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# *Gender and Household-Level Responses to Soil Degradation in Honduras*

**Michael Paolisso, Sarah Gammage, and Linda Casey**

In Honduras, the economic and social effects of natural resource decline, poverty, and population pressure, all exacerbated now in the aftermath of Hurricane Mitch, are directly experienced at the household level. Recent research and policy work on gender and environment raise a number of interesting questions on how and why household labor responses to natural resource decline may be gender differentiated. This article presents results on the gender-disaggregated response to natural resource degradation. Specifically, we investigate whether women's and men's time allocated to corn production responds to changes in soil quality. We also address the issue of whether the gender division of labor is modified as households respond to soil degradation.

**Key words**: gender, sustainable agriculture, soil degradation, Honduras, policy

## Introduction

The recent devastation in Honduras caused by Hurricane Mitch brings renewed concerns about the precarious state of the country's natural resources. Similar to other countries in Central America, decades of entrenched poverty, population pressure, and inadequate policies and programs have led to widespread natural resource degradation in Honduras (World Resources 1995). Deforestation has reached a critical state, as a result of the extensive use of unsuitable agricultural practices, commercial tree cutting, forest fires, cattle ranching, and unequal land distribution (UNDP 1994). In certain watersheds, forest cover has been reduced by as much as 64-85 percent (Pender and Duron 1996).

This extensive deforestation and the expansion of lowland agricultural practices into hill and mountainous regions marginally suited for sustained farming leads to increased soil erosion. An inadequate soil base is a significant factor in keeping Honduras from reaching self-sufficiency in basic grains (UNDP 1994). Although export products, including bananas (at least before Hurricane Mitch), coffee, and shrimp generate most of the country's agricultural income, the cultivation of corn and beans for home consumption is the main agricultural activity for the majority of farmers. Most farmers are poor, work ecologically fragile soils, and have only small plots of land. Nationally, more than 70 percent of farms are less than 5 manzanas, or 3.5 hectares, in size (UNDP 1994). In the cultivation of corn, 94.5 percent of farm plots are less than 5 manzanas.

Widespread poverty in Honduras places additional pressures on the natural resource base and presents significant challenges in operationalizing sustainable development practices at local and national levels. It has been calculated that 78 percent of the population lives in poverty, a figure which increases to 87 percent in rural zones (CELADE 1992). According to the World Bank index of human development, which includes measurements of life expectancy, literacy, average education, and per capita income, Honduras ranks 115th among 173 countries. In the Western Hemisphere, only Haiti registers a lower level of development according to this index (World Bank 1994). Efforts to reduce poverty and pressure on the natural resource base will be made more difficult due to the country's high population growth rate. In 1995 the population of Honduras was estimated to be 5.9 million people. With an annual population growth rate of 3 percent, Honduras is one of the fastest growing countries in Latin America (World Resources 1995).[1]

*Michael Paolisso is an assistant professor of anthropology at the University of Maryland, College Park; formerly he was the director of health and social analysis at the International Center for Research on Women. Sarah Gammage is an economist at the International Center for Research on Women (ICRW). Linda Casey is a community development and health specialist currently working with Healthnet International in Mozambique; formerly she was a University of Michigan population and environment fellow working with World Neighbors/Honduras.*

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The economic and social effects of natural resource decline, poverty, and population pressure, all exacerbated now in the aftermath of Hurricane Mitch, are directly experienced at the household level. In response to the productivity and financial losses brought about by natural resource degradation, one of the first strategies available to poor households, particularly those in rural areas, is the reallocation of member labor to more sustainable and profitable economic activities. A useful starting point to understanding how households allocate labor to different economic and domestic activities is to focus on the gender relations of production. Such a focus asks: What are the domains of men's and women's work and nonwork activities? How are gender-based roles and responsibilities linked by the economic and social needs of the household? How are these gender roles altered in response to external change, such as decreased natural resources due to environmental degradation?

Recent research and policy work on gender and environment raise a number of interesting questions on how and why household labor responses to natural resource decline may be gender differentiated. One hypothesis asserts that in poor households women may have greater motivation than men to protect and manage local natural resources. This greater motivation arises from a gender division of labor that assigns women the domestic responsibility of ensuring that households meet their daily food and health needs, a responsibility whose successful completion is made easier by access to sufficient natural resources (e.g., fuelwood, water, productive soils for agriculture). From a policy perspective, women are an untapped human resource in the fight against natural resource degradation. However, this human resource may be more vulnerable to the negative consequences of environmental degradation since many women, compared to men, face greater constraints in accessing human and economic resources (cf. Collins 1991; Dankelman and Davidson 1989; Paolisso 1995).

A second line of argument derived from ecofeminist theory argues that women are "naturally" more in touch with environmental concerns due to biological and maternal drives. These biological drives encounter difficulties when women seek to act upon them due to patriarchal subordination that leaves women powerless and marginalized from environmental decisions (cf. Diamond and Orenstein 1990; Mies and Shiva 1993; Shiva 1988).

Finally, an expanding body of empirical work, in the form of case studies, has documented how women's responses to natural resource degradation is not only successful in combating environmental degradation, but also instrumental in reconstructing gender relations within the household (cf. Joekes, Leach, and Green 1995; Leach 1992, 1991; Rocheleau, Thomas-Slayter, and Wangari 1996; Thomas-Slayter and Rocheleau 1995).

