B A S I S

Broadening Access and Strengthening Input Market Systems

RURAL POVERTY AND LAND DEGRADATION IN EL SALVADOR

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It is widely believed that low living standards and poor environmental quality in the Latin American countryside are interrelated symptoms of mediocre economic performance, which in turn has to do with human capital scarcity and policy-induced distortions in factor and output markets. Of special concern are people located in remote, hilly areas. Their labor market participation tends to be marginal. Furthermore, agriculture in less-favored areas is often accompanied by rapid soil loss, which diminishes living standards by reducing land productivity.

Various responses to the plight of small farmers and the fragile lands they occupy are possible. Technical assistance can be provided to foster the adoption of soil conservation measures. Human capital investment can be increased and labor market imperfections corrected in order to stimulate off-farm employment. Migration away from areas that are poorly suited to crop and livestock production can also be promoted, by reforming policies that discourage the full utilization of prime agricultural land, the market transfer of that resource (to those prepared to use it more efficiently than current owners are), or both.

This paper addresses various initiatives, including policy reform, for reducing rural poverty and land degradation in one country, El Salvador, where both these problems are severe. Special attention is paid to choices made by small farmers about erosion control, which are related to factors influencing the returns and costs of soil conservation. Also investigated are linkages between a rural household's soil management decisions and the success it has achieved in diminishing its dependence on agriculture as a source of earnings.

Data Sources and Conceptual Framework

Although erosion is a major environmental concern in El Salvador (Panayotou, Farris, and Restrepo, 1997), there has not been much investigation of its causes and its economic impacts. From the late 1970s through the early 1990s, systematic data collection in the country's northern hills and mountains, where erosion rates are especially high, was precluded by armed conflict. Drawing on the limited information at hand, McReynolds, Johnson, and Geisler (1994) identified various factors related to the use and management of land resources. Sain and Barreto (1996) surveyed farmers in three communities located in western El Salvador, where the fighting was less intense, and used the data to describe the adoption of soil conservation practices. More recently, two members of a World Bank mission that assessed rural poverty in El Salvador have made limited use of a national survey of more than 700 rural households carried out in early 1996 by the *Fundación Salvadoreña para el Desarrollo Económico y Social* (FUSADES). In their resport, various factors influencing the use and management of land resources are identified (Pagiola and Dixon, 1997).

The 1996 FUSADES survey is one of the data sources drawn on in this study, which is being supported by a U.S. Agency for International Development (USAID) project (González-Vega, 1998). Also to be utilized are data collected in a follow-up survey that FUSADES carried out in early 1998. As was done two years earlier, interviews were conducted with a stratified sample comprising three sorts of rural households:

- farmers with at least 2.5 manzanas (equivalent to 1.75 hectares) of land;

- familes with less land or none at all but without significant non-agricultural earnings; and
- households deriving income primarily from jobs outside of agriculture.

This paper's coauthors contributed to the modification of separate questionnaires developed for each these groups. In all, more than 80 percent of the 738 households interviewed in 1996 were surveyed again in 1998; the other participants were selected because they shared key features of the households that had been included in the sample two years earlier but were unavailable for the follow-up survey. Another information gathering effort, virtually identical to 1998's in terms of the sample and the questionnaire, will be undertaken early in 2000. Thus, a panel data set will be available for more in-depth analysis in the near future.

Among the participants in the 1996 survey, family income during the preceding 12 months averaged 16,240 colones (about $2000 at prevailing exchange rates). Fifty-two percent of all income was from non-agricultural wages and another 13 percent or so resulted from crop sales. Other income was derived from home-based work unrelated to agriculture (6 percent) as well as working for other farmers (23 percent). About 5 percent of average household income was from remittances from family members (Table 1).

As also indicated in Table 1, the typical rural household has six members. Educational attainment is low, as reflected in readings for an index measuring differences between actual number of years of formal education and the potential number (nine for adults and fewer for school-aged children) for all member of rural households. By gender, the average readings for males and females are 44 percent and 39 percent, respectively. Although 55 percent of the respondents have electricity, 93 percent cook with fuelwood. Outside of a few areas where farmers specialize in coffee, basic grains, especially corn, are the primary output. A little more than half of all crops produced is for household consumption. *Coyotes* (i.e., intermediaries who circulate in rural areas) buy most of the commercial output; the balance is sold to neighbors, in local markets, or to industrial buyers.

Many farmers perceive their land resources to be fragile in one way or another, with 45 percent of producers reporting that erosion is a problem on at least part of their land. Fifty-two percent of farmers reported using some sort of conservation practice, but only twenty percent of the households that regarded degradation threats to be real reported use of a conservation practice. Average net returns from agricultural production were approximately 20 percent lower for households reporting erosion threats on their land, while average net returns for households implementing conservation practices were about 2 percent higher than what others earned.

