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# Factors Influencing Soil Conservation Decisions in Developing Countries: A Case Study of Upland Farmers in the Philippines

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**Abstract:** *This study examines the factors that influence the adoption intensity of a soil conservation technology in a developing country. Factors that influence adoption intensity may not be the same as those that influence the incidence of adoption. In this study, adoption intensity is defined as the percentage of total upland acreage planted with Sloping Agricultural Land Technology by farmers in the Philippines. Because of the dependent variable's truncated nature, a Tobit model is used in the analysis. Economic theory and previous research provide the basis for the soil conservation decision variables included in the study. Results suggest that age of the head of household, tenure status, availability of family labor, and government programs have significant influence on adoption intensity. Contrary to expectations, income and education of farmers do not have significant impacts on adoption intensity. These results are discussed in terms of their implications for conservation programs in developing countries.*

**Key Words and Phrases:** *Soil conservation decisions, Intensity of adoption, Tobit models, Developing countries, Upland farmers.*

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Many studies have examined the quantitative importance of farm household characteristics and environmental factors on the decision to adopt modern soil conservation practices, i.e. "the incidence of adoption" (Feder et al.; Norris and Batie; Bell et al.). Dichotomous choice models were used to measure the probability of adoption or the intention to adopt (Dubman and Smathers). The availability of technical and financial assistance; tenure status; risk attitudes; farm size; educational levels; age of head of household; and income were identified as factors influencing soil conservation decisions (Norris and Batie; Baron; Forster and Stem). A major issue that has received less attention in the literature is the amount of soil conservation effort rendered by the farmer, i.e., "the intensity of adoption." This omission results from the difficulty in determining the

appropriate measure for soil conservation effort. Some researchers have measured conservation effort as the difference between erosion rates without practices and with recommended practices (Ervin and Ervin) and by the amount of farmers' investment in the practices (Norris and Batie). Lin measured soil conservation effort by the percentage of total land under conservation practices.

Factors that influence the incidence of adoption can be different from those that influence the intensity of adoption (Ervin and Ervin). Feder et al. have suggested that although small-scale farmers may have a lower probability of adopting soil conservation practices, their soil conservation efforts may be greater. Therefore, studies on the amount of soil conservation effort rendered by the farmer provide additional information for developing soil conservation policies.

The purpose of this study is to obtain quantitative estimates of the factors influencing how intensely upland farmers in the Philippines adopt a conservation technology, Sloping Agricultural Land Technology (SALT). The remainder of this paper is divided into four sections. The first begins with a brief description of the study's setting, survey procedure, and data. The second develops a conceptual model of the relationship between the socioeconomic factors and farmers' adoption intensity of soil conservation technologies. An econometric model, used to obtain quantitative estimates of the influence of selected socioeconomic variables on Filipino farmers' SALT adoption intensity, is also presented. The third section provides the results from this econometric model. The final section of this paper evaluates the results and derives policy implications.

### *The Data and Study Setting*

In the Philippines, it is estimated that approximately 9.4 million hectares of land, or about 31 percent of the country's total land area, is classified as hilly or mountainous (Celestino and Elliott). About 4.3 million hectares of this hilly land is being cultivated primarily by subsistence farmers.

The Philippines government, with funding support from the U.S. Agency for International Development (USAID), initiated the Farming Systems Development Project—Eastern Visayas (FSDP-EV) in 1982 to generate, adapt and transfer agricultural technologies to subsistence farmers in the uplands of Region VIII. Four institutions and organizations were responsible for introducing SALT in the study area. As a part of a larger technological package, SALT was initially introduced by FSDP-EV at the sites of Bontoc and Villaba on the island of Leyte. Farmers were provided

with training, technical assistance and free planting material. The Philippines Department of Agriculture, Catholic Relief Services and the Land Bank of the Philippines, in cooperation with the Center for Social Research at the Visayas State College of Agriculture, were responsible for the secondary diffusion of SALT at other sites on the island. These agencies provided training, technical assistance, cash grants and loans to potential SALT adopters.

