

The Long-Term Effect of Environmental Degradation on Women in the Hills of Nepal\*

PRELIMINARY DRAFT

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**I. Introduction**

It is not a new revelation that households in rural areas of developing countries rely very heavily on the surrounding environment for products such as fuelwood and water. Households in many developing countries collect these and other goods from the environment, a task that in many areas is predominantly carried out by women. This is certainly the case in the hill region of rural Nepal, where women may spend several hours per day collecting fuelwood, water, and cut grass or leaf fodder for livestock. This study attempts to analyze some of the long-term responses of households to the relative scarcity of these environmental goods, and how those responses affect the lives of women and girls in the households as compared to men and boys.

More specifically, this paper has two major areas of focus. The first is to analyze changes in the consumption of environmental goods and in intra-household labor allocation between men, women, and children to environmental good collection. Studies using Nepal data from 1982/1983 indicate that households respond to increasing costliness of environmental goods, at least in the short run, by consuming less of them and devoting more female labor to their collection. One important line of questioning is whether this is still the case after enough time has passed to undertake other responses to the costliness such as planting trees for fodder. Do women continue to bear most of the labor burden of increases in environmental good scarcity?

The second focus of this paper is on the effect of environmental good scarcity on the educational attainment of children growing up over the 14 year period since 1982/1983. The use of educational attainment allows measurement of a more cumulative impact of environmental conditions on girls and boys. In Nepal children's labor is widely used for collecting environmental goods, particularly water and leaf fodder. It is of interest to know whether children in households initially in relatively worse environmental conditions that require longer to collect a unit of an environmental good have acquired less education than those initially in relatively better conditions, and whether the effect on female educational attainment has been larger than the effect on male educational attainment.

This study has the advantage of resurveying the same households after a 14 year period. This allows for an assessment of the effects of environmental changes over time as opposed to

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relying principally on cross-sectional analysis. The data used also allow seasonality to be taken into account. Household productive activity varies dramatically in Nepal between the monsoon and dry seasons, as does the availability and ease of collection of various environmental goods. Inferences drawn for one season may not hold for the other.

## II. Data and Background

### - The data

The data for this study come from several different surveys on the same sample of households in the middle hills of Nepal. The households were initially sampled in 1982/1983 for the Nepal Energy and Nutrition Survey (NENS).<sup>1</sup> There are data for 118 households in the NENS data set. Three different Village Development Committee areas (formerly called *panchayats*), one in each of three districts in Nepal's Western Development Region, were originally chosen for the survey. Two wards were then selected from each Village Development Committee (VDC) to obtain variation in ethnicity, altitude, market access, and environmental degradation. Approximately 20 households were randomly sampled from each ward.<sup>2</sup> The NENS data contains observations from four survey rounds conducted over a one year period, allowing for an assessment of seasonal variation. The data are at the household level, with no individual-level data available. In 1996/1997 the NENS sample was resurveyed both by myself with funding from IFPRI and Goteborg University and by Winrock International-Nepal. This study uses data collected by both resurvey teams. Data from survey rounds covering the late dry season and the monsoon season in 1997 are used in this paper, and correspond to NENS data covering the same periods.

Seventeen of the original 118 households had either migrated (10 households), died leaving no one able to respond (5 households), or simply were not found in any of the resurvey rounds (2 households). Twenty-seven additional households not classified by this study as NENS households were also surveyed in both the late dry season and the monsoon season. Generally these are households that are living in the home of a NENS family that migrated, or are a close neighbor (and often a relative) of the original NENS household. For most purposes in

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and Goteborg University, Sweden.

<sup>1</sup>NENS 1982/1983 Agricultural Projects Services Center of Nepal, Food and Agriculture Organization of the United Nations, International Food Policy Research Institute.

<sup>2</sup>See Kumar and Hotchkiss (1988) for more information on the survey design and sampling strategy.

this study, however, only data from households defined strictly as original NENS households are used. In almost all cases this means the households have the same household head, or have a new head that is the son or wife of the deceased NENS household head.

#### - Household description

The region of study ranges from roughly 500 to 1500 meters and consists of steep hills and valley bottoms. All of the survey sites are rural, and they have varying degrees of access to roads and markets. One site has had a road built to it since 1983. Most survey wards have seen an increase in the number of households over the last 14 years, and in some cases this increase has been quite dramatic. One ward which is furthest from a road and predominantly Gurung in ethnicity is the exception to this general increase; the number of households appears to have remained relatively constant.

The households for this study are mostly small-scale agriculturalists producing primarily for home consumption. Maize, rice, wheat, and finger millet are the principal crops in the region. Agriculture is conducted all year long, although the summer monsoon season (roughly July - September) is by far the heaviest agricultural season. Fifty percent of the NENS households are Brahmin, or high caste, and 16% are occupational, or low caste. Approximately 30% percent belong to Tibeto-Burman ethnic groups (Gurung and Magar). Household size has dropped slightly over the last 14 years for the NENS households from approximately 6.5 residents to 5.9 residents. This decrease is largely attributable to fewer adult men (age 16-59) and fewer very young children (age 0-5) in the households. One cause of this change may be that children are growing up and leaving the household. In 1983 only 5 households had 2 or less household residents while 12 did in 1997. The average age of the household head in these small households increased from 38 in 1983 to 62 in 1997. In general, the NENS households are aging, although often at least one son will live with the household, bring in a wife, and produce the next young generation of household residents.

Almost all of the NENS households own farmland. Farmland may be divided into two types; lowland (*khet*) which can be irrigated and usually is found in valley bottoms, and upland (*pakho*) which generally consists of hillside terraces where irrigation is not possible. In the 1982/1983 survey all households owned at least some land, with average landholding of slightly

less than 1.5 hectares. In the 1996/1997 the NENS household average landholdings had dropped to 0.8 hectares and one household now has no land. This drop in the amount of land owned may be due to giving land to sons who are starting their own households. However, the average landholding of the non-NENS households sampled is even lower than that of the NENS households, at slightly less than 0.6 hectares, indicating that scarcity of farmland may be worsening as local populations increase. Perhaps not surprisingly, average land ownership is the smallest in the sites with the largest growth in the number of households.

Most of the NENS households own either cattle or buffaloes or both. Over the 14 year period since 1983 average holdings of cattle and buffaloes have dropped from 5.2 animals to 4.4 animals. The average number of she-buffaloes held has increased slightly however. She-buffaloes are very productive animals in that they produce milk and manure which is an important source of fertilizer. One rarely sees an adult male buffalo. Households often stall feed their livestock, a practice that has increased since 1982/1983. Typical livestock feeds are straw, leaf fodder and grass, and a cooked gruel of oilseed cake, straw, and water called *kundo*. Livestock may also be grazed.

- Collection and use of environmental goods

Traditionally hill households such as those in the NENS sample have relied quite extensively on local forest areas for fuelwood, water, leaf fodder, and grass. Table 1 shows the average daily household consumption of these goods by season for 1982/1983 and for 1997. Most energy consumption comes from fuelwood which is used both to cook household meals and *kundo* for livestock. Households may also use crop residues such as maize stalks and cobs as fuel. This is particularly true in the monsoon season after the maize harvest. Water is collected for household consumption and for *kundo* preparation. Leaf fodder and cut grass are important sources of livestock feed, and are seasonal in nature. Cut grass is the preferred livestock feed, but it is generally only available in the monsoon season. In the dry season households rely on leaf fodder.

Table 1 indicates that average consumption of fuelwood, grass, and leaf fodder has declined since 1982/1983. While some of this may be attributable to lower livestock holdings and smaller

household populations, the decline in consumption seems larger than these factors alone would cause.<sup>3</sup>

Collecting these four environmental goods can take up many hours of a household's time in a day. Table 2 gives the average daily time spent on collection activities by season and year. Times are given in minutes. Water, cut grass, and leaf fodder generally are collected on a daily basis. Fuelwood may be collected and stored as is discussed more in depth below. On average the total household time spent collecting is lower in the dry season than in the monsoon season, although for specific goods such as leaf fodder more time may be spent in the dry season. In the dry season most collection hours are spent collecting fuelwood and water. Most collection hours in the monsoon season are spent collecting grass. In the 1997 monsoon season for example, roughly 7 hours per day were spent collecting, 5 hours of which were spent collecting grass.

