in Honduras: economic evaluation of soil conservation practices*. Thesis (M.S.) Virginia Polytechnic Institute and State University.

Central Intelligence Agency (USA). (2003). *World Fact Book, Honduras.* Retrieved October 25, 2003 from http://www.cia.gov/cia/publications/factbook/geos/ho.html

Constance, P. (1999). *Lessons learned or lessons lost? Unless preventive measures are taken, the tragedy of Mitch is likely to be repeated*. Retrieved November 19, 2003 from Inter American Development Bank http://www.iadb.org/idbamerica/archive/stories/1999/eng/e299e4.htm

Cuesta, M.D. (1994). *Economic Analysis of Soil Conservation Projects in Costa Rica*. In: Economic and Institutional Analyses of Soil Conservation Projects in Central America and the Caribbean. Washington, DC: The World Bank.

Ericksen, P.J. & Ardon, M. (2003). Similarities and differences between farmer and scientist views on soil quality issues in central Honduras. *Geoderma* Vol.111(3-4): 233-248.

Ericksen, P.J., McSweeney, K, & Madison, F.W. (2002). Assessing linkages and sustainable land management for hillside agroecosystems in Central Honduras: analysis of intermediate and catchment scale indicators. *Agriculture Ecosystems & Environment* Vol 91(1—3): 295-311.

Farnsworth, S., Conroy, M., Murray, D., & Rosset, P. (1996). *A Cautionary Tale: Failed US Development Policy in Central America*. Boulder: Lynne Reinner.

Food and Agricultural Organization of the United Nations. (2003). *Support to Investment: Land Management, Soil Conservation and Soil Fertility.* Retrieved November 19, 2003 from http://www.fao.org/tc/tci/sectors/landcons.htm

Harper, D.E. & El-Swaify, S.A. (1998). *Sustainable agricultural development in North Thailands: Conservation as a component of success in assistance projects*. p. 77-92, *In* Moldenhauer, W.C. & Hudson, N.W. (Eds.). (1988). *Conservation Farming on Steep Lands*. Iowa: Soil and Water Conservation Society.

Hellin, J., William, L.A. & Cherrett, I. (1999). The Quezungual System: an indigenous agroforestry system from Western Honduras. *Agroforestry Systems* Vol 46(3): 229-237.

Hellin, J. & Haigh, M.J. (2002). Better Land Husbandry in Honduras: Towards the New Paradigm in Conserving Soil, Water and Productivity. *Land Degradation and Development* 13: 233-250.

Hossner, L.R. (2000). *Report on Travel to Honduras*. *SM-CRSP Project: Decision Aids for Integrated Soil Management*. Texas A&M University. Retrieved October 25, 2003 from http://intdss.soil.ncsu.edu/download/trip_reports/Hossner_Honduras_0100.pdf

Inter-American Development Bank. (1999). *Reducing Vulnerability to Natural Hazards: Lessons Learned from Hurricane Mitch*. *A Strategy Paper on Environmental Management.* Retrieved November 20, 2003 from http://www.iadb.org/regions/re2/consultative_group/groups/ecology_workshop_1.htm

Inter-American Development Bank. (2003, December 3). *IDB approves $17.5 million soft loan to Honduras for "Pro-Bosque" Forestry Program*. Retrieved December 13, 2003 from http://www.iadb.org/NEWS/Display/PRView.cfm?PR_Num=244_03&Language=English

Kammerbauer, J.B. & Ardon, C. (1999). Land use dynamics and landscape change pattern in a typical watershed in the hillside region of central Honduras. *Agriculture, Ecosystems & Environment*, Vol. 75(1/2): 93-100.

Krajick, K. (2001). *Holding Their Ground: A study of hurricane damage demonstrates the value of soil conservation*. Ford Foundation Report. Retrieved December 13, 2003 from http://www.fordfound.org/publications/ff_report/view_ff_report_detail.cfm?report_index=310

Leonard, D. (1996). *Small Farmer Sustainable Agriculture Economics Honduras.* Retrieved October 29, 2003 from http://www.sare.org/htdocs/hypermail/html-home/13-html/-0050.html.

Library of Congress, Federal Research Division. (1993). *Country Studies: Honduras*. Retreived December 13, 2003 from http://memory.loc.gov/frd/cs/hntoc.html

Lobet, I. (1999, May 14). Honduran Agriculture after Mitch. *Latino USA.* Retrieved October 25, 2003 from http://www.latinousa.org/mitch/honduranagriculture.html

Lopezpereira, M.A., Sanders, J.H., Baker, TG, & Preckel, PV. (1994). Economics of erosion-control and seed-fertilizer technologies for hillside farming in Honduras. *Agricultural Economics*, Vol 11(2-3): 271-288.

Lovejoy, S.B. & Napier, T.L. (1999). *Institutional constraints to soil conservation on steep lands.* p. 107-114, *In* Moldenhauer, W.C. & Hudson, N.W. (Eds.). (1988). *Conservation Farming on Steep Lands*. Iowa: Soil and Water Conservation Society.

Merrill, T. (ed.). (1995). *Honduras: A Country Study*. Washington, D.C.: Federal Research Division. Retrieved October 25, 2003 from http://memory.loc.gov/frd/cs/hntoc.html.

Moldenhauer, W.C. & Hudson, N.W. (Eds.). (1988). *Conservation Farming on Steep Lands*. Iowa: Soil and Water Conservation Society.

Morera, M.C. (1999). *At the crossroads: soil conservation and livelihood strategies on the hillsides of Honduras*. Thesis (M.A.) University of Florida.