This article presents results from Honduras on the gender-disaggregated response to natural resource degradation. Specifically, we explore the differential responses of men and women in rural, farm households to differences in soil quality. Based on preliminary ethnographic work, we hypothesized that male time allocation to agriculture would be positively correlated with the quality of agricultural soil. In fields with better soil quality, men spend more time growing crops, presumably because of the associated higher yields. Conversely, we hypothesized that women's agricultural labor would be negatively correlated with soil quality. This hypothesis is based on two cultural patterns. First, in general women in Honduras spend little time in agriculture, and most likely less in fertile fields that are productive even at lower levels of labor input. Second, in degraded fields, agricultural production may be so low that men need to move off-farm and pursue local wage labor or migrate in search of alternative employment. To continue at least a minimum level of on-farm agricultural production, women's labor is substituted for men's on-farm labor.[2]

Our study is relevant to the research and policy questions raised by recent work on gender and environment. It allows us to investigate whether women are responding (not just motivated to respond) to the natural resource degradation, and if so does this response create additional work burdens that conflict with other domestic and economic activities. It also allows us to speak to the issue of whether gender relations are modified as households respond to local natural resource degradation

## Project Background

The findings presented below on gender and soil degradation are based on a two-year (1994-1996) collaborative investigation of gender and environment in the Honduras (Casey and Paolisso 1996a).[3] The collaborating organizations, World Neighbors/Honduras and the International Center for Research on Women (ICRW) brought complementary interests and expertise to the project. World Neighbors/Honduras undertakes projects that promote low-cost agricultural practices to reduce soil erosion and improve soil fertility, provide basic educational services, and offer family planning and maternal-child health. ICRW conducts policy research which includes a focus on the effects of environmental change on women's productive and reproductive activities, both in terms of the contributions women make to conserving natural resources and the possible costs and/or constraints women incur as a result of environmental degradation.

### Fieldwork Site

Between 1994 and 1995, fieldwork was undertaken in four communities in the municipality of Yuscarán, located in southeastern Honduras, approximately 80 km from the capital of Tegucigalpa. Yuscarán was selected as the study area for a number of reasons. First, the agricultural practices of farmers in Yuscarán are similar to poor farmers in many other areas of Honduras and Central America: small farm sizes; emphasis on subsistence production of corn and beans; some cash cropping and off-farm work to meet income needs; and

a degrading resource base that limits access to high-quality soils, water, and forest products. Second, World Neighbors had been working with the study communities, which facilitated access to and acceptance by farm households in the communities.[4]

According to the most recent population census carried out in 1988, the municipality of Yuscarán had about 9,132 inhabitants, 7,031 of whom were concentrated in villages, the remainder populating the town of Yuscarán (Presidencia de la República 1992). In geographic and environmental terms, Yuscarán is characterized by elevations between 600 and 1,600 meters, a variation reflected in its mountainous appearance. The average annual precipitation ranges from 1,000 to 1,500 millimeters per year, and the vegetation in the zone consists principally of densely populated pine forests with patches of broadleaf forest in the areas of highest altitude.

The natural environment of Yuscarán has undergone significant change over the last several decades. Visibly deforested and eroded hillsides and the testimonies of long-term residents attest to the fact that today there is much less forest, wildlife, water in local streams and creeks, and fertile soil for cultivation. Structured interviews with community residents revealed widespread consensus that, compared to 10 years ago, today there is significantly less forest, water, and fertile soils for farming (Casey and Paolisso 1996a).

## Fieldwork Methods

A number of quantitative and qualitative instruments were used to obtain information on gender and natural resources at the individual, household, and community levels. A rapid survey was used to collect preliminary data on household socioeconomic status, agricultural practices, and use of local soils, forests, and water supplies. The information from this survey revealed a degree of participation in agriculture by women that was much higher than that indicated by preliminary interviews with key informants and a diversity of productive and reproductive activities carried out by both women and men. This information was essential to the development of the study's focus on soil degradation as a critical natural resource problem for Yuscarán households.

Based on information from the preliminary survey, interviews and observations in the field, a household survey questionnaire was developed. This questionnaire collected information about local environmental and agricultural conditions and practices, health, population, migration, family planning, socioeconomic conditions, and the productive and reproductive activities of men, women, and children. The majority of these factors were measured at the household level, and some information, especially environmental perceptions, was collected at the individual and community levels. One part of the questionnaire was designed for the principal woman in each household, one for the principal man, and the third for any adult member of the household (including the principal woman or man) capable of providing relevant information on its demographic characteristics.

Semistructured interviews were also carried out with a total of 27 people. Those interviewed were older residents and/or those active in community organizations. They were interviewed on their perceptions about changes in population, the environment, gender, and community organization, and this information was used to prepare community natural histories, which were distributed to community residents.

During fieldwork, seven community workshops were held during which residents provided their opinions and perspectives on community problems, gender, work, and natural resources. Two additional workshops were organized in which representatives of each community participated. These workshops responded to "community problems" identified in the community workshops. The first took up aspects related to organization, since lack of organization had been identified as a problem: a total of 25 men and women participated from all four communities. The second workshop, oriented toward the use and preparation of medicinal plants, was held with 30 women and men from the four communities. This topic also was in response to a problem identified by community members.

Finally, the research team returned to each community after the completion of data analysis to discuss the findings with community members. The study's findings were also presented to the coordinators of the eight World Neighbors projects in Honduras, strongly emphasizing the programmatic implications of the results. The results of the soils laboratory analysis were also returned to each participant, along with a nontechnical explanation of the lab recommendations.