Seasonality appears to be a very important factor in assessing collection time allocation changes over the 14 year period considered. Less total collection time is spent in the monsoon season than was spent in 1982/1983, but more is spent in the late dry season. These changes come largely as a result in changes in the collection time for fuelwood and water. Households are now less likely to collect fuelwood in the monsoon season, and rely more on crop residues and fuelwood they have stored. In the dry season, more time is spent collecting wood than previously, in order to accumulate wood for storage. Water is more time consuming to collect in the dry season since 1982/1983 despite the fact that most sites have installed some form of community water tap or taps since then. The taps still may be far from some households, and in some sites they only work sporadically or only during the monsoon season.

As evidenced in Table 2, intrahousehold allocation of collection time among men, women, and children has changed since 1982/1983. While women still spend by far the largest amount of time collecting of these three household groups, the total amount of time they spend appears to have decreased as has their percentage of household collection time. This percentage has dropped from 73% of total collection time over both seasons in 1982/1983 to 61% in 1997. Men now account for more of the average daily time spent collecting in both the late dry and

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<sup>3</sup>For the 1996/1997 data, kilogram quantities were calculated using each household's estimate of kilograms per load. The weight of a load can vary substantially (e.g., from 5 to 50 kilograms for fuelwood) Actual weighing of loads for a subsample indicated that the range and variation evident in household estimates was

monsoon seasons. Interestingly, fewer households report having men who collect in the dry season, indicating that the hours spent by men who do collect have increased. In the monsoon season, more households report men collecting than previously. A similar situation is observed with children's collection time.<sup>4</sup> In the dry season, children account for a larger absolute and relative amount of collection time than they did previously, but fewer households report children collecting. In the monsoon season, fewer households report children collecting and children average fewer collection hours per day now than they did in 1982/1983.

It is evident from the above discussion that seasonal factors affect the intrahousehold allocation of collection time among men, women, and children. In the late dry season, every group spends more time collecting water and more time collecting fuelwood on average than they did in 1982/1983. Men and women spend less time collecting leaf fodder, and children spend more time. In the monsoon season, women and children spend less time collecting fuelwood, water, and grass than they did previously, while men spend more time collecting all three. This is particularly interesting given that there are fewer adult men in a household on average than there used to be, while there are about the same number of adult women and youths of collection age (6-15). While this summary applies to average collection time across all NENS households and there is quite a bit of variation in the sample, it does appear that men are taking over some of the collection burden from women. In the dry season children are taking over some of the burden as well, with female children collecting more than male children do.

#### -Household behaviors affecting environmental good collection and consumption decisions

Table 3 reports a summary of selected household actions that can affect environmental good collection and consumption decisions. Obviously, the list is not exhaustive, but it does indicate that households are responding to environmental good scarcity in a variety of ways. Quite a few households have planted trees on their property. Fifty-three percent of the NENS households asked indicated that they had planted trees during the last 15 years and 30% said that they had specifically planted them for leaf fodder. An even larger percentage, 82%, said that

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not unusual. Unfortunately, it is not clear how load to kilogram conversions were calculated in the 1982/1983 data.

<sup>4</sup>Children's time refers to the time of children and youths under the age of 16. Distinctions between the time of boys and girls are not made in this paper since this breakdown is not available in the NENS data. In 1997, both boys and girls were found to collect, with girls on average spending more time collecting than boys.

they had let trees grow up naturally. Trees may reduce the amount of productive agricultural land available for crops, and growing them is obviously only an option for landowning households.

As indicated in the previous section, households are now spending more time collecting fuelwood in the late dry season, and storing it for use during the monsoon. In 1982/1983 only 21% of the NENS households reported storing fuelwood, while 98% of them reported storing it in 1997. Storage allows households to spend much less time collecting wood for fuel in the busy agricultural monsoon season. A small number of households have bought fuelwood or fodder. This is not a very common practice, although it does occur. Sixteen NENS households say they have ever bought fuelwood, and 11 say they have ever bought fodder. Most of these households first bought either product within the last decade, and most only purchase occasionally. Four households have switched from using fuelwood as their cooking fuel to biogas. These households still consume some fuelwood, primarily to cook *kundo*. Most households use traditional stoves. Although improved smokeless stoves have been tested in some of the sites, they have not proven very popular. Reasons for not switching to a smokeless stove include an increased risk of fire in thatched roofs higher fuel consumption due to larger mouth openings.

#### -National and community changes

These household level changes have occurred against a backdrop of national and ward-level changes. On May 12, 1991 Nepal officially changed its form of government to a constitutional monarchy. The *panchayat* system was abolished and local government officials are now elected. In 1993 the Forest Act was passed that recognized local forest user groups (FUG's) as institutions with property rights over community forests. Forest user groups manage local community forests; this can include selling forest products, restricting what is taken out of the forest, and exacting penalties on those who break the rules.

Although two of survey sites had some community forestry management in 1982/1983, all sites with a forest now have a formal forest user group. One ward has two forest user groups because there are distinctly separate forest areas used by separate groups of people. One site no longer has a community forest due to changes in the ward boundary; the forest now belongs to a neighboring ward and neither ward has a forest user group. Forest user groups generally consist

of a committee and member households. The number of committee members in the 6 forest user groups operating in the sample sites ranged from 4 to 11, and 4 user groups had at least one woman on the committee. The number of households belonging to the forest user groups ranges from 40 to over 180. In some places not all local households are group members, and there are indications that low caste households may find it more difficult to join.

What the local forest user groups do in practice and how effective they are varies between sites. In general, forest user group members meet to decide how much wood to cut down in the forest and where to cut it. In some groups member households receive a quota for fuelwood that they are allowed to collect whenever they choose. Individual households often are not allowed to cut trees or branches on their own, although some groups allow fodder collection which requires the cutting of branches. Most groups require permission before a tree can be cut for timber. All user groups report having a fine for infractions, but monitoring of forest product extraction and enforcement of any penalty varies from regularly monitored and enforced to no monitoring or enforcement. Households who are not members of the forest user groups are not allowed to cut trees or branches in restricted areas reserved for group members. This can make non-user group households have to travel further to collect forest products.

#### -Education

In Nepal, there are 10 years of school before a student goes to college. Primary school is the first 5 years. Secondary school may be divided into lower secondary, grades 6-8, and higher secondary (or high school), grades 9 and 10. Since 1961 the Nepal government has emphasized primary education. From 1980 to 1991 the number of primary schools increased 76% and the number of teachers increased 240% (although only half of these were trained).<sup>5</sup> In general, educational attainment for girls has improved dramatically in Nepal over the last two decades. Since 1975 the government has taken such measures as eliminating school fees at public primary schools, providing books free for girls up through grade 5, and recruiting female teachers in order to encourage girls to remain in school.<sup>6</sup> From 1980 to 1991 female enrollment in primary school increased 249%.<sup>7</sup>

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<sup>5</sup>Shtrii Shakti (1995), p. 36.

<sup>6</sup>Shtrii Shakti (1995).

Many girls in the rural survey sites of this study are now receiving at least a primary education, and many are continuing on past the primary level. As is evident in Table 4, boys and girls in the sample ages 6-17 are exhibiting roughly the same amount of educational attainment and girls ages 12-17 are actually averaging slightly more schooling than boys of the same age group. In older age groups the schooling levels of boys versus girls widens dramatically. Very few sample women over the age of 35 have received any schooling at all.

### III. Analytical Issues and Empirical Modeling

This study estimates household-level reduced-form demand equations for environmental goods, for time allocated by different household groups to environmental good collection, and for schooling for boys and girls. As is consistent with household maximization of a unified preference function, the reduced form demands are dependent on prices, non-wage income, and individual, household, and community level characteristics. In general, the relevant model is one of agricultural household production where maximization is constrained by budget and time constraints and by environmental good, agriculture, and schooling production functions.

-Environmental goods and collection time

One focus of this paper is on the household demands for environmental goods and for time allocated to collection of the goods by men, women, and children. The demand functions are estimated using ward-level fixed effects with late dry season and monsoon season observations from 1982/1983 and 1997. Many factors affecting household collection and consumption of environmental goods occur at the ward level (e.g., weather, terrain). Also many of the changes that occurred between 1982 and 1997 were implemented at the ward level (e.g., forest management decisions). Several households are sampled from each ward providing within-ward variation.

Table 5 gives the means and standard deviations by year for the explanatory variables included in these demand equations.<sup>8</sup> The “price” of an environmental good is measured by the minutes it takes the household to collect a kilogram of the good. For water, the time is per trip

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<sup>7</sup>Shtrii Shakti (1995), p. 36.

since that is all the information available in the NENS 1982/1983 data. The “time prices” can be used to measure the relative costliness of environmental goods to a household, and are used to proxy a household’s relative environmental condition. Collection difficulty, and thus the time per unit collected, are assumed to increase with environmental degradation.

