Does non-farm job growth encourage or retard soil conservation in Philippine uplands?

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1. Introduction.................................................................................................................................1

2. Economic growth and labor market trends since the 1970s........................................................4
   Economic growth and employment trends...............................................................................4
   Migration and agricultural expansion in upland and forest lands.............................................5
   The labor market in Bukidnon province and Lantapan municipality.......................................7

3. Determinants of labor allocation and soil conservation: a theoretical model.........................8

4. Non-farm employment and agricultural techniques..............................................................13
   Crop choices and soil conservation decisions........................................................................13
   Non-farm opportunities and soil conservation practices in Lantapan.....................................14
   Do labor market trends influence adoption of soil conservation measures?.........................14
   Econometric results and discussion........................................................................................17

5. Policies for sustainable resource management in upland agriculture....................................19

References......................................................................................................................................21

Tables and Figures..........................................................................................................................24
1. Introduction

Intensive agriculture in the uplands of tropical countries is observed to cause environmental damage. In the long run, this might jeopardize the resource base and ultimately the capacity of upland households to maintain self-sufficiency in food supplies. There are, in general, two ways to influence farmers' use of natural resources: direct interventions aimed at altering behavior, and indirect interventions (such as through prices) aimed at altering factors that influence farm decisions. In the Philippines, the most common mitigating measure for seemingly unsustainable upland agricultural practices is the direct approach, especially the introduction of soil-conserving methods through extension and farmer education. For example, Sloping Agricultural Land Technology (SALT), a package of soil management measures for sloping lands, was introduced by the Philippine Department of Agriculture (DA) in the early 1980s to combat soil erosion and land degradation in uplands and has been widely promoted in upland development projects. However, while there is some adoption of conservation measures such as hedgerows in high-intensity extension projects, there is little evidence of more widespread farmer interest in SALT, or of spontaneous adoption (Garrity et al., 1993). Though no systematic evaluation is available, the general impression is one of low and slow adoption rates primarily because farmers do not perceive such very labor-intensive technologies to be economically profitable (Regmi, 1997). Tenure insecurity is also cited as a constraining factor, as with any investment in fixed capital.

On the other hand, the use of indirect policy tools for soil conservation in the uplands is not widespread. This is arguably due to the perception among policy makers and their advisors that upland farmers are characteristically subsistence-oriented, existing somehow beyond the reach of market-based policies. However, the evidence shows that many upland farmers are commercially oriented, and respond to output price incentives (Coxhead, Shively and Shuai 2002; Coxhead, Rola and Kim, 2001). When output price changes, so too does the mix of crops produced, and labor demand alters as a consequence. Moreover, in adoption decisions on land-clearing or soil-conserving actions, where long-term land productivity and sustainable resource
management are issues of concern, the repercussions of a land use change due to external shocks such as market price or policy changes will also affect technology decisions and agricultural labor demand. One type of shock that could have a significant impact on labor allocation decisions in upland agriculture is the emergence of rural non-farm employment opportunities.

There is a need to explain the link between non-farm economic conditions and farmers’ choice of crops and techniques. In general, the availability of farm household labor is an important determinant of production and land management decisions, including those affecting soil conservation. The capacity of a farm household to establish and maintain a hedgerow system, for example, depends in part on the availability of labor and management skills for the purpose. However, the number of household members available on-farm, and the amount of time they are willing to devote to farm labor and management, could be influenced by conditions in the non-farm labor market. In general, greater earning opportunities in non-farm employment cause the supply of family labor on-farm to diminish.

There have been few attempts to examine agricultural household labor supply in the context of the wider rural labor market (Sanchez, 1991). One early work was of Lee, Jr. (1965, as cited in Sanchez, 1991), who provided a theoretical framework to explain the motivation behind decisions on the allocation of farm resources, particularly labor. The allocation decision between farm and non-farm activities is shown to be consistent with the objective of a household's welfare maximization and efficiency in the use of farm and household resources. His model suggests that the availability of non-farm employment opportunities, coupled with the awareness of farmers of such opportunities, reduces labor input on family farms.

Experience suggests that some transfer of family labor to non-farm jobs might reduce the level of disguised unemployment and thus promote more efficient use of resources in agriculture, without significantly altering the level of farm output. This would be the case if some labor were initially underemployed on the farm. In the more usual case, however, the withdrawal of some family labor from the farm requires an adjustment in crops or technologies to reduce labor input.
In this paper we hypothesize that non-farm opportunities will reduce family labor input in farm operations, even in a relatively remote upland area. This will occur because rising wages or earnings opportunities make farm work less remunerative relative to non-farm. Households will respond by cultivating less land, mechanizing some tasks, or shifting to crops or techniques that are less management and labor-intensive. In wealthy countries, rising non-farm wages have historically been associated with mechanization and the adoption of less labor-intensive cropping patterns (Hayami and Ruttan 1985; Binswanger et al. 1978). In the uplands of a developing country like the Philippines, rising wages may under some circumstances signal a shift from relatively labor-intensive annual crops to perennial crops or to less intensive farming systems, including agroforestry. Depending on its exact nature, such a shift might be characterized as a move toward a more environment-friendly agricultural development.²

We use the case of the upland community of the SANREM³ project site in Lantapan, Bukidnon, to analyze farmer behaviour in terms of crop choices and soil conservation technologies in the presence of an emerging rural non-farm labor market.⁴ The main question that we seek to address is whether changes in non-farm employment opportunities have measurable environmental effects either directly, through adoption of soil conservation practices, or indirectly, through changes in land use or technology.