SALT involves planting contours across the slopes in the uplands with hedgerows of fast growing legumes. The most commonly used legume in the Philippines is the "Giant" Ipil Ipil (*Leucaena leucocephala*, Lam., de Wit), also called the "Hawaiian Giant" (Gagni and Tabinga; Gapas). *Leucaena* helps build soil fertility through the fixation of atmospheric nitrogen and the decomposition of trimmed mulch from the hedgerows. The hedgerows reduce soil erosion, and the *Leucaena* plant can be used as timber, pulpwood and fodder for livestock.

The initial investment for adopting SALT is minimal, namely, the seeds, the labor for preparing contours and planting hedgerows, and the loss of production from land occupied by the hedgerows. Selling trimmed legume leaves rather than incorporating them in the ground can offset some short-run costs, but limit the long-run gains of improving soil fertility. Also, the trimming and maintenance of hedgerows on a continued basis represent added labor requirements for farmers. Therefore, farmers need to evaluate the higher costs of adopting SALT in the short run with the potential long-run benefits.

The extent of erosion controlled by the establishment of hedgerows represents a net long-term benefit to farmers. These benefits tend to get capitalized in higher land values. Also, as flat terraces are formed over the years, the farmers can introduce new crop enterprises to enhance their income potential. SALT is ideally suited for the crop-livestock farming system of subsistence farmers. Because of these many benefits, there is significant interest among policy makers in the Philippines, other tropical countries and international donor agencies for wider dissemination of SALT.

With the help of FSDP-EV and other agencies involved with the diffusion of SALT, a spot-map of all 137 adopters on Leyte was developed. All SALT sites were included to provide a more comprehensive study area for evaluation. In total, farmers located in fourteen "barangays" (villages outlying a municipality) from around five municipalities were included in the study. Most of the adopters were visited to determine the extent of their SALT adoption and to seek cooperation if they were selected in the sample. Farmers who adopted the technology only on paper and those

remotely located or otherwise inaccessible were excluded from consideration in the final sample. Neighboring farmers of these adopters, who were not using SALT, were selected as non-adopters. The sample consisted of 153 farmers—77 adopters and 76 non-adopters. The data were collected in 1988.

With the exception of education, and family and farm size, there are significant differences in the socioeconomic characteristics of the adopters and non-adopters: 1) the average adopter is younger (41.8 vs. 44.0 years old) and better educated (4.6 vs. 3.3 years) than the non-adopter; 2) family size is 4.1 and 4.3 for adopters and non-adopters, respectively; 3) the average farm size is 2.09 hectares for adopters exceeds the 1.87 hectares for non-adopters; 4) the average annual farm income (2,979 pesos vs. 2,940 pesos) and non-farm income (2,474 pesos vs. 1,030 pesos) is higher for adopters than for non-adopters.

### *Factors Affecting Adoption*

Economic theory and previous research provide the basis for the soil conservation decision variables included in the study. These variables are defined in Table 1.

Norris and Batie found farmers with higher income levels in Virginia, to have a greater probability of adopting soil conservation practices. McLean-Meynsse et al. found that small farmers in northeast Louisiana do not participate in Conservation Reserve Programs if revenues from crop land are an important source of income. That is, lower income levels may increase financial constraints in their adoption. The positive influence of income on conservation decisions in the United States may also occur because higher income farmers have a greater incentive to reduce their marginal tax rates by adopting conservation measures (Norris and Batie). The influence of total income (INCTOT), farm and non-farm, on SALT adoption efforts is expected to be positive.

Farm size is frequently cited as a factor that influences soil conservation (Norris and Batie). Most of the evidence indicates that the incidence of adoption of new agricultural technologies is positively related to the size of holding. Larger farms are associated with greater wealth and increased availability of capital which increases the probability of investing in conservation practices (Norris and Batie). Because of fixed transaction and information acquisition costs, there may be a lower limit on the size of adopting farms. In this study, farm size and total income are the two variables included in the model to represent wealth, availability of capital,

Table 1.