Analysis of the 1996 data set is far from complete, and we have not yet begun to work with the data collected in the follow-up survey. The conceptual framework for our econometric research is broadly recursive, comprising two parts. The first, which comprises a single equation, focuses on household survival strategies, in particular on income diversification undertaken to raise family income. The measure of diversification used as the equation's dependent variable is the portion of total household earnings derived from agriculture. [Insofar as the data permit, the portion of total income derived from farming land that is steeply sloped, highly erodible, or both might be used as the dependent variable in future econometric investigation.] Right-hand side variables, identified on the basis of previous research on the determinants of rural poverty in El

Salvador (López, 1997), include the assets that a household can draw on to diversify income – human capital and land resources (as characterized by location and other traits) – as well as how far the household is from centers of commercial and other activity.

In the second part of the model, adoption of soil conservation measures is related to various factors affecting the returns to crop production and costs of erosion control. Among the latter factors are sources of off-farm income (i.e., the dependent variable of the first equation) since earning more from non-agricultural work diminishes the relative importance of soil conservation and also raises the opportunity cost of labor. The latter impact, in turn, encourages labor-saving practices for keeping soil in place (e.g., reduced tillage) while discouraging techniques (e.g., installing and maintaining field barriers) that are labor intensive.

Results

Estimation of the first of the model's two parts was carried out with all 724 useable observations from the 1996 survey. A variable was created relating non-agricultural wages to overall household income, defined as the sum of net returns from crop and livestock production and agricultural and non-agricultural wages. [Remittances and earnings from cottage enterprises not included in the denominator.] The dependent variable, which by definition has a minimum value of 0.00 and a maximum value of 1.00, was regressed on a number of indicators of a household's ability to derive income from farming and other activities:

- the index of family educational attainment mentioned above;

- distance to medical services (which was the best indicator of how far a household is located from a center of commercial activity);
- extent of agricultural landholdings;
- family size;
- reliance on fuelwood for cooking; and
- a slope shifter for residence in the department containing the national capital, San Salvador, where earning prospects are, in general, superior.

Estimated coefficients are reported in Table 2, along with t-ratios, p-values, and share elasticities. Each of the six variables test to be different from zero at the 90 percent confidence interval. Furthermore, regression results confirm what one expects about how a household's endowments of human capital and other assets affect its market behavior and survival strategies. For example, families with more education and better access to a commercial center and that do not spend a lot of time gathering fuelwood and performing agricultural chores are more apt to mobilize wage income from non-agricultural sectors. Non-agricultural earnings as a share of total income is most responsive to a household's location in the San Salvador metropolitan area, its reliance on fuelwood, family size, farm size, family education, and distance from a commercial hub (of the sort that contains a doctor's office or health center).

The second part of the regression model focuses on the decisions that households make about soil conservation. Among the variables influencing these decisions are access to technical assistance, family education levels, the sort of crops grown, and the household's sense that erosion is, indeed, a problem. Another causal factor is income diversification, as measured by an increase in the relative importance of non-agricultural earnings. Since diversification is assumed to result from household decisions, observed values of the share of income derived from non-agricultural sources are not exogenous to the adoption of conservation practices. In order to avoid simultaneity bias, then, estimated values of the income-share variable, obtained from the first regression, have been used in place of actual values.

For obvious reasons, estimation of the second part of the model used only observations for households possessing agricultural land, which made up about 40 percent of the sample. The results are reported in Table 3. The coefficients comprise odds ratios, which range upward from zero. Each ratio shows the effect of a marginal change in the corresponding independent variable on the probability that the household will adopt a conservation practice. If the ratio is a positive fraction of one, then a marginal increase in the variable reduces the chances that erosion will be controlled. A coefficient greater than one indicates a positive relationship between the right-hand-side variable and the odds of adoption.

Three variables appear to have positive and statistically significant impacts on the odds of adoption: access to technical assistance, production of basic grains (as opposed to high-value commodities, like coffee) on the farm, and the household's recognition of soil erosion as a constraint on output. Adoption odds appear to decrease as educational attainment rises and increase as non-agricultural income grows in relative importance. However, neither of these last two effects is significant at conventional levels.

There are several reasons for the absence of a clear, straightforward relationship between income diversification and the application of erosion control measures. Some of these measures, like conservation tillage, allow for a reduction in overall labor inputs to crop production. Others, building and maintaining terraces for example, are labor intensive. Needless to say, the former are attractive to households with good off-farm employment prospects, while the latter are not. Sample selection bias might also be a problem.

Another interesting result, which merits explanation, is that farms that produce basic grains are more than two and a half times as likely to adopt a conservation practice rather than doing nothing at all about soil loss. This is plausible since reduced tillage, residue management, and other cultural practices, which are the best way to reduce soil loss from many grain fields, are fairly easy to apply. The situation is different in the coffee sub-sector. Like other perennial crops, coffee protects soil from the elements, which reduces the need for erosion control measures. Also, many of the measures recommended for coffee farms are structural, which can be expensive to put in place. In addition, a great deal of coffee, fruit, and other high-value commodities is grown on El Salvador’s best land, where erosion risks are not especially high. For all these reasons, a positive relationship between crop value and conservation practice adoption, of the sort hypothesized by Pagiola and Dixon (1997), does not to hold.