In the next section we discuss economic development and employment trends in the Philippines, and in the Bukidnon and Lantapan labor markets in particular. In section 3 we analyze the links between non-farm employment and changes in agricultural techniques and activities, including practices with direct environmental implications. In section 4 we present some empirical analysis of the determinants of adoption of soil-conserving practices. Section 5 surveys policy scenarios for sustainable resource management. Section 6 contains a brief conclusion.

Our study makes use of both primary and secondary data. Secondary data are taken from published reports and municipal (Lantapan) and provincial (Bukidnon) statistics. Farm and household level data are from farm surveys conducted in the study site during the dry seasons

2. Economic growth and labor market trends since the 1970s

Economic growth and employment trends

A review of Philippine economic performance over recent decades reveals that as the economy has grown, it has experienced structural changes of the kind predicted by development theory, although at a rather slow and fitful pace. The industrial sector share of GDP has remained roughly steady at around 35%, while the services sector increased from 38% in 1970 to over 45% by 1999. The share of agriculture in GDP has declined somewhat, from 28% in 1970 to 20% in 1999 (Figure 1). Low growth rates in industry have deep historical roots in Philippine macroeconomic conditions and trade policy regimes (Bautista, Power and associates 1979; Hill and Balisacan 2002). A period of relatively rapid growth and structural change in the mid-1990s was attributable to economic and labor policy reforms, strong merchandise export growth, and a double-digit growth rate of net factor income from abroad, mainly in the form of foreign exchange remittances by overseas workers. That period was marked by a big improvement in productivity and output in industrial sectors, led by electronics, garments and other manufactured exports, which ballooned from barely 1% of exports in 1970 to more than 70% by the late 1990s. In stark contrast, agricultural exports fell from more than 90% of the total in 1970 to 28% in 1985, and 15% by 1995 (ILS, 1997).

(Figure 1 about here)

Matching the relatively slow pace of long-run industrial growth, most change in the structure of employment has come from growth in the service sector. Agriculture’s share in total employment has declined in step with the sector’s GDP share (Figure 1). With relatively rapidly
growing population and slow overall growth, real wages in the Philippines have stagnated since 1980, present a rather depressing picture (Figure 2). Steeper increases in the agricultural wage after 1994—and a compression of the sectoral wage ratio—correspond to the decline in the agricultural sector share in total employment. This could reflect the effects of the structural change toward growth in more labor-intensive manufacturing sectors.

(Figure 2 about here)

Migration and agricultural expansion in upland and forest lands
Migration to upland and frontier areas has been a prominent feature of modern economic development in the Philippines. In the early postwar years, government programs sponsored migrants to convert forest lands for agriculture. Subsequent migration, though spontaneous rather than sponsored, has retained the same motivation, i.e. the search for resources which, when combined with labor, can generate household income. The total population living in "forest lands" (officially defined as land of slope greater than 18%, whether forested or not) continued to grow rapidly through the second half of the twentieth century, trebling from 6 million in 1950 to nearly 18 million by 1985 (M. Cruz et al. 1992). The growth rate of the upland population has consistently exceeded that of the population as a whole. Accordingly, a very large fraction of Filipinos now resident in "forest lands" (i.e. engaged in upland agriculture) are at most second-generation descendants of in-migrants.

The motives for migration are not hard to intuit, and have been quantified in an excellent empirical study by Cruz and Francisco (1993). These authors used linear regression techniques on municipality-level migration data together with economic, geographic and demographic data from censuses and other official sources to identify factors associated with migration into forest lands. Their results reveal per capita income and literacy in lowlands, and population density in uplands, are factors associated with low upland migration rates. Slope, upland urbanization, and the open access nature of uplands were all associated with higher migration rates. Upland incomes were not significantly associated with migration. As Cruz and Francisco concluded, the.
results suggest that "migrants are motivated more by lack of other livelihood options than by the attractiveness of destination lands" (p.26); increases in lowland incomes, and better definition and enforcement of property rights over forest lands could both constitute major deterrents to migration.

Of course, the migration decision is undoubtedly driven in part by changes in expected income in uplands relative to that in the location of origin, and this feature of the economic calculus of migrants may not have been well captured in the census data on average household income used by Cruz and Francisco. In particular, changes in the relative profitability of lowland and upland agricultural production are likely to have influenced intra-rural migration decisions. The peak years of the Green Revolution, which enabled lowland irrigated rice farms to increase factor productivity by very large margins during the 1970s, were accompanied by down-slope migration from neighboring upland areas (Kikuchi and Hayami 2001). In subsequent decades, however, the rate of technical progress has slowed, and the thrust of Philippine agricultural policy has generally delivered relatively large profitability gains to crops grown in uplands rather than in irrigated lowlands. The implicit and effective protection rates on corn, the largest upland crop by area sown, increased dramatically from the 1970s to the end of the century, with the nominal protection coefficient (the ratio of domestic wholesale to world market prices) rising from near zero to 100% and more (David 2002). Similarly high protective rates prevailed throughout the period for other upland crops such as temperate climate vegetables (Coxhead 1997). The rise in price of these upland crops relative to rice, in a context of generally static real wages and slow growth in non-agricultural incomes, must also have been a factor in encouraging migration to uplands. We may therefore expect to observe that late twentieth century migration rates to areas in the Philippines that combined both open access to land and agronomic conditions suitable for corn and vegetable cultivation were very high. This was indeed the case in the upland areas of Bukidnon province.
The labor market in Bukidnon province and Lantapan municipality

Labor force growth in Bukidnon province is strongly influenced by in-migration. In the 1995 Philippine Census projections of inter-regional and inter-provincial migration patterns, Bukidnon was projected to have positive net migration rates (NMR), for both males and females (Table 1).\(^5\)

(Table 1 about here)