There are some difficulties associated with using the time per unit collected of a good as the good’s price to the household. From a theory perspective, the time per unit of a good can be thought of as the inverse of the marginal product of labor for household production of that good. However, this does not represent the full “shadow price” of the good to the household. Such a shadow price should include some measure of the opportunity cost of the household’s time, such as the wage rate. Unfortunately, the 1982/1983 and 1997 data sets do not contain compatible measures of wage rates.<sup>9</sup> However, research with the NENS data alone indicates that the coefficient results obtained using time prices are very similar in sign and significance level to those using full shadow prices.<sup>10</sup> Most variation in the shadow prices arises from the time per kilogram component. A second difficulty with the time per unit measures is that they are endogenous. Theoretically, the decisions of how much to collect of a product and how long to take collecting it are simultaneously determined. At this point in this study, no correction has been made for this.

It is interesting to note in Table 5 that the average time price of fuelwood has fallen by half since 1982/1983. The decrease may be due to the actions of forest user groups (e.g., group felling of trees and branches) and more concentrated collection efforts for fuelwood during the dry season. Leaf fodder and cut grass now take slightly longer to collect per unit. These products are collected on much more of a daily basis than is fuelwood, are not stored, and are not subject to forest user group management in most survey wards. Water takes slightly less time to collect on average, although this now varies significantly by season. In 1982/1983 the time per trip for water was roughly the same in either the late dry season or the monsoon season. In 1997, water was much more time consuming to collect in the late dry season.

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<sup>8</sup>The explanatory variables included in the estimated demands are specified to be generally consistent with similar demand equations estimated in Cooke (1998a) with the 1982/1983 NENS data.

<sup>9</sup>This is due to the small number of women working off-farm for labor in 1997 and the lack of agricultural wage data in the NENS 1982/1983 data.

<sup>10</sup>See Cooke (1998a, 1998b) for similar research with the NENS data using full shadow prices.

The remaining explanatory variables included in the environmental good and collection time demand equations measure a variety of household and production characteristics. Household population variables are included as is the gender of the household head. In 1982 all but one of the household heads were male. This has changed as some original NENS heads have died and their wives have taken over as head. The age of the household head, the percentage of literate adults in the household and a caste dummy for households of Tibeto-Burman ethnicity are also included. These variables may affect the preferences of the household and thus influence labor allocation and consumption decisions. Land ownership variables for upland area (*pakho*) and lowland area (*khet*) measured in hectares are included as is the number of she-buffaloes owned. The land variables are assumed to be parameters in the household's environmental good and agricultural production functions. She-buffaloes influence agricultural production through their provision of manure for fertilizer. Real non-labor income is measured as the yearly remittances and pension payments received by the household. Many households do not receive such payments and so have a value of zero. Nominal figures are converted using the Nepal CPI for 1982 and for 1993. This latter figure is the latest year for which the CPI is available. There has been inflation in Nepal since 1993, so 1997 non-labor income figures may be overstated in real terms.

There is potentially a problem of sample selection bias in the estimation of grass and fodder consumption and collection demands using the time prices of these goods. Both of these goods exhibit extreme seasonality in their collection and use due to their availability, although a few households do report using them in their respective off-seasons. To reduce any selection bias problem, the fixed-effects model for leaf fodder is estimated using only late dry season observations, and that for cut grass is estimated using only monsoon season observations. This is also necessary for leaf fodder since the original NENS survey did not collect data on leaf fodder collection and use during the monsoon season (on the relatively safe assumption that no one used it then). Time prices for these two goods are left out of all estimations using the full four rounds of data; their inclusion leads to too many dropped observations due to lack of data. Another similar problem arises with the time price of fuelwood in the 1997 monsoon season. Few households collected fuelwood then, and so time prices are not available.

-Schooling attainment model

Estimating the quantity of schooling attained by a child measures the cumulative schooling performance of the child. It provides an opportunity to assess the determinants of a household's demand for schooling including the household's environmental condition. A unique aspect of this study is that the household's initial environmental condition in 1982/1983 can be used in the analysis, and the effect of this condition on subsequent schooling demand assessed. This provides a way to measure the more long-term and cumulative impact of poor environmental conditions on household members, and whether there is any gender variation to this impact.

A two-limit Tobit specification is used to model the years of schooling completed by a child.<sup>11</sup> The model has a lower limit due to children who have never attended school and thus have a schooling value of zero. We do not know how many years of schooling those children would acquire if they were to attend. The dependent variable is also censored at the right since many children in this group have not yet completed their schooling and we do not know what education level they will achieve.

The relevant two-limit Tobit model may be written

$$E_i^* = \beta_1 * I_i + \beta_2 * H_i + \beta_3 * C_i + \mu_i$$

where

$$\begin{aligned} E_i &= E_{1i} && \text{if } E_i \leq E_{1i} \\ &= E_i^* && \text{if } E_{1i} < E_i^* < E_{2i} \\ &= E_{2i} && \text{if } E_i^* \leq E_{2i} \end{aligned}$$

$E_i^*$  is the latent variable and  $E_i$  is the observed dependent variable. The terms  $I$ ,  $C$ , and  $H$  are vectors of explanatory variables corresponding to individual, community, and household characteristics respectively, and  $\mu$  is a random disturbance term.<sup>12</sup> The subscript "i" denotes the individual. The vector  $I$  includes the age of the individual and whether the individual is a child of the household head. The model is estimated separately for male and female children so the gender of the child is not included. While it would be preferable to include some measure of an

<sup>11</sup>This follows the methodology of Alisjahbana (1994).

<sup>12</sup>Maddala (1983), pp160-162.

individual's innate ability, there is no proxy for this available. Individual variables as well as community and household characteristic variables are described in Table 6.

Community characteristics at the ward level include the number of community forest areas in the ward, whether the ward has a high school, and the average number of minutes it takes to reach a road from the ward. Given that there are only a small number of wards in the sample, other ward-level variables were dropped due to multicollinearity. This complicates the interpretation of those ward variables included since they may capture other ward-level characteristics as well. The number of community forest areas is intended to proxy the quantity of environmental resources in the ward. Obviously, this variable can only approximate community resources and not those that are privately owned. Whether a ward has a high school is meant to capture the level of educational infrastructure. To the extent that greater educational infrastructure reduces the cost of obtaining schooling, we would expect the sign on this variable to be positive. However, this is a somewhat flawed measure of relevant educational infrastructure since children can go to school in other neighboring wards or nearby urban areas. The minutes to a road variable does a good job in proxying closeness to an urban areas. This may serve as an indicator of the returns to education in a community since these returns are likely to be higher close to urban areas that would have relatively more non-agricultural labor opportunities.

Household characteristics include the age, gender, years of schooling, literacy, occupation, and residency of the household head. Unfortunately the same information for the head's spouse is only available for male headed households and so is not included in the model. Females are generally household heads only after their spouse has died, and information on deceased spouses is not available. It is also not possible to include information on a specific child's mother and father if the child is not a child of the household head since it is not always clear which adults are the child's parents. Over 75% of NENS household resident school-age children are sons or daughters of the household head, and this percentage is close to 80% for the broader sample.

The current number of resident non-school-age children is also included in the household characteristics. It has been postulated that children, particularly girls, may receive less education if there are younger children requiring supervision in the household. The number of school-age

boys and the number of school-age girls are also included. The caste of the household and the initial environmental condition of the household complete the household-level variables included in the model. A dummy is included for occupational caste households. These are low socio-economic group households in rural Nepal who generally have less land and less income than higher caste households. A household's initial environmental condition is defined by a ranking based on the time it took the household to collect a kilogram of fuelwood, fodder, or grass and the time per trip for water in 1982/1983. For each of the four environmental goods with a time per unit measurement in the top quarter of the sample a household receives one ranking point. Thus, a household with no time per unit measurements high enough to be in the top quarter has an environmental ranking of 0. For those with high time per unit measurements for all four goods, the ranking is 4.<sup>13</sup>

The years of schooling completed are estimated at the individual level for resident children and grandchildren of the current household head. The model is estimated for male and female children separately in order to determine whether there are differences in the factors influencing the demand for schooling of boys and of girls. Children ages 6-17 are included. This is the normal age range for children to be in school in the survey area, and includes children who have grown up in the sample households over the last 14 years. Children older than 17 are not included due to possible selection bias problems. On average, the number of female children and grandchildren older than 17 who are resident in the household drops more than the number of males of the same age due to females marrying out of the household. Individual information for children who have married out of the household is not available. The educational attainment model is estimated first using individuals from NENS households only and then using all sample households. Obviously, the environmental ranking variable is only included in the NENS household specification. However, since there is a relatively small sample of individuals when using only NENS households, it is useful to compare whether the male/female differences on other determinants of educational demand hold up in a slightly larger sample from the same area.

