



Insights and Applications

Poverty and Soil Management—Relationships From Three Honduran Watersheds

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This article questions poverty as a (major) cause of environmental degradation and the assumption that the poor are caught in a vicious circle with regard to their natural resource management. Examining the soil management of farmers of different poverty level in three Honduran watersheds, the article explores the relationships between poverty, soil quality, and soil management strategy. It argues that the relationship between the overall level of poverty and soil degradation often is a statistical artifact, resulting from a failure to disaggregate the soil management of the poor and the nonpoor, rather than a casual relationship. Further, the article shows that although they are inhibited from using chemical fertilizers due to capital constraints, poor farmers are no less likely than nonpoor farmers to adopt labor- and land-requiring soil-conserving measures.

Keywords Central America, environmental degradation, Honduras, poverty, soil management

Poor farmers are often assumed to be caught in a vicious circle in their management of natural resources. Due to lack of resources and their struggle just to ensure day-to-day survival, poor farmers are believed to offset concerns with long-term sustainability of their resource management and to degrade already fragile resources, such as steeply sloping, erosion-prone hillsides. This, in turn, aggravates their poverty even more. Thus, poor people are seen both as victims and agents of environmental degradation (WCED 1987; During 1989; World Bank 1992; UNEP 1995). Concrete evidence of this vicious circle relationship between poverty and environmental

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degradation is, however, sporadic (Leach and Mearns 1995; Reardon and Vosti 1995; Duraiappah 1998). Even more alarming, virtually no evidence exists to establish the relative importance of the economic activities of the poor vis-à-vis those of the nonpoor in explaining environmental degradation (Boyce 1994; Duraiappah 1998).

Ever since the United Nations Stockholm conference on the Human Environment in 1972, many Third World governments have expressed concern that environmental goals could detract from their development goals (UNEP 1995). Likewise, many donor organizations have been reluctant to accept the potential contradictions between goals of growth, poverty alleviation, and environmental sustainability. Thus, the ready acceptance of the vicious circle relationship between poverty and environmental degradation appears to be based on the convenience of its implications, namely, that poverty alleviation is a prerequisite for environmental sustainability and, inversely, that the poor will benefit the most from environmental improvements (WCED 1987; World Bank 1992; Reardon and Vosti 1995; UNEP 1995), rather than on evidence.

This article questions poverty as a (major) cause of environmental degradation and the assumption that the poor are caught in a vicious circle with regard to their natural resource management. Examining the soil management of the “nonpoor,” the “not-so-poor,” and the “poorest” farmers in three Honduran watersheds, the article provides evidence of the existence of different relationships between poverty and soil degradation. The article argues that the relationship between the overall level of poverty and soil degradation often is a statistical artifact, resulting from a failure to disaggregate the soil management of the poor and the nonpoor, rather than a casual relationship. Further, the article shows that although they are inhibited by lack of capital from using chemical fertilizers, poor farmers are no less likely than nonpoor farmers to employ more labor- and land-requiring soil-conserving or improving measures.

Methods and Materials

The Study Area

This article is based on field research carried out in three rural watersheds in Honduras: Río Saco watershed (1200 ha) in the Atlántida department in the north; Cuscateca watershed (4100 ha) in the department of El Paraíso in the south; and Tascalapa watershed (11,400 ha) in Yoro department in central Honduras (see Figure 1). The three watersheds possess rather distinct agricultural potentials (see Table 3, later, for differences in soil quality) as well as opportunities for agriculture versus other economic activities. Río Saco watershed, situated in the Tiburón Mountains, is characterized by very steep slopes and high rainfall. Río Saco's location close to the Caribbean coast as well as to the large commercial pineapple plantations on the coastal plains provides its inhabitants with a range of income-earning opportunities other than small-scale farming—for example, as fisherman, sailors, and plantation workers, and as recipients of remittances from relatives in the United States. In contrast, the populations of both Cuscateca and Tascalapa watersheds depend to a much larger extent on local agricultural production for their livelihood, though in different ways. Biophysically, Cuscateca contains relatively large extensions of flat land with good, alluvial soils. The area has easy market access to the Honduran capital, Tegucigalpa, situated at a distance of 2 hours from the watershed along a good tarmac road. Moreover, employment

