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Factors Influencing Soil Conservation Decisions by Tobacco Farmers in Hanguranketha Area, Sri Lanka: An Application of Tobit Model

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ABSTRACT: Developing theory and compiling evidence on the process whereby farmers decide to use conservation practices is an initial step to improve the efficiency of a soil conservation programme. This study attempts to identify social, economic, institutional and physical factors influencing tobacco farmers' soil conservation decisions in the Hanguranketha Walapane area. Data were collected from 120 farmers using a structured questionnaire. A soil conservation decision model for conservation expenditure was constructed. Tobit analysis was used instead of OLS method to capture decision making as well as the measures taken.

Formal education does not have a positive influence on conservation decisions. However, informal education has a positive influence, although the degree is less compared to other variables. Profit attitudes negatively influenced conservation decisions while, perception on soil erosion and positive attitudes towards conservation have a positive influence on conservation decisions and efforts. Thus, changing attitudes through informal education is a means to achieve better soil conservation in tobacco lands. Land tenure has a strong negative influence on soil conservation while subsidy has a significant positive influence on conservation decision and efforts. Therefore it is suggested to look in to possibilities to change tenurial relationships and continue to give subsidies to improve soil conservation in the study area.

INTRODUCTION

Tobacco cultivation is an economically attractive venture for a large number of small holders in the hill country. Soil erosion is one of the major causes of land degradation in Sri Lanka and tobacco cultivation

in hilly areas is considered to be one of the most soil erosive land use practices in the country. Recent research findings reveal that soil erosion in tobacco lands is continuing at an alarming rate. (Economic Review 1982, Stocking 1986, Wickramasinghe 1989, Thiruchelvam 1989, Gunatilake 1990, NORAD 1989). In addition, cultivation of the crop is carried out in an ecologically vulnerable area of the Upper Mahaweli watershed. Thus soil conservation in tobacco lands bears utmost importance from the watershed management point of view as well.

Failures of soil conservation policies and programmes are reported to be common in many Third World countries. Often such failures are attributed to technical factors by analysts who fail to see conservation problems in their socio-economic context. Highlighting these shortcomings, some critics have argued using empirical evidence that socio-economic causes are more fundamental than technical factors for the future of soil conservation programmes (Blaikie, 1985).

Individuals sharing similar soil erosion problems may adopt different levels of conservation, or reach different conservation decisions. In the past, this behaviour was mainly explained by the individual time preference or discount rate and the length of the planning horizon, in the profit maximization framework of conventional economics (Lee 1980). However, such economic theory provides limited guidance in modelling farmers' conservation behaviour because the strict profit maximization framework fails to encompass attitudinal variables (Lynne *et. al.*, 1988). Theory and evidence concerning the process whereby farmers decide to use or not to use conservation practices in their farms is certainly an initial step of improving the efficiency of any soil conservation programme (Ervin and Ervin, 1982).

Numerous variables such as physical factors of the land, personal factors i.e. education and age, and institutional factors can affect the decisions to use or not to use soil conservation measures in a farm in addition to economic variables. An in-depth understanding of the impact of these factors on conservation decisions is therefore required to devise an effective,farm level soil conservation programmes (Noris and Batie 1987, McDowel and Sparks 1989, McDowel *et al.*, 1989). Following the above discussion the objective of this study is to identify socio-economic and institutional factors influencing tobacco farmers' soil conservation decision in the Hanguranketha Walapane area.

METHODOLOGY

The data for this study were gathered from primary sources using a structured questionnaire. The questionnaire was developed based on the earlier works of Hoover and Witala (1980), Ervin and Ervin (1982), Abeygunawardena (1983) and Lynne *et al.*, (1988). The total sample of 120 tobacco growers was drawn equally from Hanguranketha and Walapane AGA divisions.

Since there are different categories of tobacco growers the sample was stratified into two, namely barn owners and sub-growers. A barn owner usually buys tobacco from 3 - 4 sub growers. One forth of the total sample, therefore, was drawn from barn owners. A list of barn owners was obtained from the agricultural officer for the area. Using random numbers 17 barn owners from each division were selected. A formal list of sub growers was not available and therefore sub-growers assigned to selected barn owners were chosen for the interviews.