Several variables are omitted from the educational attainment model. Specifically the reduced-form demand for schooling implied by household maximization should be a function of the price of schooling, non-labor income, and wage rates. Unfortunately, none of these can be

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<sup>13</sup>To qualify as being in the top quarter a household's minutes per unit needed to be greater than 19.2 for fuelwood, 6 for leaf fodder, 6.6 for grass, and 33.75 for water.

included. There is no good measure of school price. Although a household's total expenditures on schooling have been collected, these are endogenous and are not broken down by individual. The round-trip time to school is available, but this is also an endogenous variable. Households do not always choose to send their child to the closest school available, and may choose to use a school that is further away but is perceived to be of higher quality. This study cannot address the issue of school quality or schooling choice. Ward-level agricultural wage rates are available, but are not included due to multicollinearity problems. Household level wages are not available due to the small number of households with people working off-farm for wages. Household non-labor income is excluded due to the large number of zero-value observations.

#### **IV. Empirical Results**

All of the demand functions estimated in this paper have sample selection bias as a potential problem. Ten of the households in the 1982 sample have migrated and selected themselves out of the sample. If these households left the sample due to adverse environmental conditions, then the results in this study could be biased. To check whether this is potentially a problem or not a probit equation using the 1982/1982 NENS data is estimated to determine whether a household's time per unit of collection variables for the four environmental goods influenced the decision to migrate. The results of the probit equation (not presented here) indicate that household time per unit variables do not have any significant explanatory power regarding the decision of whether or not to migrate. Households with higher adult literacy rates and higher remittances are more likely to migrate, while those with more male adults and more livestock are less likely to migrate.

##### **-Environmental good consumption and collection**

Table 7 presents the ward-level fixed-effects results for household environmental good demands. The dependent variables are measured in terms of kilograms per day. Time per kilogram variables for leaf fodder and cut grass are not included in fuelwood demand estimates which use all four quarters of available data. The extreme seasonality in the collection and consumption of these goods results in too many missing observations for them to be included. Similarly, the fuelwood "time price" is not included in the grass demand equation since the very

small number of households who collected fuelwood in the 1997 monsoon season also results in too many missing observations.

As expected, own “time price” variables are negative and significant in all demand equations. Households who take longer to collect a unit of the good use significantly less of it, although the absolute decrease in the amount consumed is generally small. Although there have been 14 years for changes to occur, the demands for fuelwood, leaf fodder, and grass are very inelastic with respect to the time prices indicating that there still are not very many feasible substitutes to their use. Time price elasticities are 0.15 for fuelwood and for grass, and 0.18 for leaf fodder.

Of particular interest to this study is how consumption of these products has changed over time. Leaf fodder and cut grass consumption both are shown to have decreased significantly since 1982/1983 even when accounting for household and community level changes. The absolute values for the decrease are rather large. This may be related to the decline in the average number of cattle and buffaloes sample households own. Having an additional she-buffalo tends to increase the consumption of these products. Fuelwood and fuelwood per capita consumption does not appear to have changed since 1982/1983. The monsoon season dummy coefficient is also insignificant, although the monsoon/year interactive dummy is significantly negative. Households consumed significantly less fuelwood even in per capita terms during the 1997 monsoon season. The amount of the decrease is large in absolute terms as well at over a kilogram per person less than during all other survey periods. It is hard to interpret this result satisfactorily. Other data in the 1997 surveys indicates that households continue to prepare the same number of regular meals per day as in the dry season. They may be less inclined to prepare “tiffen” or midday snacks however as the monsoon is an extremely busy time of year agriculturally.<sup>14</sup> It is not clear why this would have changed since 1982/1983 however. Evidence is that households supplement their fuelwood use with crop residues, particularly maize stalks and cobs. The quantity of these crop residues consumed for fuel can be quite large for some households. Unfortunately, while the NENS data contains dummy variables on stalk and cob use for fuel, there are no quantities given that can be used for comparison with more recent data.

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<sup>14</sup>1997 data is not sufficient to test this.

Table 8 reports estimation results for total collection time for all four environmental goods broken down by the time of men, women, and children. Once again, the time prices for leaf fodder and grass are dropped from the estimation due to a lack of observations if they are included. The time households spend collecting leaf fodder and grass are included in the total collection time measurement however. Total collection time is given in minutes per day. In general, a higher time price for water significantly increases the total minutes per day men, women, and children all spend collecting environmental goods. The increase borne by women is larger than that borne by men or children, however, and only women's collection time is increased with an increase in the time per unit collected of fuelwood.

It appears that women's labor burdens are relieved somewhat by the presence of an additional adult male in the household. While men's total collection time increases by almost sixteen minutes a day when another adult male is present, there is some evidence that women's time decreases by almost the same amount. The slightly significant (at the 10% level) coefficient on the household head's gender dummy also indicates that women in female headed households, those which typically do not have many resident adult males, spend more time collecting. This indicates that men do bear some significant portion of the environmental collection burden. The year dummy suggests that men's portion of household collection time is increasing. After accounting for household, ward, and seasonal factors, these results indicate that women and children are not spending more minutes collecting environmental goods than they did in 1982/1983. Men, on the other hand, are spending over 50 minutes more per day on average.

As found in Cooke (1998a), children appear to spend significantly more time collecting during the monsoon season than during the dry part of the year. However, the result on women's collection time is opposite to that found in Cooke (1998a) using the 1982/1983 NENS data alone. Using the NENS data it appears that women spend more time collecting during the monsoon season. The monsoon season dummy results in this paper indicate that women tend to spend less time collecting during the monsoon season. However, women, and men as well, appear to have spent more time collecting during the 1997 monsoon season than at other times, and children appear to have spent less time.

A more detailed examination of the factors influencing collection time allocation is possible by estimating the collection time demand equations for different environmental goods

separately. Table 9 summarizes the time price, year dummy, and season dummy coefficients. With every good, the absolute effect of the own time price on the collection time spent on a particular good is largest on women, and in all cases it increases the time spent in collection. This is not surprising for inelastic goods. The largest increases in women's collection time appear to come from increases in the time prices of cut grass and leaf fodder. Men's time collecting cut grass and leaf fodder is significantly increased by own time price increases of these goods as well, although by a smaller amount.

Although women in households facing higher time prices for cut grass and leaf fodder spend significantly more time in their collection than those facing lower time prices, the year dummy indicates that women spend less time collecting these products now than they did in 1982/1983. This corresponds with the results indicating that households are consuming significantly less of these goods than they did previously. The year dummy also indicates that men, women, and children are all spending more time collecting fuelwood than they did in 1982/1983, and in this particular case the largest increase in collection time comes from men.

#### -Educational attainment

The results of the tobit equation on children's educational attainment may be found in Table 10. Results are given for estimates using children resident in NENS households only, and for estimates including resident children in all households sampled in 1997. The results are generally similar between the two groups. Of immediate interest to this study is the effect of a household's initial environmental condition on the schooling level attained by girls versus boys. The results in the NENS household estimates indicate that there is a significant decrease in educational attainment for girls in households with a relatively worse environmental condition ranking, but that there is no significant decrease for boys. This gives some evidence to support the hypothesis that girls are placed at a disadvantage educationally compared to boys when more time must be taken to collect a given quantity of environmental goods.

The negative effect of initial environmental conditions on girls' education appears to be relatively small. The negative effects of several other variables on female educational attainment are much larger. Notably, girls in low caste households receive much less education than those in higher caste or Tibeto-Burman households. This effect holds in the larger sample, although

the coefficient is smaller. Girls in households where the head is a farmer tend to receive less education, as do girls in female headed households.<sup>15</sup> None of these factors appear to influence male educational attainment. In fact, being in a female headed household significantly increases the amount of education that boys receive. This dummy variable may be capturing some effect due to households experiencing the death of a household head since most female household heads are widows. Girls may be having to take on more responsibilities at home in such a situation, and boys may be being groomed to take over as household head.

Both boys and girls tend to receive more education in households where the head is literate although the coefficient in the female equation is only significant at the 10% level. Boys in households with more school age girls tend to receive slightly more schooling. Households with more girls may rely less on boys for household tasks such as environmental good collection. In the larger sample estimate, girls receive less education if there are more school age boys in the household. This appears to indicate that households will educate boys before girls if there are both in the household.