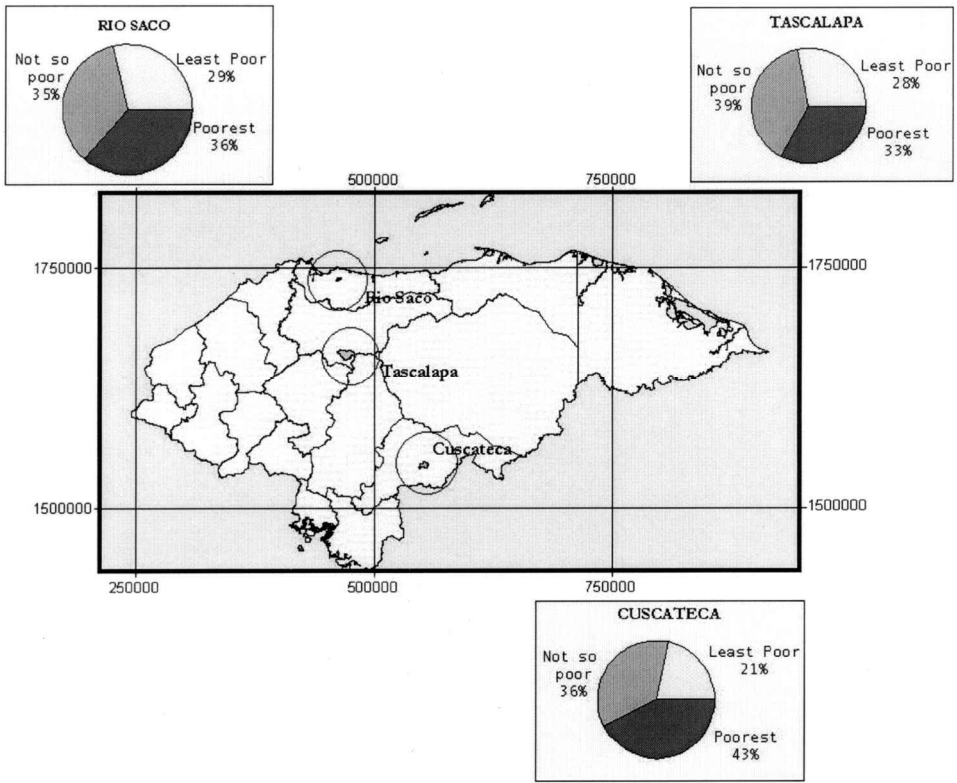


FIGURE 1 Poverty in Río Saco watershed, Atlántida; Cuscateca watershed, El Paraíso; and Tascalapa watershed, Yoro, Honduras. Levels are shown as percent poorest, not-so-poor, and least poor households by watershed.

opportunities exist in the many cigar factories situated around the thriving municipality of Danlí. Tascalapa, on the other hand, is characterized by a much more hilly terrain. Infrastructural facilities and market opportunities are limited as are employment opportunities outside agriculture. The different conditions provided by the three watersheds give rise to quite distinct poverty situations (see third section).

Data Collection

The field research was designed to develop a poverty profile for each of the three watersheds and to explore if and how household natural resource endowments and management strategies relate to the level of household poverty.¹ Inspired by the reservations of Sen (1981; 1985) toward understanding and measuring poverty and well-being solely on the basis of income or expenditure data, and in line with the increasing recognition among agencies like IFAD (Jazairy et al. 1992), UNDP, and the World Bank (e.g., Narayan et al. 2000) of the multidimensionality of poverty and the importance of including poor people's own perceptions in poverty assessments, the poverty profiles developed for this study are based on people's own perceptions of poverty, identified through well-being rankings. The rankings were conducted in a sample of 90 communities, drawn from the departments of

Atlántida, El Paraíso, and Yoro using a maximum variation sampling strategy with respect to factors that could potentially lead to the existence of different perceptions of well-being. The descriptions of different poverty levels resulting from the rankings were “translated” into indicators. Subsequent analysis examining the extent to which the use of specific indicators was associated with specific types of communities found no such association. Thus, one single set of well-being indicators could be identified for the three departments of Atlántida, El Paraíso, and Yoro. The indicators covered aspects related to sources of livelihood, basic needs satisfaction, and ownership of assets and resources² and were made quantifiable through the formulation of a household questionnaire. The questionnaire was administered to three independent samples, drawn as simple random samples from the watersheds, based on complete list of households elaborated specifically for this study. The samples comprise 208 households for Río Saco, 270 households for Cuscateca, and 290 households for Tascalapa. A scoring system was designed according to which a score (33, 67, or 100) was assigned to each household for each indicator depending on its characteristics. These were then combined into a poverty index on the basis of which three poverty categories were defined, namely, the nonpoor, the not-so-poor, and the poorest households. Following this procedure, qualitative poverty descriptions are turned into an absolute, but locally informed, poverty measure. For a more detailed description of the methodology and how it was applied in the Honduras study, please refer to Ravnborg et al. (1999).

In addition to the questions necessary to quantify the poverty indicators, the questionnaire contained a set of questions related to the biophysical properties of the household’s most important basic grains plot³ and the soil management strategy employed. Not all households included in the samples operate land on their own account, that is, either own or rent land or as part of a sharecropping arrangement. Thus, in each of the watersheds, the “farming households” comprise only a proportion of the total number of households included in the sample.

