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Effect of Socio-Economic Factors on Adoption of Soil Conservation Measures in Kurundu Oya Sub Catchment

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ABSTRACT. *Human induced soil erosion continues to be a major issue in terms of crop production and river water quality of the Upper Mahaweli Catchment Area (UMCA). Although the direct causes of soil erosion are well known, the underlying root causes are embedded in socio-economic conditions in the society. Many researchers have pointed out that the problem of low adoption is associated with incompatibility of the technology with the prevailing socio-economic condition of the community. Therefore, an attempt was made to identify the constraints to adopt soil conservation measures in the study area. The study consisted of three steps including a questionnaire survey, in depth interviews and transects walks. According to the results of the study, the investment on soil conservation measures is likely to increase with the farm income, level of awareness and the ownership security of the land. It was identified that even the encroachers (people who encroached the state lands) can be mobilized towards soil conservation to a certain extent through awareness programs. The capacity of the extension service has to be strengthened in order to make the farming community aware of soil conservation. Land alienation programs could make effective changes in soil conservation by giving social values to the land owner through a more secure land tenure system.*

INTRODUCTION

Human-induced soil erosion poses a great threat to sustainability of soil and water resources in the Kurundu Oya sub catchment of the Upper Mahaweli Catchment Area (UMCA). Middle and upper parts of the sub catchment are among the areas mostly affected by soil erosion (Kumarihamy and Dayawansa, 2009). Human-induced soil erosion in the UMCA was accelerated during the colonial period with the introduction of plantation agriculture. The evidence of the first attempt made to control soil erosion dates back to 1873, when the Secretary of State ordered that, no land above 5000 feet should be alienated (Madduma Bandara, 1997). Then the Forest Ordinance (1907) was enacted by the colonial administration, mainly to restrict encroachments by peasants. The Soil Conservation Act (1951) was introduced to make provisions to acquire sensitive lands for conservation purposes, to control exploitation of forest lands and to provide assistance to owners of lands in sensitive areas. Several donor-funded projects have been implemented to address the issues of the land degradation in the UMCA during the past two to three decades. Some of these projects were Land Use Planning Projects in 1983, Upper Mahaweli Management

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Project in1987 and Upper Watershed Management Project in 1997. Over the years, these projects have promoted various soil conservation measures, namely, hedgerows, stone bunds, terraces and contour ditches. However, in the absence of locally available material, many of these soil conservation technologies require substantial investment of resources which are not affordable to many households. The top-down approach used to plan and implement soil conservation projects also led to keep communities away from the adoption of new technologies. Since nearly 80% of the lands are under state control, the pressure on land has been gradually developed with increasing population. Subsequently, the conflicts between the authorities and community arose because of high tendency to encroach state lands. Although the direct causes of soil erosion are well known, the underlying root causes are embedded in the socio-economic conditions of the society. Many researchers pointed out that the problem of low adoption is often not due to the technology, but rather due to the incompatibility of the technology with prevailing socio-economic conditions of the community (Aheeyar, 2000). Thus, the limited success in the adoption of soil conservation measures necessitates the investigation of the social and economic factors that influence farmers' willingness to invest on conservation measures. In this context, the study was conducted to evaluate social and economic factors that influence the adoption of soil conservation measures in the Kurundu Oya sub catchment of the UMCA. Therefore, this study was carried out to identify the constraints to the adoption of soil conservation measures in the study area, to study the association between constraints and the investment in soil conservation and to make recommendations to overcome the problems under prevailing conditions.

MATERIALS AND METHODS

The study area

The study was conducted in Kurundu oya catchment (located in between $7^0$01' and $7^0$13' N and $80^0$48' and $80^0$55' E coordinates) which lies mainly in the mid and up country of Sri Lanka (Fig. 1). The total area of the catchment is approximately 76 km^2, and it is situated at an altitude ranging from 250 to 2250 masl. The area is representative of potential soil erosion zones in the UMCA with respect to soil properties, landscape, farming systems and the socio-economic conditions. The area has varying slope up to 100% and medium to high mountains with narrow valley bottoms. This topographic variation has created several microclimates and soil complexes within the catchment. Major soil types according to USDA classification are Typic Rhodudults, Typic Hapludults and Typic Troporthents (Mapa *et al.*, 2005).