Why has Bukidnon been such an attractive area for migrants? Surveys and local histories show that migrants came from other parts of the country to cultivate temperate crops in the cool highlands, attracted by the opportunity to colonize land and convert it to intensive agricultural production. In recent years, the high migration rate also reflects strong job growth in the province, compared with other provinces in Northern Mindanao (Table 2). Non-farm employment opportunities have increased rapidly in the urban areas of Bukidnon’s major towns, Malaybalay and Valencia, and province-wide data show nominal and real non-agricultural wages to be slightly higher than plantation wages, but significantly higher than the non-plantation (i.e. farm) wages since the mid-1990s. However, Bukidnon has also the highest visible underemployment rate, i.e. those employed are not necessarily fully employed. This may reflect in-migration by workers hoping to find full-time work, and willing to endure a period of unemployment or underemployment in the course of their search—a provincial version of the well-known Harris-Todaro migration model (Harris and Todaro 1970).

(Table 2 about here)

Rapid growth of the provincial economy also affects the labor supply decisions of long-term Bukidnon residents. For many farm families in the province, distances and travel times to urban areas are now small enough to allow for daily (or at least weekly) commuting. Because of the proximity to alternative employment opportunities, rural household members can decide whether to seek farm, off-farm or non-farm jobs. Naturally, non-agricultural labor demand favors workers with more education or experience, so the degree of intersectoral labor mobility is likely to be influenced by factors on both the demand and supply sides of the market as well as the transactions costs of moving between markets.
Compared with other Philippine upland communities, Lantapan farmers practice highly commercialized agriculture, thus providing for year-round agricultural employment. A number of farm activities have remuneration on a daily wage rate basis.\textsuperscript{6}

Are there other opportunities for employment in Lantapan aside from agriculture? From a 1996 survey of 120 households, 66\% of all labor is mainly on own-farm, 7\% mainly in off-farm, and 27\% mainly in non-farm activities. Eighty-six percent of the non-farm workers are females.\textsuperscript{7} The results of a 1998 survey of the same set of households also suggest higher wage rates per day for non-farm incomes obtained by households than farm incomes (Table 3). In 1998, two banana plantations were established in the town. With these in operation, off-farm employment became more widespread. Banana plantation wages are higher than farm and even non-farm wages. (Table 3 about here)

Several factors influence entry to non-farm work, including education and the willingness to pay for transport and transactions costs, and sometimes, the cost of migration. Our data show that most farm workers reside in their own place of work, while some non-farm workers reside outside Lantapan, and that the proportion of latter has increased somewhat since the mid-1990s (Rola and Coxhead 2001).

3 Determinants of labor allocation and soil conservation: a theoretical model

Clarke (1992) presents a model of dynamic optimization by farmers in which investments in soil conservation are chosen so as to produce an optimal amount of soil “quality”, used as an input to production. With some amendments, this model yields a structure which, while highly stylized, captures the main features of the labor allocation problem. We extend the Clarke model to include the possibility of non-farm employment by farm household members, with the expected non-farm wage assumed to depend on the labor market characteristics of the worker. Soil conservation also uses family labor, so the household labor endowment must be allocated between crop production, soil-conserving investments, and non-farm employment. Optimizing farmers also make land use choices, increasing or reducing the area planted in response to soil
productivity and economic incentives. The model characterizes soil-conserving investment decisions in terms of input and output prices, expected wages, implicit land rental values, and the parameters governing rates of soil quality depletion and recovery.

Farmers allocate land and other resources to produce crops using as inputs soil quality \( Q \), land \( N \), family labor \( L^C \), and other inputs (including hired labor) with production technology \( F(Q, N, L^C, X) \). We assume that labor inputs to current crop production are complementary with soil-conserving investments, so that an increase in the quantity of one raises the marginal productivity of the other. Soil quality depends on the intensity of land use and on the effects of soil-conserving investments. Soil-conserving investments use family labor as the sole input; the marginal product of labor is assumed constant, so we have \( I(t) = L^I \).

Using a dot over a variable to denote the time derivative \( dQ/dt \), the dynamics of soil quality are given by the state equation:

\[
\dot{Q}(t) = \alpha I^I(t) - \eta Q(t) - \gamma F(Q(t), N(t), L^C(t), X(t))
\]

\( Q(0) = Q_0 \)

where \( \gamma \) denotes soil quality-depleting characteristics of crop production. The parameter \( \eta \) governs the rate of natural increase or decline in soil quality in the absence of human intervention.

The farmer chooses the time paths for current inputs of land, and the allocation of labor to current production, investments and off-farm employment so as to maximize the discounted value of returns to the combined farm and non-farm enterprise. Define \( \delta \) to be the rate of time discount, \( q \) the unit price of purchased current inputs, \( r \) the non-farm wage, and \( s \) the rental value of land. Potential labor market participants face an expected wage \( \rho r \), where \( \rho \) reflects the match of a labor market participant’s skills and ability with that demanded in the market. This parameter is bounded by zero and one, with values close to 1 indicating a good match and values
close to zero a poor one. Using vector notation, and dropping time indexes, the farmer’s problem is:

$$\max_{N, L^c, L^l, X} \int_0^\infty e^{-\delta t} \left\{ pF(Q, N, L^c, X) + \rho rL^N - qX - sN \right\} dt$$ (2)

subject to the family labor constraint \( L = L^C + L^l + L^N \). Problem (2) is an optimal control problem, solvable with the current-value Hamiltonian:

$$H = pF(Q, N, L^c, X) + \rho r(L - L^C + L^l) - qX - sN + w\left[\alpha L^l - \eta Q - \gamma F(Q, N, L, X)\right]$$ (3)

where \( w \) is the co-state variable, or shadow price of soil quality.