There are different methods of measuring adoption of soil conservation, such as, willingness to adopt, the actual adoption, the conservation effort, difference between rate of erosion before and after conservation and expenditure on soil conservation. The total expenditure on soil conservation (Y) which includes both decisions to adopt conservation measures and the conservation effort considered to be better (Norris and Batie 1987), was used to measure the adoption of soil conservation methods in the study. Expenditure on soil conservation is partly a quantitative and partly a qualitative variable. For example if Y = 0, it implies that the farmer did not adopt any soil conservation measures. If $Y \geqslant 1$, it implies that the farmer has adopted some conservation measures. In the latter case the dependant variable is a continuous one which represents both soil conservation decision and effort. If the observations are included in the sample on the basis of the values of the dependant variable, the sample is said to be truncated. For instance; consider the soil conservation expenditures in which the sample is truncated at zero:

$$Y_i = X_i\beta + U_i \text{ ; observe only if } Y_i > 0$$

Where X is the independent variable and U is the error term.

When the sample is truncated at zero either we do not observe a value or we observe only zeros for some observations. If X is a small observation, i will only be in the sample if U is large, thus U and $X_i ß$ will be negatively correlated and ß will be biased towards zero.

Under these circumstances the Ordinary Least Square (OLS) estimates would yield inconsistent and inefficient estimates because the normality assumption is no longer applicable. Further, if one includes only those observations for which conservation expenditures are greater than zero as an alternative, it would result in a sample selection bias (Norris and Batie 1987). All of these will, in general, cause OLS estimates to be biased, because of the fact that an observation in the sample gives some information about the residuals. In order to overcome these problems the Tobit model is used (Tobin 1958)

The Tobit Model

In Tobit analysis it is assumed that the dependent variable has a number of its values clustered at a limiting value, usually zero. The maximum likelihood estimation method is used here instead of the Ordinary Least Square method. The Tobit technique uses all the observations, both those at the limit and those above it, to estimate the regression line and it is preferred general, over alternative techniques that estimate a line only with the observations above the limit (McDonald and Moffit 1980). Moreover the "beta coefficients" obtained from Tobit analysis can be used to determine both changes in the probability of being above the limit (decision to adopt soil conservation) and the changes in the value of the dependant variable, if it is already above the limit (soil conservation effort).

Soil conservation decisions and hypothesis

Factors influencing farmers soil conservation decision could be broadly categorized into: personal factors, economic factors, institutional factors and physical factors.

Personal factors

Age

Younger farmers may have better education and be more involved with current innovative farming practices and as a result may be more aware of soil erosion problems and available solutions. The shorter planning horizon and less than perfect capitalization of yield changes are the other reasons for older farmers not to apply soil conservation practices (Norris and Batie 1987, Lee 1980, McDowel and Spart 1989).

Education

Higher education is assumed to be associated with access to new information on consequences of soil erosion and conservation measures as well as higher management expertise. Moreover, understanding of biological sciences or ecology is expected to create a positive impact on conservation in the decision making process. Abeygunawardena (1983), McDowel and Sparts (1989) and Noris and Batie (1987) hypothesized a positive relation between education and conservation efforts.

Experience in Tobacco Farming

Farmers who have been cultivating tobacco for a long period may know the productivity impact of soil erosion and hence tend to conserve their soil. Therefore a positive relation between conservation effort and experience in tobacco farming is assumed.

Farmer Category

Different categories of farmers such as barn owners and sub-growers have various levels of income and different access to information and supporting services. It is therefore assumed that there may be a difference in their conservation efforts.

Attitudes

As described by Lynne *et.al.*, (1988) attitudes can positively or negatively influence soil conservation. Three attitudinal variables are used in this study, which are: Positive attitudes towards conservation (PCONC), Profit attitudes (PROFT) and Perception (PERCP) on conservation. Earl *et al.*, (1979), Ervin and Ervin (1982) hypothesized a positive relationship between perception and conservation effort and Lynne *et al.*, (1989) McDowell and Sparts(1989) assumed that conservation effort have positive and negative relationships to PCONC and PROFT respectively.

Economic factors

Income or wealth

Higher income reduces the financial constraints to adopt conservation. Wealthy farmers who have higher social status usually have better access to the institutional support given for conservation. It is therefore assumed that there is a positive relationship between conservation effort and income or wealth.

Debt level

An anticipated reaction to higher debt levels is to exploit the soil resource without investing on soil conservation.

Farm size

Operators of larger farms are likely to spend more money on conservation because in many cases a large farm size is associated with capital availability which make investment in conservation more feasible.

Institutional factors

Farm Agency contact

Abeygunawardena (1983), Lee (1980), Noris and Batie (1987) assumed a positive relationship between conservation efforts and the number of visits by farm agencies.