*Description of Variables Used in the Analysis*

Variable Name	Variable Description
INTENS	Percentage of total upland acreage planted with SALT as of 1988
INCTOT	Total family income, farm and off-farm
LAND1	1 if total farm size, rented and owned, operated by the farmer is equal to or less than one hectare, 0 otherwise
LAND2	1 if total farm size, rented and owned, operated by the farmer is greater than one but less than or equal to two hectares, 0 otherwise
LAND3	1 if total farm size, rented and owned, operated by the farmer is greater than two hectares, 0 otherwise
AGE	Age of the farm head of household
TENURE	1 if the largest parcel (with SALT for the adopters) is owned by the farmer, 0 otherwise
LANLAB	Is the ratio of the amount of upland to available family labor
SCHOOL	Educational level in years for farm head of household
ASSIST	1 if the farmer was offered assistance to adopt SALT, 0 otherwise

and ability to borrow and bear risks. However, these are the two variables that are most highly correlated (positively) among all the explanatory variables. Rather than omitting a relevant variable, two discrete variables were used to examine the linkage between intensity of adoption and farm size. Bell et al. used a similar approach to examine whether large farms are more likely to participate in Tennessee's Forest Stewardship Program. In this study, farm size, including both owned and rented land, is measured by two dummy variables, LAND1 equals farms with less than, or equal to, one hectare and LAND2 equals farms with more than one, but less than, or equal to, two hectares. To avoid multicollinearity, a dummy variable

was not included to represent farms larger than two hectares, i.e., the effects of LAND3 are captured by the constant. It is hypothesized that small-farm-size groups will have a lower SALT adoption intensity.

Several studies (Baron; Forster and Stem) suggest that a negative relationship exists between age and soil conservation decisions because: 1) older farmers exert less effort to maintain soil productivity because the full benefits of conservation are not received within their short planning horizons; and 2) younger farmers may exert more effort to maintain soil productivity since they are likely to be more educated and, as a result, more aware of soil erosion problems and solutions (Norris and Batie). Therefore, the coefficient for AGE is expected to be negative and significant.

There is no consensus in the literature regarding the relationship of tenure and conservation adoption decisions because the implied relationships between tenure and other omitted socioeconomic factors are not considered appropriately (Feder et al). Tenure, defined in previous studies as "the ratio of total rented cropland to total operated cropland acreage" (Norris and Batie), may be highly correlated to wealth, and consequently to access to credit, input and product markets, and technical information. Therefore, if the largest upland parcel (with SALT for the adopters) is owned by the farmer, a qualitative variable (TENURE) equal to one is included to capture the effect of land ownership. This variable should exert a positive influence on the SALT adoption effort because farmers tend to invest more on soil conservation practices on their own land compared to rented land (Norris and Batie).

The impact of land intensity on conservation decisions is not well established by previous research. Since SALT is labor intensive, land intensity (LANLAB), measured as the amount of upland cultivated per family member, is hypothesized to have a negative relationship on the intensity of SALT adoption (Burke).

Formal schooling enhances farmers' ability to perceive, interpret and respond to new events in the context of risk (Schultz). Several empirical studies have verified the link between higher levels of educational attainment and early adoption of new technologies (Lin; Duraisamy; Ervin and Ervin; Forster and Stem). Therefore, based on the theory developed by Schultz, educational level of head of household (SCHOOL) is expected to have a positive influence on the intensity of SALT adoption.

Researchers have found the receipt of government assistance to positively affect farmers' use of conservation practices (Ervin and Ervin; Norris and Batie, McLean-Meynsse, et al). This conclusion is because government assistance can reduce the cost of adopting conservation

practices. The qualitative variable (ASSIST) representing farmers who were offered assistance (technical assistance and seed) to introduce SALT is hypothesized to have a positive impact on adoption intensity.