Data collection

The field research consisted of three stages including both formal and informal survey methods (Chambers, 1992; Wijesuriya and Thattil, 2005). The first stage involved discussions with key informants and a group of farmers with the aim to analyze the existing situation of the adoption of soil conservation measures. The second stage consisted of a household survey using a pre-tested questionnaire. The survey was administered to collect information regarding farming systems, household characteristics and constraints in adopting soil conservation measures. The agricultural extension staff was also interviewed at this stage to obtain technical information on soil conservation. The information collected in the first two stages was confirmed by transect walks conducted at the third stage. Secondary data

including scientific reports, paper and digital maps, and survey reports were also used as additional sources of information.

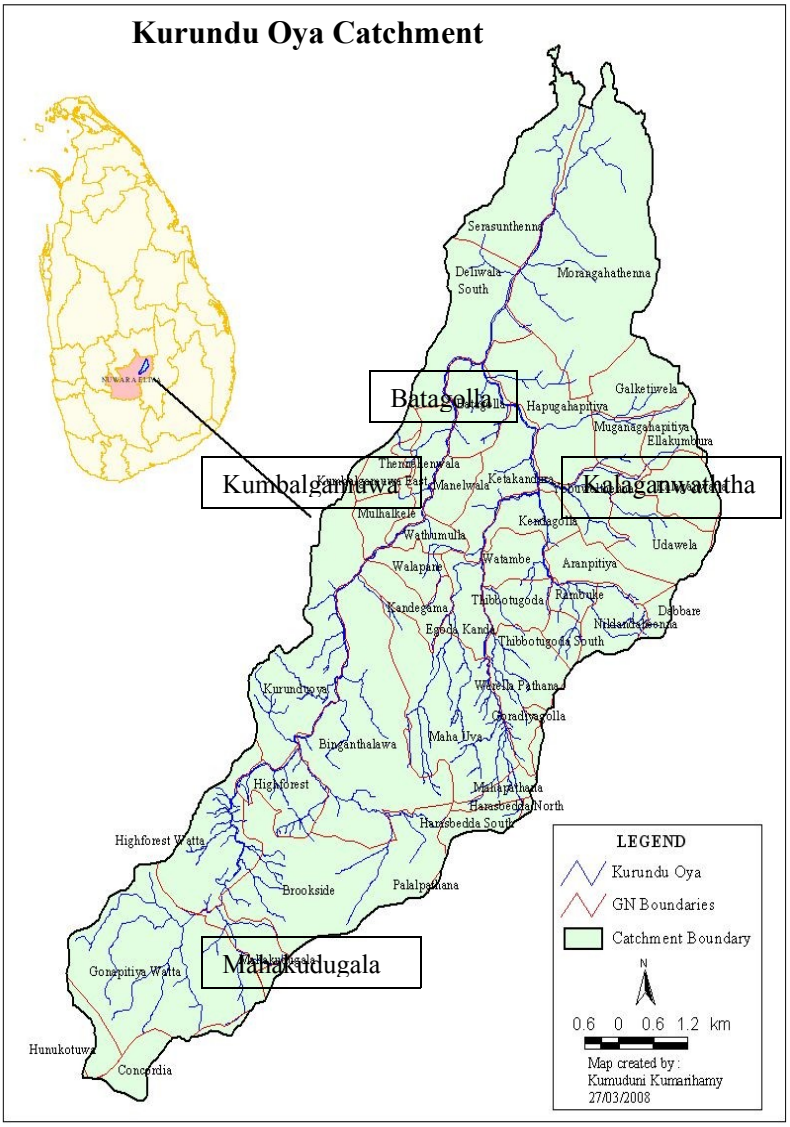

Fig. 1. Location of the study area

Sampling procedure

Since Kurundu Oya catchment is highly heterogeneous in relation to topography and the distribution of farming systems, stratified random sampling was applied to select the sample for the household survey. First, the catchment was divided into three groups according to the altitude, representing lower (below 750 masl) middle (750-1250 masl) and the upper catchment (above 1250 masl). This stratification by altitude was undertaken since soil erosion is affected in different ways with its on-site and off-site effects. The second