Distance from a road has a significantly negative effect in the educational attainment equations for boys and for girls in the larger sample. The longer it takes to get to a road, the further away the community is from an urban area where there would be more employment opportunities. This effect is very small, however. Community level educational infrastructure as captured by whether there is a high school in the ward appears to encourage female educational attainment, but does not influence the level of schooling boys attain. However, caution must be used in interpreting this dummy variable. Only one ward has a high school, so this dummy may be capturing other characteristics unique to this ward. Specifically, this ward has two women's groups, one of which is extremely active in growing vegetables for sale and soliciting funding to build water taps. The educated women of the group keep detailed financial records of the group's membership dues, loans to members, input costs, and sales. The presence of such a group and its success may be encouraging households to educate their girls and the girls to put more effort into their schoolwork.

## **V. Conclusion**

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<sup>15</sup>Psacharopoulos and Arriagada (1989) find that having one's father be a farmer has a strong negative impact on grade attainment for children age 7-14 in Brazil.

This paper provides some evidence as to the effect of changing environmental conditions on rural women in the hills of Nepal. The time per unit of collection for environmental goods, or their “time price,” is used by this study to approximate a household’s relative environmental status. Since the time of the original NENS survey, on average these time prices have risen for environmental goods used to feed livestock, and have fallen for fuelwood. For water, often cited as a problem by survey households, the time price now varies dramatically by season although it is lower on average than in 1982/1983.

The labor burden of collection activities is one way in which women bear the cost of adverse environmental conditions. The results in this paper confirm results obtained using only the NENS data that indicate households spend significantly more time collecting environmental goods when their time prices are higher. For some environmental goods, men and children respond to higher per unit time costs by spending significantly more time collecting. However, after correcting for ward-level changes and changes in household factors over time, women still account for the lion’s share of collection labor time increases due to higher time prices. High time per unit collection costs for leaf fodder and cut grass generate the largest increases in women’s collection labor demand.

Overall it appears that the percentage of total collection time accounted for by women has decreased and that accounted for by men has increased since 1982. This would seem to indicate some positive change for women’s labor burdens. However, ward-level fixed-effects estimates indicate that women do not spend significantly less total time in collection activities than they did in 1982/1983 when accounting for other factors. Men do appear to be taking over some of the labor burden however, and women are spending significantly less time collecting at least some products, namely leaf fodder and cut grass.

Unfortunately, part of the decrease in women’s collection time for leaf fodder and cut grass may be due to significantly reduced consumption of these items rather than reallocation of labor burdens among family members. It is not immediately clear what substitutes are being used for these goods given that households in general are still feeding their livestock more than in 1982/1983. Reduced livestock holdings may be accounting for part of the decrease. Reduced

livestock holdings along with reduced landholdings are indications that households are worse off economically than they were 14 years ago.

There is some evidence that the amount of time spent collecting by children has increased, at least for those households with children who collect. Although there is no gender breakdown for children's collection activities in the NENS data, in 1997 girls spent more time collecting than boys on average. Children appear to be spending more time collecting during the late dry season. This is potentially detrimental to a child's schooling since school is in session during this time of year. In general, girls and boys seem to be achieving similar levels of educational attainment. This is apparently a marked improvement over attainment levels in the region 15 years ago. Factors that influence educational attainment do differ by gender. Estimates of the long term effect of poor environmental conditions on years of schooling indicate that girls may receive somewhat less education than boys due to spending more time collecting. However, other factors have much stronger negative effects on female educational attainment. If a girl belongs to a household that is disadvantaged in socio-economic terms due to caste or having the male household head die, she is likely to receive significantly less education. If these households are the ones in relatively worse environmental conditions then the negative effects on girls' educational attainment may be compounded.

On a positive note, there is evidence of increasing community-level actions that may work towards improving the lives of women and girls (and men and boys too) with regard to environmental good collection and use. Actions of some newly forming women's groups are encouraging. Women's group activities aimed at improving the availability of resources such as building water taps can potentially reduce women's labor burdens. Forest user groups and the involvement of women in their management activities (at least to some extent) are also encouraging. Forest user groups are meant to manage community forests so that forest products may be extracted on a sustainable basis. By instituting and enforcing rules that prevent overuse, the groups may improve forest resources in the long run thus making collection easier. In the short run however, rules may make it more difficult for households to collect the forest products they desire. This is particularly true for households who are not forest user group members and who therefore must travel to non-regulated areas for collection.



**Table 1: Household Collection and Consumption of Environmental Products by Season and Year (NENS households only)**

| Variable<br>(average kgs/day) | Late Dry Season  |                             |                  |                             | Monsoon Season   |                             |                  |                             |
|-------------------------------|------------------|-----------------------------|------------------|-----------------------------|------------------|-----------------------------|------------------|-----------------------------|
|                               | 1997             | % of<br>sample<br>consuming | 1982/83          | % of<br>sample<br>consuming | 1997             | % of<br>sample<br>consuming | 1982/83          | % of<br>sample<br>consuming |
| <b>Fuelwood</b>               |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Consumption</b>            | 9.59<br>(6.54)   | 100%                        | 10.88<br>(5.32)  | 100%                        | 5.30<br>(5.57)   | 94%                         | 10.37<br>(6.29)  | 99%                         |
| <b>Consumption per Capita</b> | 1.82<br>(1.26)   | 100%                        | 1.87<br>(1.25)   | 100%                        | 1.17<br>(1.70)   | 94%                         | 1.81<br>(1.22)   | 99%                         |
| <b>Collection</b>             | 28.19<br>(28.60) | 93%                         | n/a              | n/a                         | 1.94<br>(5.06)   | 36%                         | n/a              | n/a                         |
|                               |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Leaf Fodder</b>            |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Collection/Consumption</b> | 4.35<br>(6.30)   | 53%                         | 21.33<br>(18.39) | 75%                         | 4.38<br>(9.39)   | 22%                         | n/a              | n/a                         |
|                               |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Cut Grass</b>              |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Collection/Consumption</b> | 1.53<br>(4.81)   | 12%                         | 2.28<br>(7.78)   | 9%                          | 45.91<br>(40.28) | 95%                         | 61.00<br>(35.38) | 96%                         |
|                               |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Water</b>                  |                  |                             |                  |                             |                  |                             |                  |                             |
| <b>Collection trips/day</b>   | 6.90<br>(3.72)   | 99%                         | n/a              | n/a                         | 6.31<br>(3.97)   | 95%                         | n/a              | n/a                         |

Standard deviations in parentheses

Sources: Nepal Energy and Nutrition Survey, 1982/1983, Western Region, Nepal, Nepal Agricultural Projects Service Center, the Food and Agriculture Organization of the United Nations, and the International Food Policy Research Institute; and Nepal Household Resurveys, 1996/1997, Winrock International-Nepal, the International Food Policy Research Institute, Goteborg University, Sweden, and author's fieldwork.

**Table 2: Household Collection Time for Environmental Products by Season and Year (NENS households only)**

| Variable<br>(minutes/day)  | Late Dry Season    |                              |                    |                              | Monsoon Season     |                              |                     |                              |
|--|--------------------|------------------------------|--------------------|------------------------------|--------------------|------------------------------|---------------------|------------------------------|
|  | 1997               | % of<br>sample<br>collecting | 1982/83            | % of<br>sample<br>collecting | 1997               | % of<br>sample<br>collecting | 1982/83             | % of<br>sample<br>collecting |
| <b>Total Collection Time</b>   |                    |                              |                    |                              |                    |                              |                     |                              |
| <b>All household members</b>   | 382.83<br>(252.54) | 100%                         | 341.45<br>(265.97) | 100%                         | 423.26<br>(286.17) | 100%                         | 570.42<br>(310.69)  | 100%                         |
| <b>Men</b>   | 77.98<br>(109.56)  | 60%                          | 33.17<br>(48.91)   | 73%                          | 107.21<br>(142.05) | 68%                          | 22.56<br>(41.76)    | 46%                          |
| <b>Women</b>   | 271.73<br>(208.93) | 100%                         | 296.50<br>(254.32) | 100%                         | 218.10<br>(166.38) | 98%                          | 226.94<br>(209.60)  | 100%                         |
| <b>Children</b>  | 42.63<br>(86.66)   | 37%                          | 11.77<br>(25.83)   | 54%                          | 85.29<br>(123.23)  | 55%                          | 128.57<br>(120.02)  | 84%                          |
| <b>Collection Time For:</b>  |                    |                              |                    |                              |                    |                              |                     |                              |
| <b>Fuelwood</b>  | 149.91<br>(148.23) | 93%                          | 101.79<br>(93.53)  | 100%                         | 15.70<br>(34.34)   | 37%                          | 116.45<br>(148.54)  | 74%                          |
| <b>Water</b>   | 181.03<br>(170.29) | 98%                          | 139.67<br>(134.93) | 100%                         | 92.21<br>(100.30)  | 94%                          | 128.133<br>(133.43) | 99%                          |
| <b>Leaf Fodder</b>   | 35.20<br>(74.54)   | 54%                          | 81.61<br>(94.82)   | 75%                          | 22.73<br>(53.99)   | 24%                          | n/a                 | n/a                          |
| <b>Cut Grass</b>   | 17.09<br>(48.62)   | 13%                          | 18.37<br>(67.90)   | 8%                           | 298.57<br>(251.31) | 95%                          | 325.59<br>(264.70)  | 92%                          |
| Standard deviations in parentheses<br>Sources: Nepal Energy and Nutrition Survey, 1982/1983, Western Region, Nepal, Nepal Agricultural Projects Service Center, the Food and Agriculture Organization of the United Nations, and the International Food Policy Research Institute; and Nepal Household Resurveys, 1996/1997, Winrock International-Nepal, the International Food Policy Research Institute, Goteborg University, Sweden, and author's fieldwork. |                    |                              |                    |                              |                    |                              |                     |                              |