Assuming that an interior solution exists, the first-order necessary conditions for a solution are given by the equations:

$$\frac{\partial H}{\partial L^C} = 0 \quad \Rightarrow \quad F_c(p - w\gamma) - \rho r = 0$$ (4)
$$\frac{\partial H}{\partial L^l} = 0 \quad \Rightarrow \quad \rho r - w\alpha = 0$$ (5)
$$\frac{\partial H}{\partial N} = 0 \quad \Rightarrow \quad F_q(p - w\gamma) - s = 0$$ (6)
$$\frac{\partial H}{\partial X_i} = 0 \quad \Rightarrow \quad F_i(p - w\gamma) - q = 0 \quad \forall i = 1, ..., n$$ (7)
$$\dot{w} = \delta w - \frac{\partial H}{\partial Q} \quad \Rightarrow \quad \dot{w} = w(\delta + \eta + \gamma F_Q) - pF_Q$$ (9)

In the steady state \( \dot{w} = 0 \), and (9) can be rewritten as \( w(\delta + \eta) = (p - w\gamma)F_Q \). The term \( p - w\gamma \) that appears in these conditions represents the net value of each factor’s marginal contribution once effects on land productivity are taken into account, and is positive as long as \( \delta + \eta > 0 \).

Since in the steady state we can define \( w = \rho r/\alpha \) from (5), define:
\[ E = (p - \gamma pr / \alpha) \]

from which it can be seen that value marginal product exceeds the conventional \( F_i = w_i / p \) when \( \gamma \) is large, \( \rho \) is large, \( r \) is large, and/or \( \alpha \) is small. Assuming that the second-order conditions for a maximum are met, these first-order conditions describe the optimal allocation of labor to current crop production, soil-conserving investments and non-farm work as well as the optimal quantity of land farmed (or conversely, fallowed) and the quantities of other inputs used as functions of output prices, input prices, wages and labor market characteristics, the family labor endowment, the various soil quality parameters and the discount rate. Thus in the steady state, \( L_j = L_j(p, q, r, s, L, \alpha, \beta, \gamma, \delta, \eta, \rho) \), and similarly for \( N \) and each \( X_i \).

Deriving and signing comparative static results from these relations requires a great many assumptions on the nature of the substitution or complementarity relationships among variables, and we do not attempt this. Rather, our goal has been to identify the explanatory variables that will appear in any theoretically consistent empirical estimation of the allocation of labor and land resources to production, conservation, fallow (for land) or non-farm employment (for labor). Nevertheless it can be seen from (4) - (8) that higher non-farm wages, more productive soil-conserving technologies, or less soil quality-depleting crop production technologies all raise the value marginal product of land and of labor used in cropping or conservation. Moreover, a close fit between the characteristics of the family labor endowment and those demanded in the non-farm labor market (i.e., a value of \( \rho \) close to 1) raises the opportunity cost of labor used on-farm, whether for cropping or conservation. From this we can state intuitively that increases in the demand for labor in non-farm sectors will result in substantial reductions in farm labor use for crops as well as conservation, and a decline in total area planted among farm households where \( \rho \to 1 \), and conversely little or no change in land or labor use in households where \( \rho \to 0 \). In the former case, a great deal will depend on the extent to which other inputs (including hired labor)
can be used as substitutes for family labor, and on the extent to which land can easily be brought into or out of production.

The reality of the land and labor allocation problem is, of course, much more complex than described by the model. In particular, the choice of crops is an integral part of the labor allocation decision; if hired and family labor are poor substitutes, as is arguably the case in vegetable production and in soil-conserving investments, both of which require management skills in addition to ‘raw’ labor input, then rising non-farm employment may see households switching to less management-intensive crops such as corn and trees as part of their overall response. Embedded in this is a decision among types of soil-conserving investments; some (such as contour plowing and hedgerows) are labor-intensive, while others (such as falling or planting perennials) are relatively labor-saving. Clarke (1992) offers an extension to his basic model to include falling; another augmentation would be to allow for different crops, in effect writing $F(\bullet)$ as a vector and permitting land to be reallocated among crops. Yet another extension would be to recognize the role of fixed costs for some soil conserving technologies, so that $I(L^I) = L_0 + \beta L^I$. We leave these as subjects for future research.

Finally, it should be noted that the model sketched above lends itself to a variety of policy analyses. Changes in crop production technology, and in the efficacy of soil conservation techniques (for example, through extension or on-farm research), can be captured through alterations in the values of $\gamma$ and $\alpha$ respectively. Taxation schemes that discriminate among land uses or technologies can be introduced via market-based measures (affecting $p$, $q$, or $s$) or command-and-control measures such as land use regulations. More broadly, interventions that alter the demand for non-farm labor, or the quality of the household labor resource in relation to non-farm demand through education and training, can also be assessed for their effects on the uses of land and for soil-conserving investments.
4. Non-farm employment and agricultural techniques

*Crop choices and soil conservation decisions*

For given non-farm conditions, the level of farm employment in Lantapan is largely influenced by technology and crop choices. Farm labor intensity differs by crop. Hired (or paid) labor is high when external input use is high (Rola and Tagarino, 1996); it is thus lowest in coffee and highest in vegetable systems. A shift from corn to vegetable cultivation, for example, would involve increased demand for both and management, as would the shift from perennials to annuals (e.g. coffee to corn) (Rola, 1995; Coxhead et al. 2002). Less labor available for farm work should then shift crop choices to perennial (and potentially more environment-friendly) crops such as coffee or even agroforestry.