stratification was done according to the farming systems available in the catchment. From the stratified sampling frame, a random sample of households was obtained in order to get a representative sample (Table 1). The household was considered as a sampling unit and the total sample size was 150. The sample size obtained from different farming systems was decided according to the population density.

Data analysis

Cross tabulation was used to interpret the general characteristics of the selected sample. The farmers' perception on constraints in adopting soil conservation measures was analyzed by conducting a matrix ranking exercise. Six constraints were identified in the preliminary discussions with farmers and were put into the columns of the matrix. Then the farmers were asked to rank them from one to six according to the descending order of the severity. The Friedman's test was used to analyze data in the matrix. The farmers involved in the ranking exercise were considered as 'blocks' and the constraints as 'treatments' (Wijesuriya and Thattil, 2005). The analysis was done employing the statistical package, Minitab version 7, and the multiple comparison was carried out as suggested by Siegel and Castellan (1988).

Regression analysis was conducted to examine the influence of the socio-economic variables on the investment in soil conservation. Since this study was mainly focused on soil conservation, the investment in soil conservation was considered as the dependent variable. It was found that farming income is a function of crop type (TC), education level (EL) of household head and the farm size (FZ). Therefore, two regression models were fitted (Equations 1 and 2).

FI = f (TC, EL, FZ) ---------- (1)
ISC = f (FI, AW, LT) ---------- (2)

Where,
FI = Farmer's income from farm (Rs./month),
TC = Types of crop, dummy (TC=1 for vegetables and 0 otherwise),
EL = Education level of the household head, dummy (EL=1 for education above grade 8 and 0 otherwise),
FZ = Size of the farm (Ac),
ISC = Investment in soil conservation (Rs./acre/season),
AW = Awareness of soil conservation, dummy (AW=1 for satisfactory level of awareness and 0 otherwise) and
LT = Land tenure, dummy (LT=1 for legally owned and 0 otherwise)

RESULTS AND DISCUSSION

The Kurundu Oya catchment consists of a considerable heterogeneity in geomorphology and the farming systems (Table 1). Paddy farming is the dominant land use system in the lower part of the catchment where water is available year round. Most of the arable lands in the middle catchment are kept under rotational farming system which consists of paddy in the wet season and vegetables in the dry season. Intensive vegetable farming is mainly confined to the upper catchment because of the prevailing favorable climatic conditions. Apart from that, home gardening and rain-fed farming are practiced at subsistence level all over the catchment.

Table 1. Characteristics of the surveyed sample

Location of the catchment	Village	Farming system	Household Head (according to gender)	
			Male	Female
Lower	Batagolla	Paddy	22	8
Middle	Kalaganwaththa	Home gardens	18	12
		Rain-fed farming	10	3
	Kumbalgamuwa	Paddy -Vegetable*	32	4
Upper	Mahakudugala	Intensive vegetable	34	7
Total			116 (77%)	34 (23%)

* Paddy during *Maha* and vegetables during *Yala.*

According to the results in Table 1, 77% of the heads of households are married men while the remaining 23% are women. In general, women are involved more in regular household activities than men (Wickramasinghe, 2007). Therefore, the contribution of women to the farming and conservation activities is relatively low.

With respect to the education level, about 46% household heads have received education up to primary level, and 42% have got education up to GCE (O/L) or higher. However, 11% of the surveyed households have received no formal education. The households with higher education level adopt conservation measures better than others since they are in a better position to understand soil erosion issues and have more access to information (Amarasekara *et al.*, 2008). Nearly 89% of household heads are below 65 years, and they belong to the working force. Twenty five per cent of the sampled farmers are below 30 years and is the most active and innovative group of the farming community. They have better understanding of soil erosion problems and are more interested in soil conservation. Income, which is primarily from farming, is a key factor that affects investment on soil conservation. Forty two per cent of the sampled farmers earn less than Rs. 2500 per month and hence they are not in a position to invest on soil conservation. Only 11% of the households earn farm income over Rs. 10000 per month (Table 2). Most of them are involved in intensive vegetable cultivation.