## Study Sample

Four communities in Yuscarán participated in the study: La Cidra, Rancho de Obispo, El Zarzal, and Tabla Grande.[5] The four communities are small villages, structured around a subsistence farming economy. Due to their close physical proximity, within a 9-km radius, they have similar although not identical environmental, demographic, and economic characteristics (Table 1). All 179 households in the four communities agreed to participate in the study, a testimony to the rapport that World Neighbors had established with community residents.[6]

Information from the household survey questionnaire revealed a sociodemographic situation in the study communities that is representative of many rural communities in Honduras. Nuclear families predominate, which average 5.7 persons per household. Women head 12 percent of the households. Permanent migration plays an important role in the sociodemographic dynamic of this population, with more women than men leaving the communities on a permanent basis. Temporary migration also occurs, although it is less common. Only 8.1 percent of the population leaves the community for short periods of time to work and live, and more than 66 percent of these people return at least every two weeks. Of the people who leave for short periods of time, 66 percent are men and 34 percent are women.

**Table 1. Basic Characteristics of the Four Communities**

| | La Cidra | | Rancho El Obispo | | Tabla Grande | | El Zarzal | |
|---|---|---|---|---|---|---|---|---|
| Number of houses | 58 | | 40 | | 50 | | 51 | |
| Population 1994 | 316 | | 221 | | 294 | | 214 | |
| Elevation (meters) | 1400-1600 | | 700-900 | | 1100-1300 | | 800-1000 | |
| Principal Crops: | N | Mean/S.D. | N | Mean/S.D. | N | Mean/S.D. | N | Mean/S.D. |
| CORN | | | | | | | | |
| Yield (kg/ha) | 37 | 1120.9/1316.6 | 32 | 1018.7/637.75 | 30 | 376.01/330.81 | 36 | 777.63/484.25 |
| Area Cultivated (ha)* | 39 | .63/.26 | 32 | .85/.48 | 30 | 1.21/.59 | 36 | .73/.52 |
| BEANS (1st Planting) | | | | | | | | |
| Yield (kg/ha) | 5 | 1272.7/1040.6 | 7 | 802.41/370.10 | - | | 7 | 455.99/383.31 |
| Area Cultivated (ha) | 6 | .35/.22 | 7 | .65/.26 | - | | 7 | .33/.55 |
| BEANS (2nd Planting) | | | | | | | | |
| Yield (kg/ha) | 6 | 559.16/400.62 | 27 | 722.94/387.31 | 4 | 381.66/273.67 | 30 | 370.93/324.93 |
| Area Cultivated (ha) | 7 | .48/.31 | 27 | .74/.31 | 5 | .19/.15 | 31 | .65/.51 |
| COFFEE | | | | | | | | |
| Yield (kg/ha) | 19 | 636.27/821.25 | - | | 14 | 304.25/211.62 | 13 | 547.45/294.52 |
| Area Cultivated (ha) | 22 | 1.34/2.24 | 2 | .52/.25 | 17 | .58/.59 | 14 | .20/.25 |
| Potable Water System | No | | Yes | | Yes | | Yes | |

*Hectare = 2.47 acres

In terms of literacy and education, 69.4 percent of women and 66.9 percent of men over 10 years of age know how to read and write. Of the people who attended school, only 40.9 percent completed the six years of primary school, and only 4.9 percent finished at least one year of secondary education.

Residential conditions in the communities are very basic for the majority of the population in the area. Almost all homes are constructed of adobe or *bahareque* (a construction using branches or wood as a frame and a mixture of mud and grass as filling), have a dirt floor, and a tile roof. In all homes wood stoves are used for cooking, and less than a third have a chimney for extracting smoke from the kitchen. At the time of the survey, only 59.6 percent of homes had potable water piped directly to their homes.[7]

## Agricultural System in Yuscarán

Subsistence-oriented, rain-fed agriculture is the principal economic activity of rural households in Yuscarán. Ninety-four percent (n=168) of the study households are sustained by agricultural production, with 78 percent (n=140) of these households producing exclusively for home consumption. Farm size is small. The majority of land is dedicated to corn, beans, and coffee, in that order, with the latter found primarily in La Cidra and Tabla Grande. All households keep a small number of chickens, but only about 25 percent of the households have one to two larger animals, such as pigs, donkeys, mules, horses, or cows. The land used for agriculture is very steep, eroded, and located in zones of marginal productivity. The result is that most families find it difficult to cover their basic needs such as food, health care, education, and housing using their own resources exclusively.

The farming system in Yuscarán revolves around the crops listed in Table 1. Corn, beans, and coffee are the most important crops in terms of contribution to household diet and income. Potatoes are also cultivated, although only by a small number of households in El Zarzal and La Cidra. Almost all households also have permanent fields of bananas and plantains that are typically located near the homestead. Finally, households cultivate small vegetable gardens and grow fruit trees such as orange, mango, and avocado in the area immediately surrounding the house.

Farms in the study communities are small, about 1.5 hectares. Households in all four communities own most of their fields. Farmers divide their land into a number of fields (*parcelas*), some of which are cropped annually, while others, such as those containing bananas and coffee, are in permanent production. The most common pattern is for households to have up to three fields for annual crops, complemented by areas planted in bananas/plantains and, to a lesser extent, vegetables and cash crops, such as coffee and sugarcane.