**Table 3: Selected Household Actions (NENS households only)**

|   | Number of Households | Percentage of Sample <sup>1</sup> |
|---|----------------------|-----------------------------------|
| Planted trees on property between 1982 and 1997         | 54                   | 53%                               |
| Planted fodder trees between 1982 and 1997              | 30                   | 30%                               |
| Have let trees grow up naturally on property since 1982 | 80                   | 82%                               |
| Stored fuelwood in 1982                                 | 23                   | 21%                               |
| Stored fuelwood in 1997                                 | 90                   | 98%                               |
| Have ever bought fuelwood                               | 16                   | 16%                               |
| Have ever bought leaf fodder                            | 11                   | 11%                               |
| Switched to biogas for cooking between 1982 and 1997    | 4                    | 4%                                |

<sup>1</sup> Sample sizes vary.

*Sources:* Nepal Energy and Nutrition Survey, 1982/1983, Western Region, Nepal, Nepal Agricultural Projects Service Center, the Food and Agriculture Organization of the United Nations, and the International Food Policy Research Institute; and Nepal Household Resurveys, 1996/1997, Winrock International, Nepal, the International Food Policy Research Institute, Goteborg University, Sweden, and author's fieldwork.

**Table 4: Average Educational Attainment by Gender/Age Group (All sample households)**

| Age Category       | All Residents             |                           | Current Household<br>Head s Resident Children<br>or Grandchildren |                          |
|--------------------|---------------------------|---------------------------|---|--------------------------|
|                    | Male                      | Female                    | Male  | Female                   |
| Age 6-11           | 2.03<br>(1.47)<br>61 obs  | 1.76<br>(1.38)<br>56 obs  | 2.01<br>(1.49)<br>59 obs  | 1.74<br>(1.40)<br>54 obs |
| Age 12-14          | 4.89<br>(2.12)<br>39 obs  | 4.92<br>(1.82)<br>25 obs  | 4.83<br>(2.15)<br>37 obs  | 4.91<br>(1.86)<br>24 obs |
| Age 15-17          | 7.24<br>(2.01)<br>33 obs  | 7.47<br>(1.95)<br>38 obs  | 7.24<br>(2.01)<br>33 obs  | 7.41<br>(1.96)<br>36 obs |
| Age 18-24          | 8.31<br>(4.01)<br>32 obs  | 5.69<br>(4.21)<br>43 obs  | 8.92<br>(3.64)<br>27 obs  | 7.69<br>(3.70)<br>13 obs |
| Age 25-34          | 8.32<br>(5.01)<br>37 obs  | 3.89<br>(4.52)<br>55 obs  | 10.04<br>(4.10)<br>21 obs   | 2.50<br>(5.00)<br>4 obs  |
| Age 35 +           | 2.03<br>(3.70)<br>104 obs | 0.18<br>(1.05)<br>125 obs | 6.16<br>(5.30)<br>6 obs   | 0 obs                    |
|                    |                           |                           |   |                          |
| Total observations | 306                       | 342                       | 183   | 131                      |

**Table 5: Household Variable Means and Standard Deviations, by Year  
(NENS households only)**

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|  | <u>1982/1983</u> |                       | <u>1996/1997</u> |                       |
|--|------------------|-----------------------|------------------|-----------------------|
|  | Mean             | Standard<br>Deviation | Mean             | Standard<br>Deviation |
| Minutes per kilogram, fuelwood               | 14.49            | 16.15                 | 7.23             | 5.28                  |
| Minutes per kilogram, leaf fodder            | 4.05             | 3.11                  | 5.64             | 5.66                  |
| Minutes per kilogram, cut grass              | 6.52             | 4.39                  | 8.90             | 9.72                  |
| Minutes per trip, water                      | 25.20            | 24.38                 | 22.32            | 20.49                 |
| Gender of household head is male?            | 0.99             | 0.09                  | 0.89             | 0.30                  |
| Age of household head                        | 44.64            | 13.82                 | 55.35            | 11.65                 |
| Percentage of literate adults                | 42.21            | 28.89                 | 62.22            | 30.79                 |
| Number of resident males age 16-59           | 1.70             | 1.24                  | 1.21             | 1.04                  |
| Number of resident females age 16-59         | 1.69             | 1.00                  | 1.67             | 1.02                  |
| Number of youths age 6-15                    | 1.69             | 1.41                  | 1.69             | 1.49                  |
| Number of children age 0-5                   | 1.31             | 1.17                  | 0.80             | 1.03                  |
| Upland area owned ( <i>pakho</i> ), hectares | 0.83             | 0.71                  | 0.34             | 0.30                  |
| Lowland area owned ( <i>khet</i> ), hectares | 0.62             | 0.57                  | 0.45             | 0.55                  |
| Number of she-buffaloes owned                | 1.96             | 1.72                  | 2.19             | 1.31                  |
| Real non-labor income (base year=1987)       | 2645.07          | 5513.18               | 1473.21          | 2671.70               |
| Tibet-Burman ethnic group?                   | 0.33             | 0.47                  | 0.29             | 0.45                  |

*Sources:* Nepal Energy and Nutrition Survey, 1982/1983, Western Region, Nepal, Nepal Agricultural Projects Service Center, the Food and Agriculture Organization of the United Nations, and the International Food Policy Research Institute; and Nepal Household Resurveys, 1996/1997, Winrock International, Nepal, the International Food Policy Research Institute, Goteborg University, Sweden, and author's fieldwork.

**Table 6: Means and Standard Deviations, all resident persons age 6-17, April, 1997 (NENS households only)**

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Standard

|   | Mean  | Deviation |
|---|-------|-----------|
| <u>Individual Variables</u>               |       |           |
| Is Female?                                | 0.46  | 0.49      |
| Age                                       | 11.8  | 3.39      |
| Child of Household Head                   | 0.72  | 0.42      |
| <u>Household Variables</u>                |       |           |
| Current Age of Household Head             | 52.85 | 12.18     |
| Head's Years of Education                 | 1.98  | 3.8       |
| Is Head Literate?                         | 0.72  | 0.44      |
| Is Head Female?                           | 0.06  | 0.24      |
| Is Head Resident?                         | 0.84  | 0.36      |
| Is Head's Main Occupation Agriculture?    | 0.79  | 0.40      |
| Is Household of the Occupational Caste?   | 0.16  | 0.37      |
| Current Number of Children Age 0-5        | 0.84  | 1.04      |
| Current Number of Male Youths Age 6-15    | 1.47  | 0.96      |
| Current Number of Female Youths Age 6-15  | 1.29  | 0.99      |
| Household Environmental Ranking (0-4)     | 0.90  | 1.04      |
| <u>Community Variables</u>                |       |           |
| Upper Secondary School in Ward?           | 0.21  | 0.41      |
| Average Minutes to Nearest Road from Ward | 83.69 | 77.07     |
| Number of Community Forest Areas in Ward  | 2.03  | 1.59      |