Table 2. Education, age and monthly income of household heads adopting different farming systems

Description of Household head		Farming System					
		Paddy	Home gardens	Rainfed	Paddy-vegetable	Intensive vegetable	%
Education	No schooling	5	3	4	3	-	11
	Grade 8	13	17	9	12	10	46
	GCE (O/L)	10	10	-	11	15	35
	Above (O/L)	2	-	-	4	5	8
Age	Below 30	7	2	-	11	13	25
	30- 65 years	19	25	8	17	16	64
	Above 65	4	3	5	2	1	11

Monthly income	Below 2500	12	22	13	6	3	42
(Rs.)	2500 - 10000	18	8	-	19	17	47
	Above 10000	-	-	-	5	10	11

Constraints to adopt soil conservation measures

Farmers were asked to list different constraints for adopting soil conservation measures in their fields. Farmers were then asked to rank the constraints they identified in the order of their importance by assigning a score on a scale from 1 to 6 (1 for most important and 6 for least important). The results of this ranking exercise are given in Fig. 2 and the statistical comparison is shown in Table 3. According to the farmers' perception, high cost of soil conservation is the most serious constraint in adopting soil conservation measures. Nearly 42% of the sampled farmers receive an income less than Rs. 2500 per month. Gamage and Aheeyar (1998) reported that lands operated by low income groups are more susceptible to soil erosion in the UMCA. They further emphasized that lack of capital is a major factor that affects adversely in soil conservation. The second most important constraint is the lack of awareness on soil conservation. It was found in the field investigations that there are only four Agricultural Instructors for the entire catchment. The Provincial Department of Agriculture is responsible for the extension service. According to the farmers' views, their service is not adequately provided at the moment. Lack of labour and the low availability of materials were recorded as the other constraints for adopting soil conservation. Since most of the younger generation is attracted by military forces and they tend to migrate to urban areas, the availability of labour force for agriculture in the catchment has declined gradually (Anon, 2001). It creates a high demand of skilled labor and hence poor farmers find it difficult to get their services. In contrast to the common belief, land tenure was not considered as a serious constraint to adopt soil conservation measures. Though farmers often complain that practice of soil conservation measures like hedge rows disrupt farming activities, it was the least important according to the results of the ranking exercise.