Subsidy

Receiving subsidy for soil conservation is expected to promote conservation efforts since subsidies remove the financial constraint for conservation faced by many farmers. A positive relationship between conservation efforts and receiving subsidy is assumed.

Land tenure

It is generally accepted that farmers who cultivate others' land are less likely to invest on soil conservation because of many reasons. For instance, because of the perceived insecurity of his tenancy a tenant might find it profitable to mine the soil since he is not sure of receiving the benefits of conservation. Tenants are, in general, poor farmers and they lose part of their income as rent for the land, which act as a financial obstacle for soil conservation. Land owners may not be willing to invest on soil conservation in rented lands because they know that a part of the on-farm benefits of conservation would go to the tenants (Ervin, 1986).

Physical factors

Erosion potential

Some factors described in Universal Soil Loss Equation such as slope, slope length, management factors, soil type are considered here. It is expected that farmers who face severe erosion potential are more likely to practice conservation (Abeygunawardena, 1983; Ervin and Ervin, 1982).

Measuring the explanatory variables

Directly measurable variables such as age and years of experience in tobacco farming were taken directly from the questionnaires. Farmers' formal education was scaled from 1 – 6, and the given ranks were used for the analysis. Value of the total assets owned by farmers was categorized and the scales were used in the model. The farmer category was used as a binary variable in the model. If the respondent happened to be a barn owner, one was assigned and zero otherwise. Land tenure was measured as the ratio of total rented crop land to total operated cropland.

The visits made by farm agencies were not directed for soil conservation alone. As revealed by the extension workers, they spend approximately one third of their time on soil conservation related work. Therefore, one third of the total visits were taken as the number of visits in this study. Subsidy was included as a dummy variable. A score of one was given for those farmers who received subsidy or zero otherwise. The debt in the case of tobacco cultivation is a transaction taking place within a season and there is hardly any accumulated debt since The Ceylon Tobacco Company makes sure to collect debts during the harvesting period. The sum of money borrowed from CTC or any other sources and the interest is used as debt in the model.

Knowledge on beliefs as used by Lynne *et al.*, (1988) McDowell (1989), is used to infer attitudes in this study. Positive attitudes towards conservation and Profit attitudes were measured using the related statements. These statements were coded as one through five for strongly disagree, disagree, neutral or uncertain agree and strongly agree respectively. Perception of soil erosion (PERCP) was measured as a binary variable. Those who stated soil erosion as a problem in their farms and considered the degree of the problem as medium or severe were assigned one and those who stated soil erosion as not a problem in their farms and those who considered it as a problem but the degree as low were assigned zero.

RESULTS AND DISCUSSION

There are no provisions to test the goodness of fit of the model in Tobit analysis. Possible problems of multiple regression models such as heteroscedasticity and multicollinearity cannot be tested when one uses this procedure either. The Ordinary Least Square (OLS) model was therefore, fitted for the data in order to test the validity of the assumptions and data problems. The regression coefficient (R^2) indicates that 68% of the variation in conservation expenditure is explained by the model. As indicated by the corrected R^2, 0.641, there are a sufficient number of observations in the study model compared to the number of independent variables since the difference between the R^2 values is very small.

Heteroscedasticity was tested using Goldfeld and Quandt test and was not found in the model. Farm size was dropped from the model in order to avoid multicollinearity problem. This was tested estimating the correlation matrix of the independent variables and it was found that farm size was highly correlated with debt level. The results indicated that independent variables are correlated to some extent. Condition numbers exceed 20 for two variables. Their proportional correlations with other variables, however, are not very high and dropping these variables did not improve the results. These results altogether indicate that the model is reliable although there is a slight multicollinearity problem. The results of the tobit analysis is presented in Table 1.

Age and conservation effort show a negative relation as hypothesized in the study. However, the empirical evidence of the study does not support this because the null hypothesis cannot be rejected at any of the significance levels. Education shows a negative relation with conservation effort and it is significant at 0.1 probability level. Education was found to be positively related to conservation efforts in many previous studies (Ervin and Ervin, 1982; McDoewll and Spart, 1989). The reason for this unexpected result may lie in the distribution of the level of education in the sample. Most of the farmers have received grade 1 to 10 education in which very little or no attention is paid on ecological issues and conservation.

Table 1. The results of the tobit model for conservation expenditure.