Data Analysis

Data obtained through the questionnaire survey was entered into a database and analyzed using the Statistical Package for Social Sciences (SPSS). A stepwise data-reducing analytical strategy was adopted in order to first construct and then correlated composite variables representing poverty level, soil quality, and soil management strategy. Multiple correspondence analysis, a multivariate dimension reduction technique, was used. Multiple correspondence analysis⁴ explores the relationships between two or more categorical variables, by representing these in a few dimensions. Using the iterative alternating leastsquare technique, object scores are calculated, corresponding to the coordinates of the point representing the object along the dimensions included in the solution. As these object scores have metric properties, multiple correspondence analysis performs a quantification of qualitative data, and the object scores can be used as input variables for other procedures requiring interval data. In this study, the object scores are used as input variables for a cluster analysis, using the K-means cluster analysis procedure. The correlation between the constructed variables representing poverty level, soil quality, and soil management strategy was examined through a multivariate analysis of variance. However, due to nonsignificance of higher order interactions

between these variables, the correlation may be examined through detailed analysis of two-way contingency tables as presented in the seventh section.

The Different Faces of Poverty in Río Saco, Cuscateca, and Tascalapa

Almost counterintuitively, the agriculturally well-endowed Cuscateca is the watershed with the highest incidence of poverty, with 43% of its households belonging to the category of the poorest households, while the remote and hilly Tascalapa is the watershed with the lowest incidence of poverty, with 33% of the population belonging to this category (see Figure 1). More interesting than the differences in the incidence of poverty, however, are the different faces—the character—that poverty takes in the three watersheds.

In Cuscateca, poverty expresses itself as the outcome of a process of concentration of good agricultural land along with the formation of a large group of landless or virtually landless farmers with no other option than to sell their own labor, often on a day-to-day basis. As much as two-thirds (65%) of the poorest households in Cuscateca are absolutely landless and do not sharecrop with other farmers or rent land. More than half (53%) of the poorest households are day laborers for more than 3 months per year, earning \$2 to \$3 per day and with no other source of income. Thus, of the landed farming households included in the Cuscateca sample, only 15% belong to the category of poorest households.

In Tascalapa, as the other extreme, even the poorest households enjoy some degree of independence in the sense that the majority of them own at least some land. Absolute landlessness without acquiring land through renting or sharecropping only applies to 3% of the poorest households, although the majority, 78%, own only 1 *manzana* (0.7 ha) or less. In Tascalapa, poverty expresses itself as a generalized state of uncertainty in terms of unreliable climate, market access, and general provision of services—a condition that affects the poorest as well as the not-so-poor and nonpoor households but that the nonpoor households stand a better chance of facing. Thus, as much as 85% of the poorest households in Tascalapa face regular periods of food shortage, as compared with “only” 58% in Río Saco and 30% in Cuscateca.

Finally, in Río Saco, where agriculture is less important as a source of livelihood, poverty expresses itself as landlessness combined with lack of other sources of income, such as remittances from relatives in the United States, which often overshadows what can be obtained from agriculture. Overall, half of the households have nonagricultural sources of income, ranging from one-fifth (21%) of the poorest households to four-fifths (83%) of the nonpoor households.

Despite the stark difference in the incidence of absolute landlessness between the three watersheds, everywhere the poorest households control a disproportionately small part of the land. Estimates derived from the questionnaire survey suggest that in Cuscateca, the poorest households control around 7% of the total basic grains area, while the nonpoor households control approximately 50%. In Río Saco and Tascalapa, the poorest households control 25 and 20% respectively, of the total basic grains area, compared with the nonpoor, who in both watersheds control approximately 45% of the basic grains area.

Although unwarranted when judged upon the amounts of land owned by the poor, the independence and identity as farmers provided through the ownership of even very small pieces of land are assigned significant importance in the perceptions

of poverty encountered in all three watersheds. Many farmers would thus go a long way, often beyond what from an economic point of view is rational, to maintain this identity as independent farmers.

Soil Degradation

Soil degradation refers to a reduction in the capability of land to satisfy actual or potential uses (Blaikie and Brookfield 1987). With or without human interference, soils constantly change due to naturally occurring degrading and reproductive processes such as leaching, erosion, and decomposition of organic matter. However, human interference and particularly agricultural production significantly affect these processes.

Many sources describe the Central American hillsides as seriously degraded. Drawing on the Global Assessment of the status of human-induced Soil Degradation (GLASOD) undertaken by UNEP and the International Soil References and Information Centre (ISRIC), a quarter of the total agricultural area of Central America is estimated to be seriously eroded (Scherr 1999), and for Honduras the corresponding proportion is estimated at 46% (Kirschke, Morgenroth, and Franke 1999). However, several authors claim that the empirical basis for such aggregate estimates is weak (Lutz, Pagiola, and Reiche 1994; Jansen 1998). In the case of Honduras, Jansen (1998) reports that few studies have actually been conducted to measure land degradation and soil erosion and that the GLASOD study relies on experts' estimates of land degradation in the area where they work, often extrapolating from relatively limited case-study data. This tends to exaggerate the magnitude of soil degradation, among other reasons because "moved soil" is considered "lost soil," even though much of it may have been deposited on other agricultural land (Lutz et al. 1994). Moreover, assessments of soil degradation tend to focus on erosion, whereas other forms of soil degradation, such as damage to physical and chemical properties of soil or reductions in its capacity to retain moisture, are not documented (Lutz et al. 1994).