**Table 2. Total of Hours per Week by Crop and by Gender***

| | Men (n=144) | | Women (n=94) | |
|---|---|---|---|---|
| Crop | Mean | Std. Dev. | Mean | Std. Dev. |
| Corn | 176.9 (46) | 76.7 | 28.7 (40) | 61.0 |
| Beans | 75.2 (19) | 91.1 | 16.5 (23) | 56.1 |
| Coffee | 61.8 (16) | 91.8 | 11.8 (16) | 23.8 |
| Sugar Cane | 13.7 (4) | 44.1 | 1.1 (1) | 8.2 |
| Potatoes | 8.6 (2) | 41.5 | 2.3 (3) | 13.2 |
| Bananas/Plantains | 40.7 (11) | 58.2 | 7.3 (10) | 16.1 |
| Vegetables/Fruits** | 6.3 (2) | 10.0 | 4.9 (7) | 12.1 |
| TOTAL | 383.2 | | 72.6 | |

( ) = Percentage

* Total of "Hours per Week" is not equal to the total amount of time men and women spend on the crop listed. Rather it is a summation of the average time per week spent on the specific production activities for each crop during the period when these activities are undertaken. Total of hours per week does allow us to capture the relative effort men and women expend in cultivating different crops.

** Also includes other minor household compound (*huerto*) crops.

## Gender Division of Labor

The study's qualitative and quantitative data support the widely reported assertion in Honduras that men spend much more time in agriculture than do women. However, women's labor contribution to agriculture is not insignificant and, in fact, mirrors and complements men's labor, albeit on a smaller scale. Both men and women dedicate most of their time in agricultural work to cultivating corn, beans, coffee, and bananas/plantains (Table 2). Forty percent of women's time in agriculture is spent cultivating corn, with an additional 23 percent used for beans, 16 percent for coffee, and 10 percent for bananas/plantains. For men, 46 percent of their agricultural time is dedicated to growing corn, followed by beans (19 percent), coffee (16 percent) and bananas/plantains (11 percent) (Table 2).

## Wage Labor

There is no great supply of wage labor in the zone and many men and women elect not to engage in wage work at all. The most common income-earning possibilities for men are *jornales afuera* (day-work off-farm), which in Yuscarán consist mostly of day agricultural work for another farmer. Depending on the community, men spend from 8 to just over 15 hours per week in this type of informal, daily agricultural work (Table 3). The other wage opportunity for men is working on nearby coffee plantations; however, this work is found mainly in and around the communities of La Cidra and Tabla Grande and is highly seasonal. In the communities where men spend more time in coffee, they spend less time in day farm labor, and vice versa. Also, in Rancho El Obispo and El Zarzal, men have a more diversified

**Table 3. Hours per Week in Wage Work by Gender and Community**

| | La Cidra | | | | Tabla Grande | | | | Rancho El Obispo | | | | El Zarzal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men (n=46) | | Women (n=55) | | Men (n=38) | | Women (n=46) | | Men (n=32) | | Women (n=36) | | Men (n=36) | | Women (n=38) | |
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Day Farm Labor* | 8.4 | 13.2 | 1.1 | 5.9 | 11.0 | 16.7 | 0 | 0 | 15.3 | 18.8 | 1.6 | 6.1 | 14.1 | 17.6 | 0 | 0 |
| Coffee Harvesting | 3.0 | 3.5 | 1.9 | 3.1 | 2.5 | 3.7 | 0.9 | 2.2 | 0.4 | 1.6 | 0.4 | 1.5 | 1.1 | 2.7 | 0.1 | 0.1 |
| Resin Tapping | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8 | 9.4 | 0.1 | 0.3 | 0.9 | 4.1 | 0 | 0 |
| Masonry | 0.5 | 1.9 | 0 | 0 | 0.1 | 0.3 | 0 | 0 | 1.2 | 2.5 | 0.1 | 0.3 | 1.8 | 7.2 | 0 | 0 |
| Laundry | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 2.0 | 0 | 0 | 0.1 | 0.3 | 0.2 | 0.8 | 0.1 | 0.1 |
| Domestic Work | 0.4 | 2.7 | 0 | 0 | 0 | 0 | 1.9 | 8.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*In Spanish, *jornales afuera.*

pattern of wage work because these are older communities and located closer to sources of nonfarm employment (Table 3).

The pattern for women's wage work is somewhat similar to that of men's, although the amount of time is much less. In all four communities women spend some time in coffee, and in La Cidra and Rancho El Obispo they also work as daily farm laborers. As for men, in Rancho El Obispo women are involved in a more diverse set of wage activities than in the other communities (Table 3).

## Domestic Work

Women undertake the bulk of the household domestic responsibilities. Women spend most of this time providing care for children, followed by cooking, washing, and cleaning (Table 4). In contrast to other parts of Central America, in Yuscarán it is men who collect fuelwood, often on their way home from working in the fields. The second most important domestic activity for men is care of animals, where their time spent is similar to that of women, although men care for large animals while women tend to smaller ones. The relatively small time women spend collecting water is due to the presence of piped water in many households.

## Soil Base for Agriculture

According to most farmers, the three most prominent natural resources in Yuscarán are soils, water, and forests. Status of soils most directly affects household economic and nutritional well-being. Quality soil is essential to the production of corn for home consumption.

Similar to upland regions throughout Honduras, the soils in Yuscarán are only marginally suited for sustained agricultural use. Most of the land being farmed is on hilly or steep terrain. Almost 70 percent of the 296 farm plots for which information was collected were classified as being located on either *inclinada* (inclined) or *ladera* (hillside) terrain. Sixty-five percent of farmers reported having some form of erosion in their principal corn field.