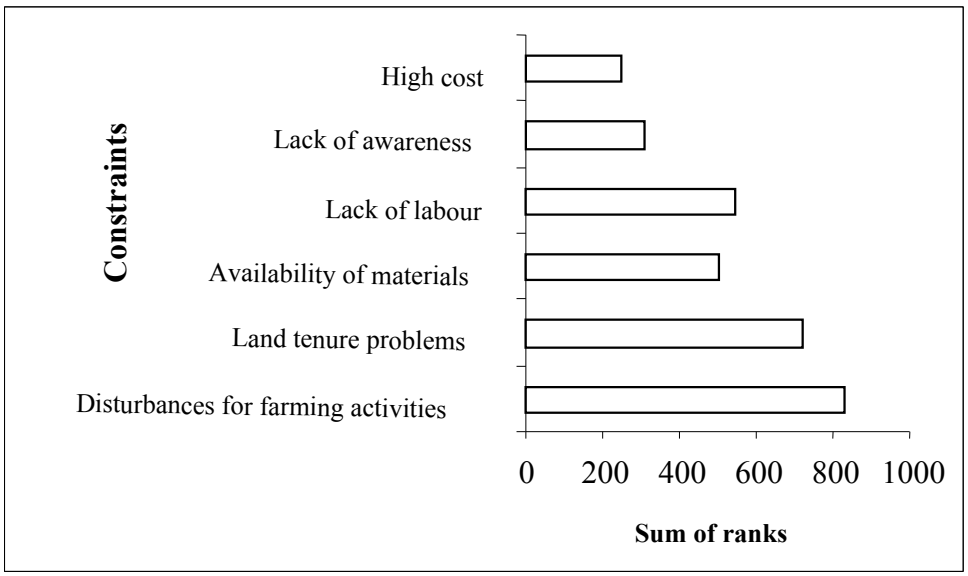

Fig. 2. Sum of ranks given by farmers for different constraints to adopt soil conservation measures (n = 150)

Table 3. Statistical comparison of the ranks of constraints in practicing soil conservation measures

Constraints	Mean Score
high cost	1.49[a]
lack of awareness	1.93[ab]
low availability of materials	3.14[c]
lack of labor	4.16[d]
land tenure problem	5.17[e]
Disturbances for farming activities	6.47[f]

Means with same superscript are not significantly different at p = 0.05.

Results of the regression analysis

The results of the first regression model revealed that farmers' income is significantly affected by all three variables, namely crop type, education level and the farm size, included in the equation (Table 4). They explain 51% of the variation in farm income. The coefficients of the three variables are significant at 5% probability and have the expected signs. The results indicated that vegetable growers earn nearly Rs. 11094 more than other farmers from one acre of land in a season. Farmers having higher education level (above grade 8) earn Rs. 2889 more compared to those who have low education (below grade 8) level. In addition, when the farm size increases by one acre farmers' income increases by Rs. 3446. Crop yields and the selling prices of the farm products can significantly affect farmers' income. However, these two variables could not be assessed accurately by the household survey, because farmers were usually reluctant to maintain farm records. The results of soil analysis revealed that nutrient management of the farming systems is inappropriate. This could be a reason for low crop yields and hence low farmers' income. In addition, the influence of the middlemen in the marketing channel suppresses the bargaining power of the farmers resulting in low income from agricultural commodities.

Table 4. Regression analysis on farmer's income

Predictor	Coefficient	SE	t statistic	Probability
Constant	1128.89	920.53	1.226	0.222
Type of crop (TC)	11093.72	1284.19	8.639	0.000
Education (EL)	2889.3	1179.8	2.44	0.016
Farm size (FZ)	3445.93	864.36	3.98	0.000
	R^2 = 52%	R^2 = (adj) = 51%		

The results of the regression model 2 (Table 5) indicate that farm income, awareness of soil conservation practices and land tenure significantly affect the investment in soil conservation, and 75% of its variation is determined by these three variables. According to the results of regression model 2, investment in soil conservation is increased by Rs. 6 if farm income is increased by Rs. 100 per season. Thus, wealthy farmers invest more in soil conservation than the poor. Dias (2002) observed that investment in soil conservation increases by 0.26 units when farm income is increased by one unit in the Naula DS division. The report of the World Commission on Environment and Development (1987) recognizes

poverty as one of the major factors that contributes to land degradation. Blaike (1986) describes the close association between farm income and adoption of soil conservation. Moreover, Lovejoy *et al.,* (1986) emphasized that, farmers usually look at the soil conservation from a business perspective as they have to survive in the competitive market while struggling to meet basic needs. Therefore, the decision to adopt soil conservation practices is decided by the short-run economic gains associated with those practices.

The regression model further shows that investment on soil conservation is related to the nature of land tenure and the awareness of soil conservation practices by the household head. Though land tenure was not considered as a severe constraint for adopting soil conservation measures in the ranking exercise, a different result was found in the questionnaire survey. It was revealed that compared to the unauthorized land owners (people who have encroached state lands), farmers who own the land invest more on soil conservation measures, recorded as Rs. 2271 per acre. Many researchers point out that the land degradation is associated with insecure land tenure systems (Gunathilaka and Abeygunawardane, 1993; Gamage and Aheeyar, 1998). On the other hand, the results show that farmers with high awareness invest Rs. 2191 more on soil conservation per acre than the farmers whose awareness is poor. Gunathilaka (1990) showed that soil erosion problem is severe in farms which are operated by people who have less awareness of soil conservation.