However, less labor on the farm may also discourage labor-using soil conservation technologies, the promotion of which has been a focus of efforts to encourage environmentally sustainable upland agricultural practices. Our data do not show a clear pattern, with adoption rates of both labor-intensive and labor-saving technologies varying substantially from year to year and season to season (Table 4). The percentage of sample plots with labor-intensive conservation methods such as contour plowing and hedgerows declined from 16% in 1996 to barely 10% in 1999, but increased to 34% in dry season of 2000. On the other hand, the proportion of plots with trees and fallow, or labor-saving conservation measures, increased from 25% in 1996 to 34% in 1999, but declined to 29% in 2000 for the dry season. During the wet season the proportion of plots with labor-saving soil conservation techniques is normally higher; this is because corn plots are often fallowed when corn prices are low. Increased off farm employment opportunities reinforce all these motivations for fallowing, by raising the opportunity cost of farm labor and relaxing the need to grow corn year-round for subsistence.

As the model in the previous section suggests, there are several additional factors which appear to require consideration, including farm prices and the influence of public policies or project interventions. An increase in the number of plots using soil-conserving measures of both types in 2000 may be due to a soil conservation ordinance passed by the municipality early in
that year. There is also substantial variation related to crop choices, with vegetable farms typically exhibiting lower in-field soil conservation measures (Rola and Coxhead 2001). Finally, weather conditions may also play a role.

(Table 4 about here)

**Non-farm opportunities and soil conservation practices in Lantapan**

Our data show that farm household members in Lantapan are increasingly participating in non-farm work, and that more of the households in vegetable areas engage in both off farm and non-farm work (Table 5). Participation in off-farm jobs fluctuates from year to year as well as according to crop choice. The El Niño drought of 1998 saw a big increase in non-farm employment shares as upland crops failed. This shift was more prominent in corn areas. Movements to off farm work in 1999 and 2000, was a consequence of the establishment of two large banana plantations in the study area. But later trends suggest that these jobs are not stable sources of income as most require skilled work.

(Table 5 about here)

Our data further suggest that households with more members working on farm practice soil conservation measures more. Households reporting contour plowing and hedgerows—the relatively labor-intensive measures—have a lower proportion of family members with non-farm incomes as compared to those reporting less labor-intensive measures such as trees and fallow. The growth of off-farm incomes among families practising contour plowing and hedgerows is also evident.

**Do labor market trends influence adoption of soil conservation measures?**

The foregoing discussion suggests that labor market changes could influence farmers' choice of crop and possibly technique. If so, what effect does non-farm job growth have on farm-level decisions that affect soil erosion and related environmental phenomena? Even the relatively simple model presented in section 3 indicated that the answer may depend on a wide variety of
factors, many of which are unobservable. Nevertheless, this exploratory analysis may at least uncover some economic and other correlates of the adoption decision.

We explore these questions by means of an empirical exercise with data from our surveys of Lantapan farmers. We first estimate a supply function for non-farm labor from the sample farms, then examine ways in which non-farm employment and wages affect on-farm decisions.

The labor supply function depends, in theory, on the opportunity cost of household labor as measured by its earning power in the most productive alternative activity. This cannot be observed directly; we have information on the non-farm earnings only of that subset of the farm labor force which is employed off-farm. Moreover there is a great deal of unexplained variation in reported non-farm wages, with some reported rates substantially (and implausibly) lower than farm wages. For this reason, we compute an expected wage for each observation according to the following formula:

\[ \text{expwage} = \max(\text{reported nonfarm wage}, \text{average farm wage}). \]

This definition is based on the assumption that those who are not working in non-farm jobs can earn at least as much as the farm wage by working on other farms, and those apparently reporting nonfarm wages less than farm wages would not in reality be earning such low sums.

Define the quantity of non farm labor supplied by \( E \), the expected wage by \( W \), and a vector \( Z \), where \( Z \) contains variables representing land tenure, the age of the household head (and its squared value), the education of the household head, and binary dummy variables for season (dry season = 1, wet season = 0) and year (1998 = 0, other years = 1). The labor supply equation is expressed as follows:

\[ \ln(E) = f(\ln(W), Z) \] (10)
Theory indicates that $\partial \ln(E)/\partial \ln(W) > 0$; this is the elasticity of labor supply with respect to the non-farm wage. The age variable is hypothesized to have a non-linear relationship with NFE, as most jobs in the rural areas would require skills and a certain age level. Older members of the family are not as employable as the younger members, especially in plantation work. Education is expected to have a positive influence on non-farm labor supply, with a more highly educated person having greater likelihood of obtaining non-farm work. The season dummy captures seasonal aspects of the labor market. The year dummy is intended to capture the labor market impact of abnormal times during the 1998 phenomenon of an El Niño drought and the Asian crisis, when it was observed that more rural household members went to in search of non-farm work; with many staying on after the crisis and drought were over (Table 5).

In the second part of the analysis we estimate the probability that a farmer will adopt soil conservation measures on a given plot (parcel). Define a binary variable C, taking a value of 1 if the parcel has a soil conservation measure, and 0 otherwise. The adoption decision is modelled in two alternate ways:

\[ C = f(W, P, Z') \]  
(11)

and

\[ C = f(E, P, Z') \]  
(12)

where $Z' = Z$ as previously defined, plus a variable representing the slope of the parcel.\(^{12}\)

The theory in section 3 indicates that land use and conservation decisions are functions of non-agricultural wages, among other variables, as in equation (11). When non-farm wages are high, there is a tendency to get out of the farm and the scarcity of the farm workers will now diminish the propensity to adopt soil conservation measures. Our use of (12) is intended to compensate for imperfect observation of non-farm wage data; the quantity of non-farm employment, $E$, may serve as a proxy for $W$. 