Smallholder agriculture in Yuscarán has at least three characteristics that affect soil fertility and the ability of farmers to maintain soil structure and nutrient level: intensive cultivation, heavy dependence on chemical fertilizers (which do not contribute significantly to long-term soil structure

**Table 4. Mean Hours per Week Spent on Domestic Activities**

| | Total Hours Worked | | | |
|---|---|---|---|---|
| | Men (n=152) | | Women (n=175) | |
| Domestic Activity | Mean | Std. Dev. | Mean | Std. Dev. |
| Collection of Wood | 4.1 | 4.6 | 1.9 | 4.4 |
| Child Care | 2.9 | 8.0 | 30.3 | 21.6 |
| Cooking* | 0.4 | 2.3 | 9.6 | 7.0 |
| Washing/Ironing/Sewing | 0.2 | 0.5 | 6.5 | 4.0 |
| Cleaning of the Home | 0.9 | 3.9 | 6.2 | 7.6 |
| Hauling of Water | 0.1 | 0.3 | 0.6 | 3.0 |
| Animal Care | 3.5 | 2.5 | 3.3 | 2.2 |
| Sale of Domestic Farming Products | 0.4 | 1.5 | 0.9 | 6.8 |
| Disposing of Waste | 0.8 | 2.5 | 1.5 | 2.1 |
| Other Nonremunerated Domestic Work | 0.4 | 2.4 | 0.2 | 1.5 |

*We believe respondents underestimated their time spent cooking, due possibly to difficulties in separating cooking into discrete tasks. Rather, cooking may be perceived as a continuous activity, although not one that completely excludes women from completing other household tasks.

enhancement) and limited use of soil conservation practices.

## Intensive Cultivation

Due to the constant need for staple foods, farmers must keep their lands in almost continual production. Seventy-seven percent of the farmers reported leaving their primary corn field in fallow for only three to six months. This short period, which often coincides with the dry season, allows little time for natural soil regeneration or the growth of vegetative cover that can protect against erosion.

A second trend is for these short-term fallows to become permanent, as agriculture becomes more sedentary. For all communities, 63 percent (90 out of 142) of the study households have been cultivating the same fields for the last five years.

The combination of decreased fallow and increased sedentary agriculture are two factors that can, in the absence of appropriate agricultural inputs, lead to stagnate or declining soil fertility and crop yields.

## Use of Chemical Fertilizers

Farmers consistently reported that their "soils are tired," and that some fertilizer is necessary to obtain an adequate yield, particularly for corn. In the analysis of soil conditions of households' primary corn field, 111 (81 percent) farmers reported using fertilizer, while only 26 said they used none. There is some indication that fertilizer use is more common today than in earlier periods. Among the 90 farmers who have been cultivating the same corn plots for more than five years, only 20 (22 percent) reported using less fertilizer today. Thirty-one (34 percent) reported increased usage, and 39 (43 percent) reported the same level of use. In terms of quantity used, the average use is just below 2 quintals (about 90 kilos) per manzana (0.7 hectares).

Most farmers use chemical rather than organic fertilizers. Eighty-seven percent of all fertilizer used on primary corn fields is a synthetic mixture of either 12-24-12 (nitrogen, phosphorous, potassium) or 18-46-0. Organic fertilizer, used also on vegetables, is usually a combination of chicken droppings or cattle manure, crop residue, and, in a few cases, kitchen scraps. In addition to corn, fertilizer is also used on a large proportion of bean fields.

**Table 5. Summary Statistics**

| Variable name | Definition | Sample Mean (s.d.)*** | Number of Observations |
|---|---|---|---|
| $Mz_f$ | Total female hours in maize production | 15.4 (46.8) | 175 |
| $Mz_m$ | Total male hours in maize production | 163.4 (83.6) | 155 |
| soilindx | Soil index | 1.21 (0.99) | 142 |
| steep | Whether the plot is located on a steep incline (0,1) | 0.26 (0.03) | 191 |
| size | Size of the principal maize plot in hectares. | 0.84 (0.51) | 136 |
| mage | Age of the male household head* in years | 44.9 (16.4) | 176 |
| mlit | Whether the male household head is literate | 0.60 (0.03) | 167 |
| fage* | Age** of the female household head in years | 40.7 (14.9) | 171 |
| flit | Whether the female household head is literate | 0.57 (0.04) | 172 |
| mmig | Dummy variable on whether the male household head has migrated in the last year | 0.09 (0.02) | 167 |
| offarm | Dummy variable on whether male labor works off-farm | 0.80 (0.03) | 191 |
| femdep | Gender-specific dependency ratio (number of children under 4/number of female adults over 15) | 0.65 (0.72) | 178 |
| nadults | Number of adult household members | 3.44 (1.79) | 191 |

* The assumption is that there are dual household heads unless a household records that it is only headed by one individual.
** The age variables are included as they reflect the age composition of the household over the life cycle of the household heads.
*** The standard deviations of (0,1) variables are calculated where s.d.=$\sqrt{\{(1-p)p\}/n}$

## Limited Soil Conservation

An important focus of the World Neighbors work in Yuscarán is to provide farmers with effective, low-cost technologies for conserving and enhancing soils. Through community-based extension agents, farmers are shown how to contour plow, plant fast-growing and heavy-foliage plants to form barriers to erosion, dig trenches to help retain rainfall and channel water to needed areas, practice minimal tillage, and plant velvet beans (Mucuna spp.) whose nitrogen-fixing roots improve soil fertility. The use of appropriate technologies to improve soil quality varies among households and by technique, although the overall usage is quite low. The most frequently reported technology used by study households was trenches or ditches (*acequias*). Only 36 percent of the study households reported using trenches to reduce soil erosion. Next in preference were contour lines (*curvas a nivel*) and minimum tillage (*labranza minima*), where only 27 (22 percent) and 24 (19 percent) households reported using these, respectively. Plant and stone barriers were used by a similar number of households. Finally, only 14 households reported using velvet beans to raise soil nitrogen levels.