Without refuting that soil degradation takes place in many parts of Honduras and in Central America more generally, the assumption of a casual relationship between environmental degradation and poverty, or more specifically the soil management practices of the poor, is based on the overlay of such aggregate estimates of soil degradation with equally aggregate poverty data (e.g., the proportion of the population being poor at department level; World Bank 1994). At such levels of aggregation it is, however, impossible to determine whether the soil degradation taking place is the result of poor people's actions or of the actions of nonpoor agents who just happen to operate in an area characterized by a high incidence of poverty. Thus, the remaining part of this article attempts to take the analysis beyond such aggregate estimates and associations to examine the soil quality and the soil management practices in relation to poverty level in the contexts of the three Honduran watersheds.

Soil Quality in Río Saco, Cuscateca, and Tascalapa

Guided by work to develop a locally applicable tool to evaluate soil quality based on immediately observable characteristics (Burpee and Turcios 1997; Burpee 1997), questionnaire respondents were asked to characterize the soil of their most important basic grains plot according to slope, soil depth, erosivity, water infiltration and retention, fertility, and presence of soil life (Table 1). Such local classifications of

TABLE 1 Soil Characteristics and Their Options Included in the Questionnaire as Immediately Observable Indicators of Soil Quality

Soil characteristic	Options indicating		
	High quality	Mid range	Low quality
Slope	< 10% > 10 in	10–30% 5–10 in	30–70% 2–5 in
Depth of top soil			> 70% < 2 in
Erosivity phrased as “does the soil get washed down during a rain shower?”	“It doesn’t happen”	“It happens, but not a lot”	“Yes, this happens a lot”
Water infiltration phrased as “what happens to the water after a rain shower?”	“It infiltrates into the soil immediately”	“It infiltrates slowly and there is some runoff”	“It doesn’t infiltrate but runs off”
Water retention phrased as “how does the soil retain water?”	“The soil maintains the humidity well”	“The soil dries out slowly”	“The soil dries out immediately after a rain shower”
Fertility phrased as “does the soil produce without fertilizers?”	“The soil produces well without fertilizers”	“The soil needs fertilizers to produce proper yields”	“The soil doesn’t yield anything without fertilizers”
Weed growth phrased as “number of species of weeds”	“Many different types of weeds grow at this plot”	“Some different types of weeds grow at this plot”	“Only few different types of weeds grow at this plot”
Soil life phrased as “number of earth worms and other soil organisms”	“The soil contains lots of soil organisms”	“The soil contains some soil organisms”	“The soil contains few soil organisms”

TABLE 2 Description of Soil Quality Clusters According to Immediately Observable Characteristics ($N = 466$ plots/households)

Characteristic	Soil quality cluster			
	Best ($n = 135$)	Good ($n = 120$)	Fair ($n = 119$)	Worst ($n = 92$)
Slope	0–10% (76%)	0–10% (42%) 10–30% (41%)	10–30% (58%) 30–70% (25%)	30–70% (37%) 10–30% (28%) 0–10% (22%)
Depth of top soil	5–10 in (36%) > 10 in (34%)	2–5 in (76%)	2–5 in (48%) 5–10 in (42%)	< 2 in (51%) 2–5 in (40%)
Erosivity	Low (61%) Moderate (26%)	Low (46%) Moderate (38%)	Moderate (73%)	High (70%)
Water infiltration	High (55%) Moderate (26%)	Moderate (74%)	Low (64%) Moderate (25%)	Low (68%)
Water retention	High (64%) Low (22%)	Moderate (66%) High (20%)	Moderate (45%) Low (40%)	Low (61%) High (26%)
Fertility	Moderate (64%) High (35%)	Moderate (93%)	High (62%) Moderate (35%)	Moderate (61%) Low (33%)
Weed growth	Low (55%) High (26%)	Moderate (41%) Low (34%)	Low (68%)	Low (41%) High (35%)
Soil life	Low (45%) High (41%)	Moderate (53%) Low (28%)	High (59%) Low (24%)	Low (62%) Moderate (20%)

Note. Percentages in parentheses indicate the proportion of the plots contained in the cluster for which the option applies. Only the most predominant options are included in the table, so that for each characteristic, a minimum of two-thirds of the plots contained in each cluster are described in the table.

soils have been found to correlate well with scientific measures of soil quality (e.g., Bellon and Taylor 1993; Talawar and Rhoades 1998). These variables were entered into a multiple correspondence analysis, and the object scores from the first two resulting dimensions were subsequently entered into a cluster analysis. Table 2 summarizes the characteristics of the resulting four soil quality clusters. Between 25% and 44% of the poorest households in the three watersheds have their most important basic grains plot on soils classified in terms of quality as the worst soils, that is, shallow, steeply sloping, and highly erosive soil with poorly developed structure, whereas this is the case for only between 8 and 13% of the nonpoor households (Table 3).