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\(^{12}\)
For each parcel, higher slope and more secure tenure are both expected to have a positive association with the adoption of conservation practices (Rola and Coxhead 2001). In addition, expected output price was defined as a variable in the model. If one expects higher output price in the future, then there is an incentive to adopt soil conservation measures where these promise higher yields. The demographic variables in \( Z' \) are intended to capture what we have referred to as the ‘match’ between the characteristics of family labor and those demanded by the off-farm and non-farm labor markets, particularly age and education. We hypothesize that earnings potential rises with each of these; however, as age captures both experience and capacity, we expect also that earnings potential increases with age at a declining rate. Therefore, we include a term for the square of age as well. On the farm, it is often observed that older persons know more about soil conservation and that their indigenous knowledge leads to more sustainable practices. It could also be that younger farmers have more non-farm opportunities through higher educational attainment, and thus tend less readily to adopt labor-using practices. Our data indicate that farmers adopting no conservation practices at all have an average age of about 30, while those adopting average about 35 years.

With the data available to us, the main testable hypothesis is that greater non-farm employment opportunities will be associated with lower adoption rates of soil conservation measures. Estimation of (10) – (12), augmented by the appropriate stochastic error structures, uses the SHAZAM package (White 1993).

**Econometric results and discussion**

Table 6 shows the results of the econometric estimation for the labor supply function (10), and the conservation adoption relationships (11)-(12). In the former, the log of the wage is a statistically significant predictor of NFE, with an elasticity of about 0.2. While this elasticity value seems low, it may not be entirely implausible if there is a lot of management content in family labor on own farms. Education does not have a significant relationship with NFE; its effects maybe captured by the age variable, as younger workers are in general better-educated.
The regression also shows that the labor supply-age relationship is non-linear. The negative value of the season dummy coefficient supports the contention that household members engage more in nonfarm employment during the wet season than the dry. The year dummy also reflects a more elastic supply of non-farm labor in 1998, the El Nino year.

(Table 6 about here)
The dependent variable in equations (11) and (12) is binary, so the appropriate estimation method is logit (Greene 1993). The results are generally as expected. The results for tenure, slope, age, age squared and education are all unchanged in the two models. Slope and tenure are as expected; higher values (indicating greater slope and more secure tenure) increase the likelihood of soil conservation. The expected crop price is not a significant determinant of the soil conservation decision. The probability of conservation adoption increases with age, but at a diminishing rate (the age^2 coefficient estimate is negative). The coefficient of education is negative, despite the lack of a direct relationship between education and NFE in (10); some aspect of the non-farm labor market is being picked up indirectly in (11) and (12). This is an appropriate subject for further research.

The coefficient of the labor market variable (whether quantity, E, or wage, W) is always negative, although the wage relationship is not statistically significant (Model 2). While non-farm employment opportunities clearly influence labor allocation between farm and non-farm (the finding from the supply function estimates), the link from that to the adoption or non-adoption of soil conservation practices is not so clear, possibly because responses are heterogeneous, with some farm households switching crops or hiring in labor or using some other strategy to compensate for the reduction in family labor. Nevertheless, the negative sign on expected NF wages indicates a tentative policy conclusion, that so long as land is not to be taken out of production altogether, the growth of non-farm employment opportunities should perhaps be matched by incentives for farmers to adopt soil-conserving strategies to reduce family labor on-farm, rather than alternatives which might worsen erosion. For example, subsidies or tax breaks for farmers reallocating their labor to non-farm employment and wishing to convert their farms to
agroforestry or other perennial crops might be justified on the grounds that by doing so, the offsite effects of soil erosion are diminished.

5. Policies for sustainable resource management in upland agriculture

In spite of slowing rates of population growth in uplands, agricultural growth will continue in the short term and will remain associated with intensive cultivation of profitable annuals such as corn and vegetables. This is because prevailing economic and technology policies that create substantial incentives to plant these crops are unlikely to change dramatically in the near term (Coxhead 2000; Coxhead Rola and Kim 2001). In Lantapan, two recent developments are currently affecting farmers’ land use and soil conservation decisions. One is the recently-adopted municipal ordinance stipulating that if farmers practice soil conservation measures, they will be favored as participants in government programs, specifically those of the Department of Agriculture. The second is the increasing availability of non-farm jobs, especially for younger workers, in new agribusiness ventures such as banana plantations and commercial-scale livestock feedlots, recently initiated in the municipality. Initial impacts of these local policies, as shown by our data, are that more of the farmers remaining in farm production are actively investing in soil conservation, while for those in off farm work, conservation takes the form mainly of fallowing.

Wives who may have remained working in the vegetable plots do not do the terracing or contours and just plant a small patch of the plot with cabbage or other vegetables.

In the long term, continued growth and structural change in the Philippine economy can be expected to further raise the opportunity cost of farm labor. Employment and wage policies, and other measures (such as trade and investment policies) that affect labor markets indirectly, can all thus serve as instruments affecting upland resource management. In this setting, non-farm employment growth can be expected to reduce incentives to expand cultivated area in uplands, in spite of technical progress in crops. However, the labor-using soil conservation technologies promoted with rather limited success by some development projects and the Philippine government in the past are likely to become even less attractive to farmers. How then can one
reconcile the aim of achieving higher incomes in commercial upland agriculture with that of sustaining the productivity of the resource base?