Table 5. Regression analysis on investment in soil conservation

Predictor	Coefficient	SE	t statistic	Probability
Constant	322.4	158.1	2.03	0.043
Awareness(AW)	2190.6	93.9	2.33	0.021
Land tenure(LT)	2270.7	92.7	2.45	0.015
Farm income(FI)	0.06	.005	18.54	0.000
	R^2 = 76%	R^2 (adj) = 75%		

Based on the coefficients of the variables in regression equation (2) the estimated expenditure pattern on soil conservation of different farmer groups is illustrated in Fig. 3. It reveals that farmers invest Rs. 6 for soil conservation from every Rs. 100 of the farm income. Farm income is a function of many technical and socio-economic factors. As described in the regression model 1, the crop selection, education level of the household head and the farm size are some of these variables. Apart from that, soil fertility is a vital factor which determines the crop yields. However, at present, farmers obtain low yields despite the high investment on basic agricultural inputs. The main reason is nutrient imbalances in the soil due to inappropriate fertilizer management (Amarasekara *et al.,* 2009). The soil test-based fertilizer recommendation may be a better option.

The private owners with high awareness on soil erosion invest more money compared to the other three categories. On the other hand, encroachers with low awareness invest the least amount on soil conservation. However, it is very clear that even the encroachers can be mobilized towards soil conservation through effective awareness programs. In this respect, strengthening of the extension service would contribute significantly to increase the investment in soil conservation. In addition, land alienation programs such as Jaya Bhoomi and Swarna Bhoomi would be more useful to motivate farming community for practicing soil conservation through more secure land tenure system.

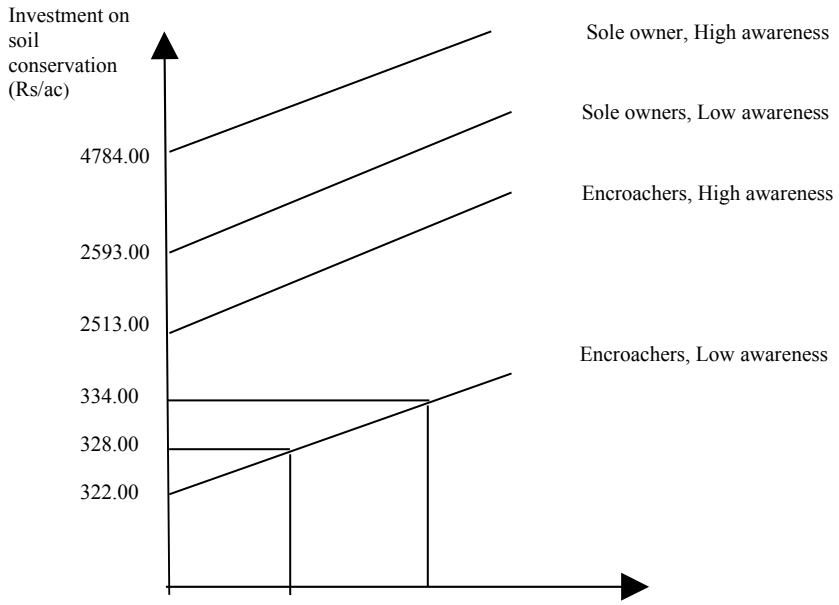

Fig. 3. Farmers' investment on soil conservation

CONCLUSIONS

According to the results of this study, farmers tend to invest more on soil conservation measures with the increase of their farm income, level of awareness of soil conservation practices and the security of the land ownership. However, farm income is determined by various other technical and socio-economic factors that can be manipulated to increase the income. It was identified that even land encroachers can be mobilized towards soil conservation to a certain extent, through awareness programs. The capacity of the extension service has to be strengthened in order to make the farming community aware. Land alienation programs could make an effective change in soil conservation by giving social value to the land owner through more secure land tenure systems.

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