Land Clearing

Over the past decades, large tracts of forested hillsides have been cleared throughout Central America, as part of what has been labeled a forest-to-pasture conversion process. Some estimates suggest that in Honduras, the proportion of land devoted to forest has been cut by almost half between 1960 and 1980 (from 63 to 36% of the total area), while pasture has increased from 18 to 30% of the total area and the cultivated

TABLE 3 Soil Quality of Most Important and Basic Grains Plot by Poverty Level and Watershed, Given as Percent Farming Households per Poverty Category, by Watershed

Watershed ^a	Soil quality	Poverty level ^b			All farming households
		Nonpoor	Not-so-poor	Poorest	
Río Saco	<i>Number of households</i>	31	34	36	101
	Best	26	21	14	20
	Good	42	21	17	26
	Fair	19	32	33	29
	Worst	13	27	36	26
Cuscateca	<i>Number of households</i>	49	54	18	121
	Best	59	35	28	44
	Good	27	46	28	36
	Fair	6	4	0	4
	Worst	8	15	44	17
Tascalapa	<i>Number of households</i>	79	97	68	244
	Best	37	24	15	25
	Good	29	14	21	21
	Fair	27	38	40	35
	Worst	8	24	25	19

^aSignificant correlation at .001 level exists between soil quality and watershed (Pearson chi-square).

^bSignificant correlation at .01 level exists between poverty level and soil quality in all three watersheds (Spearman's rho; two-tailed).

area has remained largely unchanged (from 13 to 16%) (Leonard 1987; here quoted from Thrupp 1993, 61). The FAO (1997) estimates the 1995 forest cover in Honduras at 36% with an annual deforestation rate (1990–1995) of 2.3%, almost double of the rate for Central America and Mexico as a whole (1.2%). This forest-to-pasture conversion covers a process whereby pasture, which is generally associated with the more resourceful cattle farmers, replaces and pushes other crops, mostly basic grains, from the flatter parts further up into the steeper parts of the hillsides on newly cleared forest land (Thrupp 1993; Humphries 1998). The “big picture,” therefore, is one of poor farmers being the immediate agents of land clearing, not necessarily because they lack land but often because they are pushed off their land by more resourceful farmers. However, the “small picture” is different. In none of the three watersheds were the poorest farmers the main agents behind clearing forest for agricultural purposes. Of the households who had cleared forest for agricultural purposes within the last 5 years, between 31 and 39% belonged to the category of nonpoor households, whereas between 0 and 27% belonged to the category of poorest households. Taking slope as an indicator of the marginality of these recently cleared plots, it is only in Cuscateca—the high-potential, intensively cultivated watershed—that noteworthy differences exist between the recently cleared plots and plots that have been longer under cultivation. Although two-thirds of the newly cleared plots were located on slopes of more than 30%, this was only the case for one-fifth of the plots that had been longer under cultivation—the most important basic grains plots.⁵ None of the

newly cleared plots in Cuscateca had been cleared by households categorized as “poorest.” In total, between 5 and 17% of the households in the three watersheds had cleared forest for agricultural purposes within the last 5 years.

Soil Quality Management

Many different crop husbandry techniques affect soil quality, of which some are employed specifically to improve soil quality and others are employed for other purposes but nevertheless affecting soil quality. This section describes the use of five of the most common practices affecting soil quality, namely, the use of chemical fertilizers, which primarily affects soil nutrient contents; burning of crop stubble and weeds; incorporation of crop stubble and weeds; the use of green/organic manure; and erosion control measures, all of which primarily affect soil structure. It continues to analyze whether and how their use is associated with poverty level and soil quality in the three watersheds.

Soil Nutrient Management

The use of chemical fertilizers can be characterized as capital intensive, whereas the four soil structure management practices are labor and land intensive. Thus, as would be expected from the vicious circle line of thought, the use of chemical fertilizers is significantly correlated with poverty level. In all three watersheds, the nonpoor households are significantly more likely to use chemical fertilizers than the poorest households. Among the poorest farming households in Tascalapa, only 9% use chemical fertilizers, whereas in Río Saco and Cuscateca, the corresponding percentages are 58 and 61%. Table 4 shows the frequency of use of the five practices in the three watersheds. Moreover, the use of chemical fertilizers is significantly more widespread in Cuscateca and Río Saco than in Tascalapa. Seventy-seven percent of the farming households in Cuscateca and 72% in Río Saco use chemical fertilizers, as compared with only 37% in Tascalapa. Finally, although in Cuscateca and Río Saco there is no significant correlation between soil quality and the use of chemical fertilizers, in Tascalapa, where the use of chemical fertilizers is associated with higher risk due to the more erratic rainfall pattern, chemical fertilizers are significantly more likely to be used on the better soils than on any other soil type.⁶

Soil Structure Management

As was shown to be the case for the use of chemical fertilizers, the vicious circle line of thought would suggest poor farmers to be less likely to incorporate crop stubble and weeds, utilize green manure, and take measures to control erosion, and more likely to burn crop stubble and weeds, constrained as they are in terms of land and labor. Yet, as discussed in more detail later, our data suggest that no such correlation exists between a household’s level of poverty and the likelihood of its use of any of these soil structure management practices.