Neill, S.P. & Lee, D.R. (2001). Explaining the adoption and disadoption of sustainable agriculture: The case of cover crops in Northern Honduras. *Economic Development and Social Change* Vol. 49 (4): 793-820.

Newton, H.P. & Duisberg, P.C. (1978). *Soil science in Honduras: classification, fertility and conservation*. Turrialba, Costa Rica: Centro Agronomico Tropical de Investigación y Enseñanza.

Oldeman, L.R. (1994). *The global extent of soil degradation*, p. 99-118, *In* Soil Resilience and Sustainable Land Use, Greenwood, D.J., Szabolcs, I. (eds). CAB International: Wallingford.

Paolisso, M., Gammage, S. & Casey, L. (1999). Gender and household-level responses to soil degradation in Honduras. *Human Organization* Vol. 28(3): 261-273.

Partners of the Americas. (2003). *Small scale coffee production in Honduras*. Retrieved December 13, 2003 from http://www.partners.net/what_we_do/agriculture_and_environment/farmer_to_farmer/case_studies/honduras_coffee.pdf

Rainforest Alliance. (2003, June). More sustainable coffee production and a more stable global market. *San Diego Earth Times*. Retrieved December 13, 2003 from http://www.sdearthtimes.com/et0603/et0603s12.html

Ravnborg, H.M. (2002). Poverty and soil management – Relationships from three Honduran watersheds. *Society and Natural Resources* Vol 15(6): 523-539.

Rosaso, P., Barrientos, L., & Lima, S. (1994). *Soil Erosion Control Effects in Guatemala*. In: Economic and Institutional Analyses of Soil Conservation Projects in Central America and the Caribbean. Washington, DC: The World Bank.

Ruben, R. (1991). *The agrarian problem in Honduras*. Honduras: Centro de Documentacion de Honduras, Tegucigalpa.

Shiferaw, B. & Holden, S.T. (2001). Farm-level benefits to investments for mitigating land degradation: empirical evidence from Ethiopia. *Environment and Development Economics* Vol. 6: 335-358.

Sorby, K. (2002). *What is sustainable coffee?* Retrieved December 13, 2003 from http://lnweb18.worldbank.org/ESSD/ardext.nsf/26ByDocName/WhatisSustainableCoffee/$FILE/ATN30BackgroundPaper2.pdf

Southworth, J. & Tucker, C. (2001). The Influence of Accessibility, Local Institutions, and Socioeconomic Factors on Forest Cover Change in the Mountains of Western Honduras. *Mountain Research and Development* Vol. 21(3): 276-283.

Stine, M.A. & Weil, R.R. (2002). The relationship between soil quality and crop productivity across three tillage systems in south central Honduras. *American Journal of Alternative Agriculture* Vol 17(1): 2-8.

Stonich, S. (1993). *"I am Destroying the Land!": The Political Ecology of Poverty and Envrionmental Destruction in Honduras*. Boulder: Westview Press.

The Steepland Project. (2003). *Soil Management Practices for Sustainable Production on Densely Populated Tropical Steeplands*. Retrieved October 25, 2003 from http://soilcrop.tamu.edu/research/international/projects/juosteepland/content.htm.

Thompson, M.E. (1992). *The effect of stone retention walls on soil productivity and crop performance on selected hillside farms in southern Honduras*. Thesis (M.S.), Texas A&M University.

Thurow, T.L., Thurow, A.P., Wu, X. & Perotto-Baldivioso, H. (2002). Stable soil, stable economy: targeting soil conservation investments in Honduras. *Choices*, Vol. 17(3): 20-23; 42-43.

Thurow, T.L. & Smith, J.E. (1998). *Assessment of soil and water conservation methods applied to the cultivated steeplands of Southern Honduras*. Retrieved October 29, 2003 from http://www.vetiver.com/HON_res.htm

Tracy, F.C. (1988). *The Natural Resources Management Project in Honduras*, p. 265-268. *In* Moldenhauer, W.C. & Hudson, N.W. (eds.), Conservation Farming on Steep Lands. Iowa: Soil and Water Conservation Society.

Uribe, A. (1999). *Reducing Vulnerability to Natural Hazards: Lessons learned from Hurricane Mitch: A Strategy Paper on Environmental Management*. Retrieved November 20, 2003, from http://www.iadb.org/regions/re2/consultative_group

USDA Natural Resources Conservation Service, Soil Quality Institute. (1998). *Effects of Soil Erosion on Soil Productivity and Soil Quality*. Technical Note No. 7. Alabama.

Valdés, P.A. (1994). *Economic Analysis of Soil Conservation in Honduras*. In: Economic and Institutional Analyses of Soil Conservation Projects in Central America and the Caribbean. Washington, DC: The World Bank.

Varela, A. & Cole, L. (1990). Middle School Agricultural Curriculum for Honduras. *The Agricultural Education Magazine*, Vol 62(10): 9-10.

Watson, AJ. (2003). *The story of San Luis coffee*. Retrieved December 13, 2003 from http://www.care.ca/actn/SanLuis/sanluis_e.shtm

World Bank. (2003). *Honduras At a Glance*. Retrieved December 13, 2003 from http://www.worldbank.org/data/countrydata/aag/hnd_aag.pdf

World Bank. (2003). *Land Tenure Insecurity in Honduras and Paraguay*. Retrieved December 13, 2003 from http://www.worldbank.org/html/dec/Publications/Abstracts96/03esd/esd01.html

World Neighbors. (2000). *Lessons from the Field. Reasons for Resiliency: Toward a Sustainable Recovery after Hurricane Mitch*. Retrieved December 13, 2003 from http://www.wn.org/mitch.pdf