Another unexpected influence on the odds of adoption has to do with educational attainment. The appropriate interpretation of the coefficient for the family education index is that households with meager human capital endowments may be farming the most erosion-prone land. Finally, the coefficients for technical assistance access and recognition of soil loss problems are what one would expect in addition to being statistically significant.

Table 4 reports frequencies for correct and incorrect model predictions. If all predictions greater than 0.5 are classified as conservation adoption and all predictions less than 0.5 as non-adoption, the model correctly classifies households according to individual household characteristics 68 percent of the time. This can be compared to a naïve predictor (predicting the universal adoption of conservation measures), which is correct 53 percent of the time (the actual frequency of adoption among survey participants).

Conclusions

The research described in this paper is still at an early stage. Among refinements that we expect to make is improved specification of the household location variable. The best that could be done with the 1996 data was to use distance from a doctor's office or health center as a proxy indicator. But in response to suggestions made by this paper's coauthors, direct questions about the distance between a household and the nearest commercial hub were included in the 1998 survey instrument. That questionnaire also elicited more precise information about nearby off-farm employment opportunities. Because of changes like these, future analysis ought to yield much better insights about how households earn money from non-agricultural sources, which is the focus of the first part of our model.

Regardless of its limitations, the regression analysis carried out to date reveals that economic survival strategies adopted by households and their decisions about soil conservation are truly interrelated. Moreover, the recursive model we are using appears to be a satisfactory vehicle for understanding the choices made by rural households in a place like El Salvador.

In general, there appear to be two effective strategies that a country can follow to address agriculturally-induced environmental problems. First, additional support can be provided for primary and secondary education in the countryside, so as to raise non-agricultural earnings. This diminishes the need to cultivate land that does not lend itself well to crop production. Second, adoption of conservation practices continues to be an option. Our regression findings suggest that households with significant off-farm earnings might actually be more responsive to, say, technical assistance efforts aimed at promoting adoption. However, additional investigation of this possibility would clearly be needed before definitive recommendations can be made about effective strategies for environmentally sustainable economic progress in the countryside.

Table 1 Descriptive Statists -- 1996 Rural Salvador Survey

Descriptive Statistics for all Rural Households (n=745)

Variable	Mean	Minimum	Maximum	Share of Total Income
Income Variables				
Non-agricultural Wage Income	8414	0	112160	0.52
Agricultural Wage Income	4016	0	54000	0.25
Other home income	918	0	225000	0.06
Domestic Remittances	127	0	26040	0.01
Foreign Remittances	777	0	41760	0.05
Net Cropping Returns	1987	-51265	136860	0.12
All household Income	16240	-16090	240020	
Household Characteristics				
Share Using Electricity	0.55	0	1	
Share Using Fuelwood	0.92	0	1	
Distance to Doctor (kms)	5.11	0	60	
Distance to Elementary School (kms)	1.22	0	10	
Distance to Secondary School (kms)	5.34	0	40	
Distance to Highway (kms)	6.07	0	38	
Number of Members in Family	5.89	1	17	
Family Education Index	0.43	0	1	
Family Education Index -- males	0.44	0	1	
Family Education Index -- females	0.39	0	1	
Share of Family Members who can Read	0.68	0	1	

Additional Descriptive Statistics for Farmers Surveyed (n=287)

Variable	Mean	Minimum	Maximum
Share of Households Reporting Erosion a problem	0.45	0	1
Share of Households Use Conservation Practice	0.53	0	1
Residual Rents to Land and Management	1749	-5363	39103
Share of Agricultural Output Sold	0.49	0	1
Share of Households Received Technical Assistance	0.21	0	1
Total Cultivated Acres	3.96	0.25	30
Cropping Income -- Erosion a Problem	3952	-15382	136860
Cropping Income -- Erosion Not a Problem	4861	-51265	84723
Cropping Income -- Non-adopters	5053	-30000	84723
Cropping Income -- Adopters of conservation	5250	-51265	136860

Table 2 Estimation Results for Equation Prediting Share of Non-agricultural Income

	Coefficient	T-ratio	p value	Elasticity
Family Eduction Index	0 209	3 936	0 000	0 047
San Salvador Department	0 485	7 880	0 000	0 560
Distance to Doctor	-0 007	-2 306	0 021	-0 001
Fuelwood	-0 168	-2 949	0 003	-0 415
Family Size	0 010	1 749	0 081	0 163
Size of Agricultural Holdings	-0 035	-7 486	0 000	-0 142
Constant	0 328	4 556	0 000	
Adjusted R-squared	0 19			

Table 3 Logistic Estimation Results

	Odds Ratio	Std Err	z	P>|z|
Predicted Non-ag Wages Share	2 114	1 904	0 831	0 406
Received Tech Assistance w/in Past Year	7 444	3 031	4 930	0 000
Family Education Index	0 380	0 254	-1 447	0 148
Primarily Grow Basic Grains	2 605	0 909	2 742	0 006
Erosion a problem	2 588	0 701	3 512	0 000

Table 4 Logistic Model Predictions (Cutoff Probability = 0 5)

	True		
Classified	Con	No Con	Total
Con	98	43	141
No Con	46	88	134
Total	144	131	275

Percent Conserve Decisions Correctly Predicted by Model 68

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