With respect to the use of burning as part of land preparation—a practice that is often associated with poor and allegedly “ignorant” farmers—our data show that in the most intensively cultivated watershed, where, in fact, only very few of the poorest households own land—namely, Cuscateca—the use of burning is most widespread. Here, half of the landed households use burning for clearing crop stubble and weeds, whereas in the more remote and less potential watersheds of Tascalapa and Río Saco, the corresponding percentages are 29 and 21%, respectively.

TABLE 4 Use of Soil Management Practices Affecting Soil Quality by Poverty Level in Río Saco, Cuscateca, and Tascalapa, Given as Percent Farming Households per Poverty Category, by Watershed

Watershed	Soil management practice	Poverty level			All farming households
		Nonpoor	Not-so-poor	Poorest	
Río Saco	<i>Number of households</i>	31	34	36	101
	Use chemical fertilizers ^a	87	74	58	72
	Burn crop stubble and weeds ^c	10	23	28	21
	Incorporate crop stubble and weeds ^c	84	77	69	76
	Green/organic manure ^c	26	24	19	23
	Undertake erosion control ^c	26	12	11	16
Cuscateca	<i>Number of households</i>	49	54	18	121
	Use chemical fertilizers ^b	94	67	61	77
	Burn crop stubble and weeds ^c	45	56	50	50
	Incorporate crop stubble and weeds ^c	41	33	50	39
	Green/organic manure ^c	8	2	11	6
	Undertake erosion control ^c	27	23	22	24
Tascalapa	<i>Number of households</i>	79	97	68	244
	Use chemical fertilizers ^b	70	29	9	37
	Burn crop stubble and weeds ^c	23	32	34	29
	Incorporate crop stubble and weeds ^c	57	55	52	55
	Green/organic manure ^c	17	16	9	14
	Undertake erosion control ^c	37	32	29	33

^aSignificant at $p < .05$ (Pearson chi-square).

^bSignificant at $p < .001$ (Pearson chi-square).

^cNot significant ($p > .05$ Pearson chi-square).

These differences among the watersheds are due to a conscious change in strategy among farmers in Río Saco, and particularly in Tascalapa, away from the use of burning. Asked whether they had taken any recent measures to improve the soil, one-third of the households in Tascalapa stated that they had given up burning crop stubble and weeds. In Río Saco 13% and in Cuscateca 10% of the landed households had stopped burning in order to improve the soil.

Apart from being employed as a soil improvement measure in its own right, refraining from the burning of crop stubble and weeds is also a precondition to the employment of other soil-improving measures such as the incorporation of organic matter, either the crop stubble and weeds itself, or organic manure such as compost

or green manure crops. Although burning of crop stubble and weeds is done primarily because it is easier,⁷ the principal reason stated for choosing to incorporate crop stubble and weeds is that it helps to improve soil quality.

Overall, the incorporation of organic matter is most widespread in Río Saco. Here, 76% of the households incorporate crop stubble and weeds into the soil during land preparation, and 23% use green manure, most commonly velvet bean, which is intercropped with maize and incorporated into the soil after maize harvest (Bunch 1990)—a practice that is relatively widespread in Atlantic Honduras. In Tascalapa, 55% of the farming households incorporate crop stubble and weeds into the soil and 14% use green and/or organic manure. Finally, in Cuscateca, where the overall incorporation of organic matter into the soil is least widespread, only 6% had taken up the use of green and/or organic manure, and 39% of the farming households incorporate crop stubble and weeds.

Erosion is seen by many observers as the key component of soil degradation (e.g., World Bank 1992). In many cases, it is irreversible. It not only affects the individual farmer but has potential off-site effects (both positive in the form of depositing good soil elsewhere in the agricultural landscape and negative by, e.g., silting up dams and rivers; Lutz et al, 1994).

In the three watersheds, the most common erosion control measure is the establishment of live and dead barriers. However, only in Tascalapa, a considerable proportion of the households—namely, one-third—indicated that they had taken measures “to prevent the soil from washing down the slope,” whereas in Cuscateca 24% and in Río Saco as little as 16% of the households had taken erosion control measures.