In the long run, upland agriculture should veer away from intensive cultivation without soil conservation techniques. But in the shorter run, policies are needed to influence farmer behaviour. Growth in non-farm jobs could cause labor to be withdrawn from intensive agriculture without sacrificing household incomes. A desirable scenario is one in which there is growth of small and medium scale enterprises, together with higher non-farm wages, and accompanied by better remuneration for on-farm employment as the level of employed farm labor declines. This is expected to attract shifts to more labor saving crops; i.e. perennials and labor saving soil conserving technologies. In the Lantapan site, an interesting follow up is a study of the effect of current and emerging changes in local and national government environmental policies on income sources, crop choice, household welfare and the quality of the environment.
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### Tables and Figures

Table 1: Net migration rates by gender, selected provinces, 1975–1990.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bukidnon</td>
<td>0.015</td>
<td>0.017</td>
<td>0.020</td>
<td>0.011</td>
<td>0.008</td>
<td>0.005</td>
</tr>
<tr>
<td>Misamis Occidental</td>
<td>-0.023</td>
<td>-0.015</td>
<td>-0.010</td>
<td>-0.032</td>
<td>-0.018</td>
<td>-0.010</td>
</tr>
<tr>
<td>Mountain Province</td>
<td>-0.056</td>
<td>-0.028</td>
<td>-0.014</td>
<td>-0.064</td>
<td>-0.034</td>
<td>-0.017</td>
</tr>
<tr>
<td>Cavite</td>
<td>0.061</td>
<td>0.057</td>
<td>0.118</td>
<td>0.059</td>
<td>0.059</td>
<td>0.075</td>
</tr>
<tr>
<td>Laguna</td>
<td>0.022</td>
<td>0.042</td>
<td>0.121</td>
<td>0.025</td>
<td>0.046</td>
<td>0.123</td>
</tr>
<tr>
<td>Nueva Ecija</td>
<td>-0.019</td>
<td>-0.011</td>
<td>-0.005</td>
<td>-0.019</td>
<td>-0.015</td>
<td>-0.003</td>
</tr>
</tbody>
</table>


1Projection by NSO
<table>
<thead>
<tr>
<th>Province</th>
<th>Total 15 years old and over (000)</th>
<th>Labor force participation rate&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Employment rate&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Visible under-employment rate&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region X</td>
<td>2,602</td>
<td>1,709</td>
<td>69.8</td>
<td>73</td>
</tr>
<tr>
<td>Bukidnon</td>
<td>588</td>
<td>623</td>
<td>78.7</td>
<td>88</td>
</tr>
<tr>
<td>Camiguin</td>
<td>42</td>
<td>43</td>
<td>50.0</td>
<td>57.6</td>
</tr>
<tr>
<td>Misamis Occidental</td>
<td>323</td>
<td>340</td>
<td>64.1</td>
<td>64.2</td>
</tr>
<tr>
<td>Misamis Oriental</td>
<td>701</td>
<td>743</td>
<td>65.3</td>
<td>65.4</td>
</tr>
<tr>
<td>Cagayan de Oro</td>
<td>274</td>
<td>295</td>
<td>60.2</td>
<td>63</td>
</tr>
</tbody>
</table>


<sup>1</sup>LFPR - Percent of people in the labor force population over 15 years old. People in the labor force are those people who are working plus people who are looking for work during the reference period.

<sup>2</sup>Number of people employed / number of people in the labor force.

<sup>3</sup>Visible under-employment rate - working for less than 8 hours a day.
Table 3: Average daily wages by occupation and location (P/day), Lantapan, 1998-2000.

<table>
<thead>
<tr>
<th>Type of Employment</th>
<th>Upper Watershed Villages</th>
<th>Lower Watershed Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-farm work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office Employment</td>
<td>141</td>
<td>136</td>
</tr>
<tr>
<td>Small-scale enterprise</td>
<td>94</td>
<td>110</td>
</tr>
<tr>
<td>Construction work</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>Household help</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>Sales lady/helper</td>
<td>70</td>
<td>61</td>
</tr>
<tr>
<td>Non-farm Average</td>
<td>102</td>
<td>83</td>
</tr>
<tr>
<td>Off-farm Average</td>
<td>128</td>
<td>148</td>
</tr>
<tr>
<td>Farm Average</td>
<td>59</td>
<td>78</td>
</tr>
</tbody>
</table>

Source: SANREM survey data
Table 4: Number and frequency of plots with soil conservation measures, Lantapan, 1996-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Plots</th>
<th>Plots with Contour Hedgerows</th>
<th>Plots with Trees / Fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td><strong>Dry Season</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996–1</td>
<td>224</td>
<td>37</td>
<td>16.52</td>
</tr>
<tr>
<td>1998–1</td>
<td>132</td>
<td>38</td>
<td>28.79</td>
</tr>
<tr>
<td>1999–1</td>
<td>123</td>
<td>13</td>
<td>10.57</td>
</tr>
<tr>
<td>2000–1</td>
<td>116</td>
<td>39</td>
<td>33.62</td>
</tr>
<tr>
<td><strong>Wet Season</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998–2</td>
<td>129</td>
<td>28</td>
<td>21.71</td>
</tr>
<tr>
<td>1999–2</td>
<td>118</td>
<td>18</td>
<td>15.30</td>
</tr>
<tr>
<td>2000–2</td>
<td>93</td>
<td>21</td>
<td>22.58</td>
</tr>
</tbody>
</table>

Source: SANREM Survey data
Table 5. Distribution of dry season employment by household members over 15 years old, 1996-2000.