**Table 7: Demands for Environmental Products, 1982/1983 - 1997**  
**Ward-Level Fixed-Effect Estimates**

| <b>Independent Variable</b>                                   | <b>Fuelwood</b>   | <b>Fuelwood<br/>per Capita</b> | <b>Leaf<br/>Fodder<sup>1</sup></b> | <b>Cut<br/>Grass<sup>2</sup></b> |
|---|-------------------|--------------------------------|------------------------------------|----------------------------------|
| Minutes/kilogram fuelwood                                     | -0.14**<br>(5.34) | -0.01**<br>(4.13)              | -0.03<br>(0.24)                    |                                  |
| Minutes/trip water  | 0.02*<br>(1.70)   | 0.003<br>(1.26)                | 0.10*<br>(1.77)                    | -0.06<br>(0.50)                  |
| Minutes/kilogram leaf fodder                                  |                   |                                | -0.72**<br>(2.42)                  |                                  |
| Minutes/kilogram cut grass                                    |                   |                                |                                    | -1.06**<br>(2.99)                |
| Percentage literate adults                                    | 0.01<br>(1.51)    | 0.000<br>(0.28)                | 0.01<br>(0.28)                     | 0.07<br>(0.76)                   |
| Upland area   | 1.42**<br>(2.09)  | 0.26**<br>(2.21)               | -1.54<br>(0.58)                    | -8.27<br>(1.55)                  |
| Lowland area  | 0.12<br>(0.14)    | -0.03<br>(0.25)                | 0.84<br>(0.27)                     | 1.55<br>(0.23)                   |
| Dummy=1 if Tibeto-Burman                                      | 0.10<br>(0.08)    | -0.000<br>(0.00)               | 4.05<br>(0.92)                     | 13.23<br>(1.28)                  |
| Male adults, age 16-59  | 0.35<br>(1.15)    | -0.11**<br>(2.21)              | 0.03<br>(0.03)                     | 10.53**<br>(3.53)                |
| Female adults, age 16-59                                      | 0.41<br>(1.06)    | -0.20**<br>(3.08)              | -0.66<br>(0.52)                    | 3.43<br>(1.14)                   |
| Youths, age 6-15  | 0.61**<br>(2.57)  | -0.20**<br>(4.96)              | -0.65<br>(0.79)                    | -0.42<br>(0.24)                  |
| Children, age 0-5   | 0.56*<br>(1.74)   | -0.15**<br>(2.86)              | 1.72<br>(1.49)                     | 0.06<br>(0.02)                   |
| Number she-buffaloes  | 0.21<br>(0.92)    | 0.06<br>(1.48)                 | 1.72*<br>(1.82)                    | 4.91**<br>(2.50)                 |
| Real non-labor income   | -0.000<br>(0.16)  | -0.000<br>(0.52)               | -0.000<br>(0.93)                   | 0.000<br>(0.40)                  |
| Age of household head   | -0.007<br>(0.25)  | -0.004<br>(0.98)               | 0.05<br>(0.54)                     | 0.28<br>(1.35)                   |
| Is household head male?                                       | 1.72<br>(0.90)    | 0.21<br>(0.28)                 | -2.40<br>(0.39)                    | -25.20*<br>(1.83)                |
| Dummy=1 if year is 1997                                       | -0.24<br>(0.23)   | 0.05<br>(0.28)                 | -19.64**<br>(5.47)                 | -21.30**<br>(3.13)               |
| Dummy=1 if monsoon season                                     | 0.66<br>(0.78)    | 0.02<br>(0.18)                 |                                    |                                  |
| Dummy=1 if monsoon season<br>in 1997, =0 otherwise            | -4.08**<br>(2.69) | -1.19**<br>(4.52)              |                                    |                                  |
| Constant  | 4.61*<br>(1.83)   | 2.71**<br>(6.22)               | 25.03<br>(2.98)                    | 49.99**<br>(2.69)                |
| Overall R2  | 0.26              | 0.28                           | 0.38                               | 0.28                             |
| No. of observations   | 287               | 287                            | 131                                | 170                              |
| F-test for joint significance of ward<br>categorical variable | 2.63**            | 2.81**                         | 3.86**                             | 3.25**                           |

<sup>1</sup> Monsoon season observations omitted    <sup>2</sup> Late dry season observations omitted  
Absolute t-statistics in parentheses  
\*\*Significant at 5% level \* significant at 10% level

**Table 8: Total Collection Time, Monsoon and Dry Season, 1982/1983 - 1997  
Ward-Level Fixed-Effects**

| Independent Variable  | Total              | Men               | Women               | Children            |
|---|--------------------|-------------------|---------------------|---------------------|
| Minutes/kilogram fuelwood                                     | 3.37**<br>(3.29)   | -0.03<br>(0.09)   | 1.63*<br>(1.80)     | -0.37<br>(0.94)     |
| Minutes/trip water  | 5.44**<br>(9.59)   | 0.61**<br>(2.80)  | 3.48**<br>(6.97)    | 0.62**<br>(2.87)    |
| Percentage literate adults                                    | 1.77**<br>(3.88)   | 0.31*<br>(1.75)   | 0.80**<br>(1.97)    | 0.42**<br>(2.37)    |
| Upland area   | 41.03<br>(1.62)    | -10.45<br>(1.07)  | 107.91**<br>(4.84)  | 6.27<br>(0.64)      |
| Lowland area  | 7.47<br>(0.22)     | -2.12<br>(0.16)   | 16.10<br>(0.55)     | -10.29<br>(0.81)    |
| Dummy=1 if Tibeto-Burman                                      | -23.77<br>(0.50)   | -1.49<br>(0.07)   | -49.28<br>(1.14)    | -8.27<br>(0.44)     |
| Male adults, age 16-59  | 7.49<br>(0.65)     | 15.89**<br>(3.61) | -16.72*<br>(1.66)   | 0.09<br>(0.02)      |
| Female adults, age 16-59                                      | 25.65*<br>(1.63)   | -3.56<br>(0.63)   | 8.68<br>(0.67)      | 1.62**<br>(2.08)    |
| Youths, age 6-15  | 25.65**<br>(2.89)  | 2.04<br>(0.59)    | 5.04<br>(0.64)      | 10.64**<br>(3.11)   |
| Children, age 0-5   | -17.36<br>(1.45)   | -3.92<br>(0.85)   | -11.53<br>(1.09)    | -5.26<br>(1.14)     |
| Number she-buffaloes  | 21.14**<br>(2.40)  | 3.01<br>(0.89)    | 19.09**<br>(2.47)   | 2.32<br>(0.69)      |
| Real non-labor income   | 0.003<br>(1.15)    | 0.001<br>(1.45)   | 0.002<br>(1.11)     | 0.001<br>(1.60)     |
| Age of household head   | 2.77**<br>(2.69)   | 0.05<br>(0.13)    | -0.60<br>(0.66)     | 0.72*<br>(1.82)     |
| Is household head male?                                       | -103.07<br>(1.37)  | 32.97<br>(1.14)   | -112.94*<br>(1.71)  | -33.50<br>(1.16)    |
| Dummy=1 if year is 1997                                       | 10.18<br>(0.26)    | 51.94**<br>(3.43) | -10.96<br>(0.31)    | 18.67<br>(1.24)     |
| Dummy=1 if monsoon season                                     | 204.54**<br>(6.53) | -11.12<br>(0.92)  | -111.57**<br>(4.05) | 124.33**<br>(10.37) |
| Dummy=1 if monsoon season<br>in 1997, =0 otherwise            | -93.28<br>(1.61)   | 43.75**<br>(1.95) | 114.46**<br>(2.23)  | -105.38**<br>(4.72) |
| Constant  | -79.72<br>(0.83)   | -49.90<br>(1.35)  | 195.62**<br>(4.05)  | -43.50<br>(1.14)    |
| Overall R2  | 0.45               | 0.22              | 0.28                | 0.37                |
| No. of observations   | 285                | 281               | 281                 | 281                 |
| F-test for joint significance of<br>ward categorical variable | 7.79**             | 2.42**            | 8.32**              | 2.57**              |

Absolute t-statistics in parentheses.  
\*\*significant at 5% level, \* significant at 10% level