The absence of significant correlation between the adoption of the soil structure management practices and poverty level could be due in some of the watersheds to such correlation simply being difficult to detect due to the limited extent to which the practices are adopted. Thus, assuming that the tendencies toward less adoption among the poorest households of some of the soil structure management practices would reinforce each other and thus be easier to detect, their use should also be analyzed as a whole, as specific combinations of soil management practices.

To this end, the four soil structure management practices just discussed were entered as variables into a multiple correspondence analysis to explore patterns of association between them and thus identify types of soil structure management strategies. Similar to the case of soil quality analysis, a cluster analysis was performed using the first two dimensions resulting from the multiple correspondence analysis as input variables. A solution with three clusters (soil structure management strategies) was selected and is summarized in Table 5, where the clusters are organized from most to least sustainable. The first cluster, labeled “most sustainable,” contains plots, where crop stubble and weeds are incorporated rather than burned, where green or organic manure is used on close to half of the plots, and where erosion control measures have been adopted on three-quarters of the plots. At the other end of the scale, the cluster labeled “least sustainable” contains plots where crop stubble and weeds are burned rather than incorporated, where hardly any green or organic manure is used, and where erosion control measures have been adopted on less than one-fifth of the plots. In between, we find first a cluster labeled “less sustainable” where crop stubble and weeds are incorporated rather than burned but without any use of green/organic manure or erosion control measures.

However, even when viewed as a whole, no significant correlation is found between type of soil structure management strategy used and poverty level in any of

TABLE 5 Use of Soil Structure Management Practices by Soil Structure Management Clusters, Given as Percent Plots on Which the Soil Structure Management Practice Is Used per Cluster

Soil structure management practice	Soil structure management cluster			All plots
	Most sustainable	Less sustainable	Least sustainable	
<i>Number of plots</i>	134	179	153	466
Burn crop stubble and weeds	1	0	100	33
Incorporate crop stubble and weeds	84	81	0	55
Green/organic manure	46	0	1	14
Undertake erosion control	75	0	16	27

the three watersheds. Thus, no evidence is found in support of the existence of a vicious circle type of relationship between poverty and soil structure management. Rather, the choice of soil structure management strategy differs significantly among the watersheds (Table 6). In Tascalapa, where public campaigns have encouraged farmers to prevent erosion and refrain from the use of burning as part of land preparation, and in Río Saco, where the use of green manure has been successfully promoted, households are more likely to employ the “most sustainable” soil structure management strategy than are households in Cuscateca. In contrast, in Cuscateca, which has the largest share of nonpoor farmers, households are most

TABLE 6 Soil Structure Management Strategy by Poverty Level and Watershed, Given as Percent Farming Households per Poverty Category, by Watershed

Watershed ^a	Soil structure management strategy	Poverty level ^b			All farming households
		Nonpoor	Not-so-poor	Poorest	
Río Saco	<i>Number of households</i>	31	34	36	101
	Most sustainable	36	27	25	29
	Less sustainable	55	50	47	51
	Least sustainable	10	24	28	21
Cuscateca	<i>Number of households</i>	49	54	18	121
	Most sustainable	22	11	22	17
	Less sustainable	33	33	28	32
	Least sustainable	45	56	50	50
Tascalapa	<i>Number of households</i>	79	97	68	244
	Most sustainable	41	32	31	34
	Less sustainable	37	37	35	37
	Least sustainable	23	31	34	29

^aSignificant correlation at .01 level exists between soil structure management strategy and watershed (Pearson chi-square).

^bNo significant correlation exists between soil structure management strategy and poverty level in any of the three watersheds (Pearson chi-square).

TABLE 7 Soil Structure Management Strategy by Soil Quality Cluster and Watershed, Given as Percent Plots per Soil Quality Cluster, by Watershed

Watershed	Soil structure management strategy	Soil quality clusters ^a				All plots
		Best	Good	Fair	Worst	
Río Saco	<i>Number of plots</i>	20	26	29	26	101
	Most sustainable	20	12	52	27	29
	Less sustainable	60	73	41	31	51
	Least sustainable	20	15	7	42	21
Cuscateca	<i>Number of plots</i>	53	43	5	20	121
	Most sustainable	11	14	80	25	17
	Less sustainable	23	49	20	25	32
	Least sustainable	66	37	0	50	50
Tascalapa	<i>Number of plots</i>	62	51	85	46	244
	Most sustainable	29	31	45	26	34
	Less sustainable	53	33	31	28	37
	Least sustainable	18	35	25	46	29

^aSignificant correlation at .01 level exists between soil structure management strategy and soil quality in all three watersheds (Pearson chi-square).

likely to employ the “least sustainable” soil structure management strategy, with half of the households employing it.