A major difficulty in modeling adoption intensity is the determination of the appropriate measure of adoption. Following Lin, adoption intensity (INTENS) is defined in this study as the percentage of the total upland acreage planted with SALT as of 1988. Because the range for this ratio can be only between zero and one, the two-limit tobit is the appropriate method of estimating the unknown parameters in the equation. Tobit is preferable to Ordinary Least Squares estimation because the latter, based on a censored sample, would yield inconsistent estimates (Maddala, 1983). The model used to evaluate the farmers' SALT adoption intensity is:

$$\text{INTENS} = \beta_0 + \beta_1 \text{INCTOT} + \beta_2 \text{LAND1} + \beta_3 \text{LAND2} + \beta_4 \text{AGE} + \beta_5 \text{TENURE} + \beta_6 \text{LANLAB} + \beta_7 \text{SCHOOL} + \beta_8 \text{ASSIST} + e$$

## Results

The normalized coefficients and standard errors are presented in Table 2. The model required five iterations to generate parameter estimates. The estimated value of the log likelihood function is -103.16. McFadden's  $R^2$  indicates approximately 35.6 percent of the variation in the intensity of adoption is explained by the independent variables included in the model (Maddala, 1992).

Most coefficients have the expected sign and are statistically significant. Farmers with less than, or equal to, one hectare of total land (LAND1) adopt SALT less intensively as compared to farmers with more than two hectares. Age of head of household (AGE) negatively influences the adoption intensity as does the availability of family labor to cultivate the land (LANLAB). On the other hand, government assistance (ASSIST) and ownership of the largest parcel of land (TENURE) on which SALT is practiced positively contribute to the intensity in which the conservation technique is adopted.

As expected, the coefficients for total household income (INCTOT) and the level of formal education of household head (SCHOOL) are positive. However, contrary to results presented in many previous studies, the estimated coefficients for INCTOT and SCHOOL are not significant at the 5 percent level. Bell et al. found education to be insignificant in explaining participation in forestry programs. They suggest that education is insignificant because growing a forest is a long-term investment quite different from programs evaluated in other research. Similar reasons may apply for

Table 2.

*Maximum Likelihood Estimates for Tobit Model*

Variable	Normalized Coefficient (Standard Errors)	Marginal Effects
INTERCEPT	0.148 (0.4053)	0.043
LAND1	-1.004* (0.2268)	-0.288
LAND2	-0.420 (0.1843)	-0.121
AGE	-0.020* (0.0061)	-0.006
TENURE	0.436* (0.1388)	0.126
LANLAB	-1.042* (0.2335)	-0.300
INCTOT	0.5E-05 (0.11E-04)	0.1E-05
SCHOOL	0.26E-02 (0.29E-01)	0.76E-03
ASSIST	2.003* (0.1967)	0.576

\* Significant at 5% level; Log-Likelihood index = -103.16; McFadden's  $R^2$  = 35.64

SCHOOL not being significant in explaining SALT adoption intensity. Income did not have a significant effect in the model of Filipino farmers' SALT adoption intensity because current income is sufficient only for subsistence requirements. Therefore, SALT adoption decisions are more likely to be influenced by other factors such as their wealth and/or their ability to borrow capital. Likewise, the estimated coefficient for farmers with more than one, but less than or equal to, two hectares of total land (LAND2) is not significant at the 5 percent level.

Unlike the OLS estimates, the Tobit coefficients do not represent the expected change in the dependent variable, given a one unit change in an explanatory variable. However, as discussed in Greene, the normalized

coefficients from the Tobit model can be transformed into the vector of first derivatives. This study follows the method developed by Rosett and Nelson and Nakamura and Nakamura for estimating the marginal effects for a tobit model with censoring on both ends of the distribution (Greene). The marginal effects are estimated at the mean of the independent variables. Interpretation of marginal effects is as follows. A one-year increase in age will decrease the intensity of adoption by 0.6 percent. A one-unit increase in the ratio of the amount of upland to available family labor will decrease adoption intensity by 30 percent. All of the discrete variables are intercept shifters.