Given the intensity of land use, the emphasis on chemical fertilizers, and the limited use by households of soil conservation technologies, it is not surprising that 86 percent (92) of the male farmers interviewed during the study's presurvey, ethnographic phase reported that soils are less fertile today than in previous years, with resulting lower crop yields. Today, only slightly more than a quarter of the major fields prepared by the study households contain what was reported as "good" soil. Out of a total of 296 plots for which information was collected during the study's survey, only 81 (27 percent) were reported to have good soil, and a relatively high percentage (46 percent) of these are in La Cidra, where soils have been cultivated for a shorter period of time.

At the regional level, there is little question that soils in Yuscarán have declined in fertility over the past several decades. However, there are no doubt exceptions and significant interhousehold differences in the quality of soil available for agricultural use. To develop measures of soil quality for each study household, laboratory analysis of nutrient and chemical levels from samples taken from households' principal corn field were completed. In total, soil samples from 152 households' principal corn field were collected and analyzed for nutrient content.[8] The results of the laboratory analysis of soils are used to construct soil quality variables, which in turn become independent variables in the following multivariate analyses.

## Soil Quality and Labor Response by Gender

To test the hypothesis that soil quality affects men's and women's time allocation decisions differently, data collected on time in agricultural activities were related to soil quality and a number of household demographic characteristics. We use an instrumental-variables procedure to partially overcome the problems of simultaneity that occur when women's and men's time in tasks is jointly determined (Johnston and Dinardo 1997). The assumption is that women's time in agriculture is determined by men's time in agriculture and vice versa, taking into account a host of farm characteristics and the opportunity cost of men's time in agricultural production. The model below is estimated for total hours per week dedicated to corn production.[9]

The time allocation outcomes for corn (*maize* in Spanish) may be expressed as follows:

$$(1) Mz_m = \alpha_1 + \alpha_2 soilindx + \alpha_3 (soilindx)^2 + \alpha_4 steep + \alpha_5 size + \alpha_6 mage + \alpha_7 (mage)^2 + \alpha_8 mlit + \alpha_9 mmig + \alpha_{10} offarm + \alpha_{11} nadults + \alpha_{12} zarzal + \alpha_{13} Mz_f$$

$$(2) Mz_f = \beta_1 + \beta_2 soilindx + \beta_3 (soilindx)^2 + \beta_4 steep + \beta_5 size + \beta_6 Mz_m + \beta_7 fage + \beta_8 (fage)^2 + \beta_9 flit + + \beta_{11} nadults + \beta_{13} femdep + \beta_{14} mmig + \beta_{15} offarm$$

Equation (1) relates men's time in corn production ($Mz_m$) to a soil index variable soilindx that captures soil quality.[10] The variable $(soilindx)^2$ is included because the effects of an increment in soil quality on men's time in corn production may be nonlinear. Whether the plot is located on a *steep* incline and therefore more prone to erosion may also affect the time investments of both men and women. The *size* of the corn plot is also likely to affect decisions about time allocation to corn production. We also assume that men's time in corn is related to the total number of female hours in corn production ($Mz_f$).

Age of the male household head (mage) and age squared $(mage)^2$ also appear in equation (1). These variables describe not only how the age of the household head affects time allocation decisions but provide insight into how increasing age affects the household head's ability to undertake manual labor on the family farm or to enter off-farm employment. The variable mlit is whether the male household head is literate, an attribute which may affect the male household head's ability to migrate or seek off-farm employment. Whether the male household head has migrated from Yuscarán (mmig) or whether some labor time is allocated to off-farm employment (offarm) will also affect the total number of hours that the remaining men dedicate to agriculture. Similarly, the number of adults in the household (nadults) may also determine the subsistence requirements of the household and the available labor supply that can be dedicated to agricultural production. The community El Zarzal appears to have both better soils and more off-farm employment opportunities. We include the dummy variable (zarzal) to see if there are distinct community differences.

Equation (2) expresses women's time in corn production ($Mz_f$) as a function of a similar set of variables including men's time in corn production ($Mz_m$). The assumption is that women's time in corn production is also determined by men's time in corn production and that the time allocation decisions are made simultaneously. One variable that enters equation (2) and not equation (1) is femdep, a gender-specific dependency ratio: number of children under the age of 4 to total number of female adults over the age of 15 in the household. The femdep variable is included because it captures the expectation that the care burden for small children is borne almost exclusively by women in the household. We hoped this variable will also capture the insubstitutabilities of women's time spent nursing, weaning, and caring for infants.

We would like to estimate both of the structural equations, however, the problem of simultaneity bias we would encounter when estimating these equations renders the alpha and beta coefficients unidentifiable. Since femdep enters the structural equation for women's time in maize production and not for men's time in maize production, we can use this as an instrument to trace out how changes in men's time allocation may vary with soil quality. An instrumental-variables procedure allows jointly determined variables to be purged of simultaneity (Johnston and Dinardo 1997).

Table 5 provides the summary statistics and definitions of the variables used in the instrumental variables regression of men's time in maize production.

The regression results from estimating structural equation (1) using an instrumental-variables technique reveal that soil quality does influence time allocation decisions for men (Table 6). Both soilindx and the $(soilindx)^2$ are significant in determining men's time in corn production. Increments in soil quality positively affect the amounts of time men dedicate to corn production, yet, as evidenced by the negative coefficient of the $(soilindx)^2$ variable, they do so at a decreasing rate. The signs and magnitudes of the coefficients on the soil index variables suggest that time investment for men varies nonlinearly with soil quality. Comparing low ranges of soil quality with higher ranges we observe that men's time investment increases with soil quality although there is a point beyond which further increments in soil quality decrease men's time investment in corn production. This may indeed be because men switch into more remunerative crops (e.g., coffee in El Zarzal) and women switch into corn production, or because the household is able to allocate less labor time to

work on the comparatively more productive plots. We may reasonably assume, however, that a fixed household-time investment in corn production is required to generate the minimum level of subsistence production. If men allocate less time to plots with lower soil quality yet household corn production must continue, women may bear some of the burden of compensation in those households where they are unable to purchase corn.