Moreover, the choice of soil structure management strategy is found to correlate with soil quality in all three watersheds (Table 7). In Cuscateca, which has large tracts of flat, deep alluvial soils, the need for soil structure management is less than in the hilly areas with shallow and more erodable soils of Río Saco and Tascalapa. Thus, in Cuscateca, there is a tendency for the “best” soils to be subjected to the “least sustainable” soil structure management strategy, while the “good” soils tend to be subjected to the “less sustainable” soil structure management strategy. Also, Río Saco and Tascalapa show elements of a significant inverse correlation between the sustainability of the soil structure management strategy and soil quality. In both watersheds the likelihood for “fair” soils to be subjected to the “most sustainable” soil structure management strategy is significantly higher than for any other soil types. However, in both watersheds, the “worst” soils are associated with the “least sustainable” soil structure management strategy, presumably reflecting the investment of any kind in such low-quality soils is considered very risky.

Poverty and Soil Management Relationships

In summary, while the decision to use chemical fertilizers appears to be affected by a household’s poverty level in all three watersheds, the opposite is the case for a household’s decision with respect to soil structure management. In none of the three watersheds does a household’s level of poverty appear to influence its choice of soil structure management. Rather, decisions with respect to soil structure management appear to be influenced by soil quality. Thus, despite facing constraints in terms of land and labor availability, the poorest households do not appear to sacrifice longer term concerns with the maintenance of soil structure in favor of short-term gains to any greater extent than the less poor households.

Conclusion

Two conclusions emerge from the empirical evidence of poverty and soil management relationships from the three Honduran watersheds presented in this article.

First, our data do not support the argument of poverty as a (major) cause of soil degradation. Rather than a causal relationship, our data suggest that the link between poverty and soil degradation often is only a statistical artifact. Cusateca is the watershed with the highest incidence of poverty. At the same time, it is the watershed with the highest proportion of farmers employing the “least sustainable” soil structure management strategies. Thus, at this level of aggregation, these statistics seem to confirm the assumption of poverty as a major cause of soil degradation. However, the total soil degradation caused by the poorest households, even if they all were to employ the “least sustainable” soil structure management strategy combined with no use of chemical fertilizers, is negligible given the fact that they constitute only 15% of the landed households in the watershed and control only 5 to 7% of the agricultural land. Neither were the poor found to be more likely to clear forest for agricultural purposes than the less poor in any of the three watersheds. Although high levels of association might be found between poverty level and environmental degradation in a specific region, meaningful claims of causal relationships between poverty and environmental degradation have to be based on disaggregated analysis of the resource management practices of the poor versus those of the nonpoor.

Second, poor farmers are constrained by lack of capital, labor, and land. Yet our analysis shows that only the capital constraint significantly affects the choice of soil management strategy of poor farmers, in that it inhibits them from using chemical fertilizers. Despite labor and land constraints, poor farmers were not found to be more reluctant to employ land- and labor-intensive measures to improve soil structure than the less poor farmers in any of the watersheds. This points to the importance of making available technical options for improved natural resource management, such as the use of velvet bean as a green manure crop, that are within reach of poor farmers—that is, that build on the resources that—although limited—are available to the poor.

Notes

1. The field research was carried out by Rosa Escolán, Miguel Angel Méndez, and Fernando Mendoza, and coordinated by the author.

2. Indicators of sources of livelihood include land ownership, market involvement with respect to marketing of own agricultural produce, day laboring, and sources of income other than agriculture. Indicators of basic needs satisfaction include household food security, housing quality, and capacity to attend to health problems. Finally, indicators of ownership of assets and resources are comprised of cattle ownership, animal (other than cattle) ownership, capacity to contract day laborers, and savings and capacity to give loans to neighbors.

3. Basic grains, that is, maize and beans, which constitute the staple diet in Honduras, are the crops cultivated by the largest proportion of households in the study area. In the three watersheds, between 92% and 99% of the land-owning households cultivate basic grains.

4. Multiple correspondence analysis, in SPSS called homogeneity analysis, quantifies categorical data by assigning numerical values to the cases and categories, using the iterative alternating least-squares method. All variables are regarded as categorical—that is, no assumptions are made about the distance or order between different categories of the same variable. The object scores are calculated so that objects within one category are attempted

plotted close together whereas objects in different categories are plotted far apart, and the category quantifications are the average or centroids of the object scores of the objects in that category. The multiple correspondence analysis procedure also produces a plot of discriminant measures that show how well each variable discriminates the cases. The multiple correspondence analysis procedure available in SPSS (version 10.0) was developed by Department of Data Theory, University of Leiden, the Netherlands.

5. The same pattern appears when taking distance from home of the recently cleared plots as compared with the plots that have been longer under cultivation. Only in Cuscateca were there noteworthy differences, with 50% of the recently cleared plots being situated more than 30 minutes walking distance from home; this was the case for only 20% of the most important basic grains plots.

6. The correlation between the use of chemical fertilizers and soil quality is significant at .01 level (chi-square test) in Tascalapa.

7. This reason was stated by between 77% and 82% of the households burning crop stubble and weeds in the three watersheds.

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