Variable	DF	Estimate	Std Err	Chi Square	Pr>chi
Age	1	-32.167	58.467	0.3026	0.5822
Education*	1	-1813.46	987.17	3.3746	0.0662
Experience	1	-107.69	141.31	0.5808	0.4460
Category*	1	3696.95	2036.16	3.2966	0.0694
PERCP*	1	885.358	533.65	2.7525	0.0971
PCONC*	1	2377.19	1427.37	2.7736	0.0958
PROFT**	1	-2376.56	1057.13	5.0540	0.0246
Assets	1	552.409	622.81	0.7866	0.3751
Debt*	1	0.03586	0.0184	3.7825	0.0518
Visits	1	82.3016	58.7748	1.9608	0.1614
Subsidy*	1	3744.04	2093.96	3.1978	0.0737
Tenure***	1	-87.7958	18.6026	22.2738	0.0001
Er.potential	1	-574.94	1172.93	0.2403	0.6240

* Significant at 0.1 level
** Significant at 0.05 level
*** Significant at 0.01 level

The number of visits by farm agencies, which is related to informal education, shows a positive relation with conservation efforts and although not significant at any of the predetermined levels, it has a low pr> Chi value. This implies that although the degree of influence is a little less than the other significant variables, the number of visits by farm agencies positively influence conservation efforts. These results indicate that even though formal education does not, informal education does positively influence conservation efforts.

Farmers experience does not significantly influence conservation efforts as shown by the results. Barn owners and sub-growers show two significantly different levels of conservation efforts. The total value of assets shows a positive relation to conservation efforts. The asset variable

however, is not significant in the model. Many researchers have found earlier that conservation efforts are highly influenced by wealth or the income of the farmer. Discrepancy in this result is probably due to measurement errors, since it is difficult to obtain precise data on farmer income. This must be investigated in depth.

In this study, debt level of the farmers is assumed to have a negative influence on conservation efforts. The null hypothesis cannot be rejected in this case as the debt variable shows a positive relation to conservation efforts and this effect is significant at 0.1 probability level. Debt, usually, is a financial constraint to soil conservation. In the particular institutional structure of tobacco farming, debt does not indicate a financial constraint because almost all the farmers borrow money regardless of their financial status. Moreover, rich farmers who operate bigger farms get more credit compared to poor farmers. Debt, in this case, is working capital and there is hardly any accumulated debt since the company makes sure that the loan is paid when farmers sell their product. Therefore the debt level of tobacco farmers is an indicator of their wealth or the farm size rather than a financial constraint for conservation. This may be the reason to observe a positive relation between debt level and conservation efforts.

All the institutional factors show the expected relationships to conservation efforts. Tenure negatively influences at 0.01 level while subsidy positively influences conservation efforts at 0.1 significance level. These results, altogether, signify that institutional factors play a crucial role in soil conservation in tobacco lands. The three attitudinal variables PERCP, PCONC and PROFT also show the hypothesized relation to soil conservation efforts. Erosion potential shows a negative relation to conservation efforts. This variable is not significant in the model. This result implies that farmers in decision making have not considered the factors that cause severe erosion and conservation measures have not been applied where they are necessary.

CONCLUSION AND POLICY IMPLICATIONS

Among the many variables significantly influencing soil conservation decision and effort, land tenure arrangements bear the utmost importance as shown by the results. Unfortunately, changing land tenure relationships is not easy. The ideal solution, a land reform, may not be possible under

the current socio-political context. A legislative change to formalize the land tenure including soil conservation as a condition of the lease is suggested. This needs further consideration as such measures might have adverse impacts on tenants. This measure has to be linked with an incentive scheme such as a subsidy for soil conservation, in order to avoid adverse impacts on tenant farmers.

Attitudes, as revealed by the study, play a key role in adoption of conservation measures. Changing attitudes towards a better management of land can only be achieved through educating the farmers. Formal education has little relevance in this case as its positive impact cannot be established according to the results. Influence of the visits by extension agents shows the potential of using extension education to achieve the desirable attitudinal changes.

The analysis shows a positive relation between receiving subsidy and conservation efforts. Subsidies should therefore be an element in a conservation programme. Eighty seven percent of the farmers ranked subsidy as number one when they were asked to rank the institutional support they would like to obtained, and 96.3% farmers expressed that the given subsidy was inadequate to meet the cost of soil conservation. Giving subsidy is an important strategy compared to changing land tenure or attitudes because it is a quick course of action that can be taken to promote soil conservation.

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