In specification (1), whether the farmer considers the plot steep reduces men's total hours per week allocated to corn by 22 hours. The variable steep is of interest since it may be capturing the long-term effects of erosion, soil loss and nutrient leaching. It is also clear that the size of the principal corn plot strongly influences men's time in corn production. For each additional manzana of land, men's work increases the total hours per week in corn production by 55 hours. This may be because the plot is of sufficient size to warrant the greater investment of male labor time.

**Table 6. Regression Results Using Instrumental Variables**

| Independent Variables | Men's Time in Maize Production (1) (standard error) |
|---|---|
| soilindx | 46.69 *** |
| | (17.73) |
| $(soilindx)^2$ | -12.31 ** |
| | (5.74) |
| steep | -22.22* |
| | (12.78) |
| size | 54.52*** |
| | (13.91) |
| $Mz_t$ | -0.17 |
| | (0.55) |
| mage | -0.03 |
| | (2.16) |
| $(mage)^2$ | -0.01 |
| | (0.02) |
| mlit | 3.35 |
| | (14.65) |
| mmig | -44.27 ** |
| | (18.99) |
| offarm | -11.08 |
| | (11.89) |
| nadults | 2.36 |
| | (4.79) |
| zarzal | -55.19*** |
| | (17.69) |
| constant | 150.76 *** |
| | (52.64) |
| $R^2$ | 0.51 |
| N | 101 |

*** significant at 1 %, ** significant at 5 %,* significant at 10 %

Outmigration of male household heads (mmig) decreases total hours per week spent in corn by almost 44 hours. Men's off-farm work (offarm) was not a significant predictor of men's time in corn production. This finding is explained by the fact that men's off-farm work is mainly day labor on neighbors' farms. This type of wage work is compatible with on-farm corn production, since the farmer need not leave his own farm for any significant period of time. Finally, there appear to be strongly significant differences between the communities. On average, male residents of El Zarzal reduce the total hours per week in corn production by 55 hours. This may be, as already noted, because El Zarzal has better soils

**Table 7. Reduced-Form Estimates of Women's Time in Corn Production**

| Independent Variables | Women's Time in Maize Production Reduced Form (standard error) |
|---|---|
| soilindx | 9.28 |
| | (13.05) |
| $(soilindx)^2$ | -3.05 |
| | (4.35) |
| steep | 0.80 |
| | (8.84) |
| size | -13.63 |
| | (8.82) |
| mage | -2.26 |
| | (2.29) |
| $(mage)^2$ | 0.03 |
| | (0.02) |
| mlit | 9.90 |
| | (9.68) |
| fage | 4.00 * |
| | (2.13) |
| $(fage)^2$ | -0.06 ** |
| | (0.03) |
| flit | -4.44 |
| | (8.69) |
| mmig | 10.40 |
| | (14.57) |
| offarm | 10.26 |
| | (9.44) |
| nadults | -5.70 * |
| | (3.41) |
| femdep | -13.15 * |
| | (6.99) |
| zarzal | -9.21 |
| | (9.93) |
| constant | 4.31 |
| | (47.98) |
| $R^2$ | 0.19 |
| N | 100 |

*** significant at 1 %, ** significant at 5 %, * significant at 10 %

than several other communities. It is possible that the community variable is also capturing off-farm employment opportunities in coffee for El Zarzal.

In terms of women's responses to soil quality, as mentioned earlier we cannot solve for all of the underlying coefficients in the structural equations due to the simultaneity of men's and women's decisions regarding allocation of their labor to corn. Recognizing that we cannot solve out uniquely for each of the alpha and beta coefficients, we estimate a reduced form of equation of (2), substituting men's time in corn production into the women's equation and solving out for the dependent variable. Although econometrically less satisfying, the reduced form of equation (2) nonetheless produces insightful results regarding the response of women's time in corn production to changes in soil quality. It should also be noted that a reduced form of equation (1) produced similar coefficient estimates for men's time in corn production, suggesting consistency between the structural and reduced form equations.

Table 7 reports the regression results for the reduced form of equation (2). The reduced-form estimates for women are not as illuminating as those are for men. Soil quality (soilindx) does not appear to affect women's time allocation decisions. The age of the female household head (fage) does appear to affect women's time investment in corn production, tracing out a typical labor supply curve where the level of effort varies with age (fage)$^2$. The number of adults in the household (nadults) also appears to affect women's time allocations by reducing the amount of time they spend in corn production. Similarly, the female dependency ratio (femdep) does appear to decrease the amount of time women devote to corn, suggesting that the burdens of caring for young children impose limits upon women's ability to work in agriculture. The results do not support our hypothesis that women's agricultural work increases in response to declining soil quality and increasing male off-farm work. Rather, women's response to natural resource degradation is constrained by the demographic structure of the household and the burden of caring for infants and young children.