<table>
<thead>
<tr>
<th>Year</th>
<th>Observations</th>
<th>Primary employment sector (percent of observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>On farm</td>
</tr>
<tr>
<td>Mainly corn-growing areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>120</td>
<td>60</td>
</tr>
<tr>
<td>1998</td>
<td>103</td>
<td>35</td>
</tr>
<tr>
<td>1999</td>
<td>113</td>
<td>27</td>
</tr>
<tr>
<td>2000</td>
<td>126</td>
<td>33</td>
</tr>
<tr>
<td>Mainly vegetable-growing areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>158</td>
<td>66</td>
</tr>
<tr>
<td>1998</td>
<td>121</td>
<td>52</td>
</tr>
<tr>
<td>1999</td>
<td>142</td>
<td>30</td>
</tr>
<tr>
<td>2000</td>
<td>117</td>
<td>42</td>
</tr>
</tbody>
</table>

Source: SANREM Survey data

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Non-farm labor supply (OLS) (Eq. 10)</th>
<th>Conservation adoption (logit) 1 = Soil conservation on plot, 0 = No conservation Model 1 (Eq. 11)</th>
<th>Model 2 (Eq. 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>-</td>
<td>0.76***</td>
<td>0.70***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.15)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Tenure</td>
<td>0.20</td>
<td>0.93***</td>
<td>1.24***</td>
</tr>
<tr>
<td></td>
<td>(0.38)</td>
<td>(0.26)</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Age of household Head</td>
<td>0.23**</td>
<td>0.13*</td>
<td>0.18***</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.08)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>(Age)^2</td>
<td>-0.002*</td>
<td>-0.001*</td>
<td>-0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>ln(W)</td>
<td>0.19***</td>
<td>-</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td></td>
<td>(0.03)</td>
</tr>
<tr>
<td>E (non-farm employment)</td>
<td>-</td>
<td>-0.007*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Exp. output price</td>
<td>-</td>
<td>-0.004</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.14)</td>
<td></td>
</tr>
<tr>
<td>Education of household head</td>
<td>-0.002</td>
<td>-0.18*</td>
<td>-0.15**</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.09)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Season dummy</td>
<td>-5.62***</td>
<td>-0.58*</td>
<td>-0.52***</td>
</tr>
<tr>
<td>(Wet=0, Dry = 1)</td>
<td>(0.39)</td>
<td>(0.30)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Year dummy</td>
<td>-2.94***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(1998 = 0, Otherwise = 1)</td>
<td>(0.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.29</td>
<td>-4.92***</td>
<td>-6.56***</td>
</tr>
<tr>
<td></td>
<td>(2.92)</td>
<td>(1.87)</td>
<td>(1.52)</td>
</tr>
<tr>
<td>R^2</td>
<td>0.328</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-287.02</td>
<td>-255.43</td>
<td>-414.64</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are standard errors.
* Significant at p \(\leq 0.10\)
** Significant at p \(\leq 0.05\)
*** Significant at p \(\leq 0.01\)
University of the Philippines-Los Baños and University of Wisconsin-Madison, respectively. The authors gratefully acknowledge the assistance of Isidra Balansag-Bagares in field data collection and Celia Tabien in data processing. Financial support was provided by the US Agency for International Development through the SANREM CRSP (Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program).

A number of studies conducted in the Philippines and elsewhere in the sloping uplands of the humid tropics identify the expansion and intensification of annual crop cultivation (primarily corn and upland rice) as the primary sources of agricultural land degradation, soil erosion, and (in areas where commercial forestry is no longer dominant) deforestation. Unit erosion rates are far higher under annual crops than under agroforestry and other perennial-based land use systems (David 1988), and the area covered by upland food crops is very large in relation to total upland agricultural area.

See footnote 1.

"Rural" here also includes surrounding towns in the province such as Malaybalay and Valencia, which are densely populated.

The migration projection assumptions include the differentials in the levels of development of the provinces as well as the presence or absence of a growth center. The basic indicator of change in the level and direction of net migration was the percentage change over the two migration intervals (1975-1980 and 1985-1990). In both periods, the computed NMR for Bukidnon is positive. This is in contrast with other upland areas in the Philippines like Misamis Occidental and Mountain Province, which have negative NMRs, meaning, outmigration trends.

Agricultural wage labor is usually called upon in times of plowing, planting, weeding, and harvesting. Farm labor remuneration in Lantapan includes both cash and non-cash payments. Cash payment may be daily per individual, or on a contractual basis, i.e. per hectare of land worked, per bag of fertilizer applied or per unit of crop harvested. Non-cash payments are observed in the harvesting of some crops, when harvesters get a share of output as payment. Exchange labor agreements (hunglos) among farmers are sometimes observed, specifically for planting and weeding. Daily wage rates vary depending on location, type of farm operation, sex and age of the laborer. Gender discrepancies are not distinct in corn areas, although some farmers have reported paying higher female wages in vegetable cultivation (Rola et al. 1995).

The reason for the high proportion of females engaged in non-farm work is that better-educated members of the population do more non-farm work, and more females than males complete high school and college degrees (Rola, et al. 1995).

This is not necessarily the best assumption, especially where major investments such as hedgerows and terraces are concerned, as these have large fixed-cost components (Shively 1997).
9 Since $\delta > 0$ (the rate of time preference must be positive), this condition requires only that $\eta > -\delta$, i.e. that if soil quality naturally degenerates rather than regenerates, it does so at a rate less than $-\delta$.

10 Fallowing is also a disease prevention measure for those who can afford to leave land idle.

11 These differences may be related to cultivation practices, such as that of plowing vegetable fields up and down the slope to prevent waterlogging in the root zone, rather than contour plowing to conserve soil.

12 Slope is measured by a discrete variable, where 1 stands for flat land and 3 for the steepest slope.

13 Further work on the logit analysis should try to capture life cycle effects and possibly education as a way of better separating incentives for various types of soil conservation.

14 The slope of upland farms inhibits mechanization as a labor-saving response to wage increase.
Figure 1: Agriculture's share in GDP and employment, 1970-2000

Source: World Bank
Figure 2: Real wages in the Philippines, 1980-99

Source: ...