### ***Implications and Conclusions***

This analysis concentrated on obtaining quantitative estimates of the influence of selected farmer characteristics and environmental variables on Filipino farmers' decision to adopt SALT. Because soil erosion is a consequence of inappropriate land use, the challenge is to devise and disseminate technologies that satisfy farmers' short-run aims while conserving the soil in the long run. SALT appears to meet these objectives.

Implications of this research for disseminating SALT are clear. An offer of assistance to implement SALT has a significant and positive influence on adoption intensity. Subsidized seeds and fertilizer, training and technical guidance are the types of assistance that can be provided. The cost of providing assistance is not evaluated, however. Researchers and policy makers should recognize that it is not only the incidence, but also the intensity of soil conservation efforts that affect the cost-effectiveness of these government assistance programs. For various reasons, the factors that affect the incidence of adoption need not be the same as those that affect the intensity.

Targeting assistance to younger farmers with larger farms and to those who own land could increase adoption intensity. The mean age of participants was forty-two years. A one-year decrease in the mean age will increase the intensity of adoption by 0.6 percent. Results reveal that farm size, a proxy for a host of factors including wealth and access to credit, has a significant and positive influence on the sample farmers' SALT adoption intensity. As suggested by Lin for China, our evidence from the Philippines also supports the argument for further liberalization in land markets to facilitate consolidation of small units through land market transactions.

Consolidation of small units and further targeting of assistance to younger land-owning farmers with larger acreages could favor privileged

producers. However, promoting adoption among farmers who lack complementary resources or the ability to maintain the *Leucaena* plants on a long-term basis would result in burdening them with untenable investments. Researchers and policy makers should recognize that consolidation of small units may help reduce soil erosion, but might have other negative consequences such as more unequal distribution in wealth.

An important resource required to maintain *Leucaena* plants on a long-term basis is the availability of family labor. The perception that SALT is a labor intensive technology is supported by the model results. Farmers with larger upland acreage per family member adopt SALT less intensively. An increase of one hectare in upland acreage per family member will decrease adoption intensity by 30 percent.

Previous studies suggest that income has a positive effect on soil conservation adoption decisions. Their results, however, may not be valid for subsistence farmers in developing countries. If current income is sufficient only for subsistence requirements, SALT adoption decisions are more likely to be influenced by other factors such as their wealth and/or the ability to borrow capital. Income did not have a significant effect in the model of Filipino farmers' SALT adoption intensity.

Contrary to findings in previous studies, education of head of household does not have a positive and significant impact on SALT adoption intensity. This result contradicts results in Duraisamy and Lin who found educational levels in India and China, respectively, to have a positive influence on intensity of using high-yielding rice varieties. This conclusion may result from the overall low level of formal schooling among farmers in the study area. In addition, results from a t-test suggest there is no significant difference in the mean educational levels of adopters versus non-adopters.

The educational levels of farmers included in this study may be below the necessary threshold level for them to discriminate between promising and unpromising ideas. The threshold level to discriminate in soil conservation decisions also may be higher than in decisions regarding the adoption of high-yielding rice varieties. This difference occurs because the adoption of high-yielding rice varieties can increase current income while the benefits of soil conservation technologies tend to get capitalized in land values. Therefore, the benefits of soil conservation are not realized until the land is sold. McLean-Meynsse et al. found that farmers with less than high school education are more likely to give low government payments as a reason for not participating in Conservation Reserve Programs. That is, as compared to farmers with more than high school education, those who have less education require an inducement to participate. This conclusion

supports the notion that educational attainment positively impacts adoption of a technology only above a threshold level. In addition, many studies suggest that education may have less impact in regions or countries with traditional agricultural practices, and may be highly correlated with other omitted socioeconomic variables (Jamison and Lau; Welch; Goodwin and Koudele).

According to the results of this study and other research, the factors that influence adoption intensity differ widely among countries and among farmers. The effectiveness of soil conservation programs will depend heavily on the extent to which such differences are recognized.

### Notes

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