**Table 9: Environmental Product Collection Time, by Gender and Product, 1982-1997**  
**Ward-Level Fixed-Effect Estimates**  
**Selected Results**

| Dependent Variable<br>(minutes/day) | Min/Kg<br>Fuelwood | Min/Trip<br>Water | Min/Kg<br>Leaf Fodder | Min/Kg Cut<br>Grass | Year=97<br>Dummy    | <sup>1</sup> Monsoon<br>Dummy | <sup>1</sup> Monsoon<br>1997<br>Dummy |
|-------------------------------------|--------------------|-------------------|-----------------------|---------------------|---------------------|-------------------------------|---------------------------------------|
| <b>Water</b>                        |                    |                   |                       |                     |                     |                               |                                       |
| <sup>1</sup> Total                  | -0.13<br>(0.30)    | 5.08**<br>(20.57) |                       |                     | 16.76<br>(0.99)     | -23.51*<br>(1.72)             | -5.45<br>(0.21)                       |
| <sup>1</sup> Men                    | -0.04<br>(0.29)    | 0.35**<br>(4.56)  |                       |                     | 8.34<br>(1.55)      | -15.27**<br>(3.54)            | 2.40<br>(0.30)                        |
| <sup>1</sup> Women                  | -0.11<br>(0.26)    | 3.74**<br>(16.22) |                       |                     | -0.34<br>(0.02)     | -33.31**<br>(2.60)            | -14.58<br>(0.63)                      |
| <sup>1</sup> Children               | -0.23<br>(1.05)    | 0.80**<br>(6.55)  |                       |                     | 10.96<br>(1.30)     | 29.31**<br>(4.33)             | -46.41**<br>(3.80)                    |
| <b>Fuelwood</b>                     |                    |                   |                       |                     |                     |                               |                                       |
| <sup>1</sup> Total                  | 5.53**<br>(12.90)  | 0.34<br>(1.44)    |                       |                     | 87.26**<br>(5.39)   | 4.59<br>(0.35)                | -118.38**<br>(5.01)                   |
| <sup>1</sup> Men                    | 0.11<br>(0.56)     | -0.02<br>(0.21)   |                       |                     | 42.09**<br>(5.36)   | -4.73<br>(0.75)               | -17.07<br>(1.50)                      |
| <sup>1</sup> Women                  | 4.95**<br>(13.10)  | 0.33<br>(1.59)    |                       |                     | 34.18**<br>(2.37)   | -12.28<br>(1.06)              | -72.99**<br>(3.49)                    |
| <sup>1</sup> Children               | 0.46**<br>(4.06)   | 0.02<br>(0.34)    |                       |                     | 15.97**<br>(3.68)   | 21.93**<br>(6.31)             | -34.83**<br>(5.54)                    |
| <b>Leaf Fodder</b>                  |                    |                   |                       |                     |                     |                               |                                       |
| <sup>2</sup> Total                  | -0.87<br>(0.99)    | 1.05**<br>(3.15)  | 10.62**<br>(6.38)     |                     | -109.96**<br>(5.50) |                               |                                       |
| <sup>2</sup> Men                    | -0.07<br>(0.27)    | 0.03<br>(0.39)    | 1.99**<br>(3.98)      |                     | -4.94<br>(0.81)     |                               |                                       |
| <sup>2</sup> Women                  | -0.50<br>(0.61)    | 0.95**<br>(3.15)  | 8.59**<br>(5.44)      |                     | -103.66**<br>(5.44) |                               |                                       |
| <sup>2</sup> Children               | -0.28*<br>(0.61)   | 0.01<br>(0.34)    | 0.01<br>(0.34)        |                     | -1.01<br>(0.34)     |                               |                                       |

| <b>Dependent Variable<br/>(minutes/day)</b> | <b>Min/Kg<br/>Fuelwood</b> | <b>Min/Trip<br/>Water</b> | <b>Min/Kg<br/>Leaf Fodder</b> | <b>Min/Kg Cut<br/>Grass</b> | <b>Year=97<br/>Dummy</b> | <b><sup>1</sup>Monsoon<br/>Dummy</b> | <b><sup>1</sup>Monsoon<br/>1997<br/>Dummy</b> |
|---|----------------------------|---------------------------|-------------------------------|-----------------------------|--------------------------|--------------------------------------|---|
|   | (1.91)                     | (0.30)                    | (0.04)                        |                             | (0.29)                   |                                      |   |
| Cut Grass                                   |                            |                           |                               |                             |                          |                                      |   |
| <sup>3</sup> Total                          |                            | -0.07<br>(0.08)           |                               | 8.54**<br>(3.47)            | -94.69**<br>(2.00)       |                                      |   |
| <sup>3</sup> Men                            |                            | 0.21<br>(0.63)            |                               | 1.69*<br>(1.66)             | 72.13**<br>(3.68)        |                                      |   |
| <sup>3</sup> Women                          |                            | -0.06<br>(0.11)           |                               | 6.35**<br>(3.93)            | -133.79**<br>(4.31)      |                                      |   |
| <sup>3</sup> Children                       |                            | -0.19<br>(0.59)           |                               | 0.74<br>(0.78)              | -40.33**<br>(2.39)       |                                      |   |

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1 Late dry season and monsoon season observations

2 Monsoon season observations omitted

3 Late dry season observations omitted

Absolute t-statistics in parentheses

\*\*significant at 5% level, \* significant at 10% level

Full estimation results available on request.

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**Table 10: Tobit Estimates of Determinants of Grade Attainment for Household Heads Resident Children and Grandchildren age 6-17, by Gender**

| Independent Variable                              | NENS Households   |                   | All Households    |                   |
|---|-------------------|-------------------|-------------------|-------------------|
|   | Males             | Females           | Males             | Females           |
| <b>Individual Characteristics</b>                 |                   |                   |                   |                   |
| Age   | 0.79**<br>(13.41) | 0.81**<br>(15.67) | 0.79**<br>(15.97) | 0.79**<br>(19.13) |
| Child of head?                                    | -1.26**<br>(2.05) | -0.73<br>(1.37)   | -1.48**<br>(3.02) | -0.36<br>(0.74)   |
| <b>Household Characteristics</b>                  |                   |                   |                   |                   |
| Current age of head                               | 0.00<br>(0.34)    | 0.01<br>(0.54)    | -0.00<br>(0.38)   | 0.01<br>(1.24)    |
| Is head female?                                   | 2.25**<br>(2.38)  | -1.46**<br>(2.14) | 0.74<br>(1.10)    | -1.50**<br>(2.86) |
| Head's years of education                         | -0.03<br>(0.42)   | 0.03<br>(0.49)    | 0.01<br>(0.24)    | -0.02<br>(0.51)   |
| Head literate?                                    | 1.04**<br>(2.34)  | 0.82*<br>(1.74)   | 1.01**<br>(2.79)  | 0.65*<br>(1.63)   |
| Head resident?                                    | -1.30**<br>(2.18) | 0.24<br>(0.34)    | -0.96**<br>(2.07) | 0.36<br>(0.68)    |
| Head's main occupation is agriculture             | -0.34<br>(0.48)   | -1.38**<br>(2.50) | 0.30<br>(0.64)    | -1.07**<br>(2.56) |
| Occupational caste dummy                          | -0.61<br>(1.13)   | -2.60**<br>(3.81) | -0.42<br>(1.10)   | -1.67**<br>(3.53) |
| Current number of resident children age 0-5       | 0.19<br>(1.00)    | -0.01<br>(0.05)   | 0.08<br>(0.56)    | 0.09<br>(0.64)    |
| Current number of resident male youths age 6-15   | -0.11<br>(0.51)   | -0.24<br>(1.25)   | 0.02<br>(0.16)    | -0.36**<br>(2.30) |
| Current number of resident female youths age 6-15 | 0.44*<br>(1.67)   | -0.10<br>(0.47)   | 0.41**<br>(2.13)  | 0.07<br>(0.41)    |
| Environmental ranking (0-4)                       | 0.01<br>(0.10)    | -0.32**<br>(2.04) |                   |                   |
| <b>Community Characteristics</b>                  |                   |                   |                   |                   |
| High school in ward of residence?                 | -0.73<br>(1.32)   | 1.15**<br>(2.24)  | -0.21<br>(0.50)   | 1.32**<br>(3.45)  |
| Minutes to a road from the ward of residence      | -0.01*<br>(1.77)  | -0.00<br>(0.47)   | -0.01**<br>(2.25) | -0.01**<br>(2.07) |
| Number of community forest areas in the ward      | 0.30<br>(1.00)    | -0.05<br>(0.18)   | 0.27<br>(1.16)    | 0.29<br>(1.23)    |
| <b>Constant</b>                                   | -3.84**<br>(2.27) | -3.72**<br>(1.94) | -3.91**<br>(2.83) | -5.18**<br>(3.78) |
| Log likelihood                                    | -159.52           | -110.50           | -213.35           | -169.69           |
| Number of observations                            | 92                | 72                | 124               | 107               |
| Absolute t-statistics in parentheses              |                   |                   |                   |                   |
| ** significant at 5% level                        |                   |                   |                   |                   |
| * significant at 10% level                        |                   |                   |                   |                   |

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