## Conclusions

One of the study's central research questions was whether soil quality affects men's and women's time in agricultural production differently. The regression results indicate that men's time in corn production is influenced positively by soil quality and negatively by whether the plot is prone to erosion. Women's agricultural work is not affected by differences in soil quality, but by household demographic structures and the associated reproductive duties of child care. The strong cultural and social pressures in Yuscarán, which assert that agriculture is men's work, are reinforced by gender differences in remuneration and expected involvement of women in reproductive activities. For most households in Yuscarán, it is safe to assume that men will continue to maintain significant levels of involvement in subsistence production of corn, and women will focus their efforts on household reproductive activities. Nonetheless, additional reductions in men's time in corn and/or modest increases in men's off-farm work or migration could lead to increased conflict between women's on-farm agriculture work and women's reproductive responsibilities. Moreover, the status quo of the traditional gender division of labor may now be under pressure in the post-Hurricane Mitch Honduras. In Yuscarán and throughout the country, the hurricane's torrential rains caused widespread soil erosion and mudslides, which may accelerate the out-migration from rural areas of men whose corn fields were devastated. If true, this raises the possibility that not only may women need to assume more subsistence agricultural work, but that they may do so in agroecological conditions of lower productivity as a result of heightened natural resource decline.

Panel data on the same households would be needed to draw more definitive conclusions about the changing nature of men's and women's time investments in corn production in response to soil degradation and erosion. Such data may usefully inform policies and programs to help avoid possible excessive resource depletion and/or possible "double burden" conflicts for women. The continued data collection would also need to include a qualitative assessment of how continued response to natural resource degradation is changing gender roles and relationships. The findings presented here provide a baseline for such a longitudinal study of gender and soil degradation.

From an applied perspective the results presented here are of relevance to sustainable development polices and programs throughout Honduras. The research was undertaken in conjunction with an in-country NGO that works with a number of communities in Honduras to promote the use of sustainable agricultural practices, particularly in fragile hillside areas. As such, the results are also relevant to national and local policies and programs for improving agricultural production while maintaining the resource base, particularly for poor farmers. An additional applied goal realized by the project was to contribute systematically collected information to a nascent movement in Honduras concerned with how gender affects the sustainable use of natural resources (cf. Arzu 1994; CDM 1995; Urban and Rojas 1994).

Finally, the study's findings provide confirmation of the overall appropriateness of a number of programmatic activities undertaken by World Neighbors in Yuscarán. The evidence in support of a focus on sustainable agriculture and conservation of natural resources is compelling. This focus should include increased attention to improving the soil base for agriculture by promoting soil conservation and the use of appropriate technologies. Although the low yields and difficult agricultural conditions also point to the fact that the zone is not ideal for subsistence agriculture and that other more appropriate activities should therefore be developed, a certain level of subsistence agricultural production must be maintained at the present time, since any shift in production patterns will take place over the long-term, and rural fami-

lies must continue to meet their immediate needs. The viability of this subsistence agriculture will depend in part on the degree to which men and women can work together to balance labor requirements for domestic, agricultural, and off-farm work.

## Notes

[1]Although the total fertility rate is slowly dropping, it is still relatively high at 5.1 children per woman (ASHONPLAFA 1992). More than 47 percent of the population is less than 15 years of age (World Resources 1995). No other country in Central America has such a young age distribution, placing Honduras at the threshold of a considerable population increase in the next couple of decades.

[2]There are few consistent off-farm employment opportunities for women that do not involve migration and therefore the majority of off-farm employment opportunities are for men.

[3]Casey and Paolisso (1996a) is also available in Spanish (1996b).

[4]World Neighbor's Yuscarán Project officially ended in 1997. However, many of the collaborating families residing in the area continue to promote project activities. Also, World Neighbors may begin a new project in Yuscarán due to the damage caused by Hurricane Mitch.

[5]In terms of official geographic boundaries, Tabla Grande is actually located in the neighboring muncipality of San Antonio de Oriente, Department of Francisco Morazán. However, residents of Tabla Grande have the same cultural and economic relations with the town of Yuscarán as those in the other three communities. From an ethnographic perspective, it is more appropriate to view the four communities as located within in the area of Yuscarán.

[6]We elected to enroll the entire population of the four communities in the study, rather than select a sample. To a large degree, this decision was influenced by the approach World Neighbors uses in the communities. This approach seeks the active involvement of households in the design and implementation of program activities. Since many of the households in the four communities were already participating, to varying degrees, in World Neighbors' Yuscarán project, it was decided that we should not exclude any households from participating in the study. Of concern was that households would not understand why they were not participating, or why other households were participating. As is often the case in small, close-knit communities, these concerns can lead to ungrounded rumors and possible negative repercussions for program work.

[7]Many other households have indirect access to potable water. Rubber hoses are used to "tap" a faucet in a neighbor's house and buckets/containers are used to transport potable water short distances to houses not connected to the water system.

[8]Field enumerators, who were trained by the study team's soil scientist, collected soil samples. Sampling consisted of dividing the corn plot in a uniform pattern and, with the aid of a Hoffer tube, obtaining samples of dry soil found 20 to 30 centimeters below the topsoil. These different samples were then mixed together to form one bag per plot. Bags were then stored in dry places away from sunlight until taken to the laboratory for analysis. These samples were analyzed at the soils laboratory of the Panamerican Agricultural School to determine certain physical and chemical characteristics. Each sample was accompanied by a "technical form," which contained detailed information about the management practices for that same plot.

[9]The model is estimated for total time in corn production since the soil quality data were collected for the principal corn plot.

[10]The soil index is a composite index that comprises a variety of indicators of soil quality scaled using a Guttman Scaling procedure to cluster attributes that are correlated with superior soil quality and those that are correlated with inferior soil quality. This variable scales increments of organic matter, nitrogen, phosphorous, and potassium so as to rank collections of attributes or scores that are strictly superior to others.

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