ESTIMATING THE USER COST OF SOIL EROSION IN TEA SMALLHOLDINGS IN SRI LANKA

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ABSTRACT Soil erosion in developing countries is a widespread problem causing considerable economic damage. It still remains an intractable problem in many countries. Available research findings on costs of soil erosion indicate them to be high. Soil erosion continues to be a problem due to the difficulties of estimating the economic damages and attendant difficulties in developing effective control policies. This paper considers soil to be a nonrenewable resource and estimates the marginal user costs using a yield damage function. Results indicate user costs to be low for individual farms. The low user costs are due to some of the assumptions made with respect to a number of parameters such as prices of tea, costs, and technological developments. The results also indicate that marginal user costs are sensitive to prices, soil depth and soil loss.

1. INTRODUCTION

Soil erosion has been of major concern for decades but there is little information on the economic impacts or the economic value of soil in many countries. The losses of soil in terms of the irreplaceable inputs are the primary factors determining the productivity and economic costs of erosion. The causes and consequences of soil erosion are far from being settled. Inappropriate government policies and institutions, commodity prices, farm subsidies, taxes and other forms of government intervention have all being implicated in soil erosion. Lipton (1987) argued that high commodity prices would encourage "soil mining" for quick and bigger crops now. LaFrance (1992) concludes that where both cultivation intensity and the level of conservation activity responds to market forces, higher prices lead to more intensive use of soil thereby aggravating soil erosion.

Clarke (1992) found that investment on soil conservation measures would increase when product prices are favourable and that economically viable conservation technologies are available. The World Bank's Development Report (1986) states that the poor performance of agriculture in low-income countries is due to macroeconomic policies such as overvalued exchange rates and agricultural taxes which alter incentives for farmers. Chisholm, Ekenayake and Jayasuriya (1997) examined Sri Lanka's trade liberalisation and cautioned that economic losses from soil erosion in Sri Lanka are quite substantial even under low erosion-low economic impact assumptions and that trade reforms alone are inadequate to substantially reduce soil erosion. They contend that policies, which directly target soil erosion, are required to minimise social losses from such erosion.

Soil erosion produces both on-site and off-site damage such as water pollution and sedimentation of waterways (Herath, 1985). Some off-site effects can be beneficial but often damaging effects are apparent. These externalities persist due to market failure caused by the absence of property rights. The costs of soil erosion and the benefits of soil conservation are difficult to determine. Available studies show these costs to be high. The annual cost of soil erosion in Java has been estimated at US$ 340-406 million, around 0.5 percent of total GDP (Magrath and Arens, 1989). In Sri Lanka, losses due to soil erosion in the Nuwara Eliya district were assessed at Rs. 814 million per year (Abeygunawardnea and Samarakoon, 1993). In another study conducted on potato lands in the Nuwaraeliya district in Sri Lanka, the estimated on-site nutrient replacement cost ranged from Rs. 4251/ha to Rs. 3443/ha in the Maha and Yala seasons[1] respectively (Samarakoon and Abeygunawardena, 1992). For the development of policy, oriented towards sustainable development of agriculture, some quantitative assessment of the on-site and off-site damage due to erosion is required.

1.1 Objectives

(a) review the theory of optimal non-renewable resource use;
(b) present the marginal user cost (*MUC*) as a concept to measure in-situ losses due to erosion;
(c) estimate *MUC* of soil erosion for tea smallholders in Sri Lanka; and
(d) develop policy implications to minimise erosion.

This paper is organised as follows. The first part of this paper provides an introduction to soil erosion and the associated causes and costs. The second part discusses the theoretical aspects of soil as a non-renewable resource. Section three presents theoretical aspects of *MUC*. Section four provides information on the importance of the soil erosion problem in tea in Sri Lanka. Section five presents estimates of the *MUC* of soil erosion for three tea growing regions and the estimates of regional and national costs of soil erosion based upon the *MUC* estimated. The implications of the results are discussed in the concluding section.

2. THEORY OF OPTIMAL USE OF SOIL RESOURCE

Natural resources are broadly classified into renewable and nonrenewable resources. Renewable resources regenerate rapidly during exploitation as long as certain threshold levels are not exceeded (Howe, 1979). Most biological resources such as forests, fisheries etc. belong to this group. Non-renewable resources however, are resources that are available in limited quantities such as minerals, where the regeneration rates are extremely low. The soil resource is often classified as a non-renewable resource, although under natural conditions, topsoil is a renewable resource. Ciriacy-Wantrup (1968) classifies topsoil as a renewable resource with a threshold level below which resource use makes it

[1] Maha and Yala seasons are the two main rainfall seasons in Sri Lanka fed by North East and South West Monsoons.

non-renewable.

However, empirical observations especially in developing country agriculture show clearly that threshold levels are often exceeded which transforms the soil resource into a non-renewable resource. These high rates of current extraction reduce the future availability of the productive soil thereby reducing the consumption benefits of the soil for future generations. Efficient use of the soil thus involves an appropriate allocation of the soil resource stocks between generations. The soil erosion problem needs to be examined in an inter-temporal framework using dynamic efficiency criteria where society maximises the present value of net benefits obtained from a resource. This typically requires the balancing of resources between current and future consumption. The *MUC* thus becomes a relevant issue. *MUC* accommodates the dynamic element through the discount rate.

3. MARGINAL USER COST

In case of a non-renewable natural resource, the fact of scarcity itself imposes costs in the inter-temporal setting. Consumption in period one comes at the expense of satisfaction foregone in later periods (Randall, 1987). The present value of the forgone future opportunities due to exploitation of a unit of soil at the margin is defined as the marginal user cost (*MUC*).

In Figure 1, the net returns obtained by using a resource in period t_1 and t_2 are $\mathbf{NR}t_1$ and $\mathbf{NR}t_2$, respectively where $\mathbf{NR}t_1 > \mathbf{NR}t_2$. If no depletion (or soil erosion) has occurred, the net revenue stream, $\mathbf{NR}_0$ would be constant over time. This is not realistic since soil erosion inevitably occurs and lowers future revenues. The loss of future revenue due to resource extraction during the period t_1 to t_2, the marginal net revenue loss is $\mathbf{NR}t_1$ - $\mathbf{NR}t_2$. That is, soil erosion due to crop production lowers future returns because the soil resource stock is smaller. The *MUC* for the n^{th} unit of soil, over an infinite time horizon, can be stated as,

$$MUC = \frac{\mathbf{NR}\, t_1 - \mathbf{NR}\, t_2}{r} \qquad (1)$$

where r is the real discount rate.

The depleting nature of the soil creates an upward shifting *MUC*. This implies that as the resource is extracted, the *MUC* rises. In other words, the present value of the future benefit stream foregone due to each unit of soil erosion at the margin rises. In determining optimal use, the marginal extraction cost as well as the *MUC* should be considered.

The equilibrium quantity of the soil resource used is lower when *MUC* exists. This difference in quantity represents the amount that the resource owner will sacrifice in order to use it in the future. A positive *MUC* implies physical and

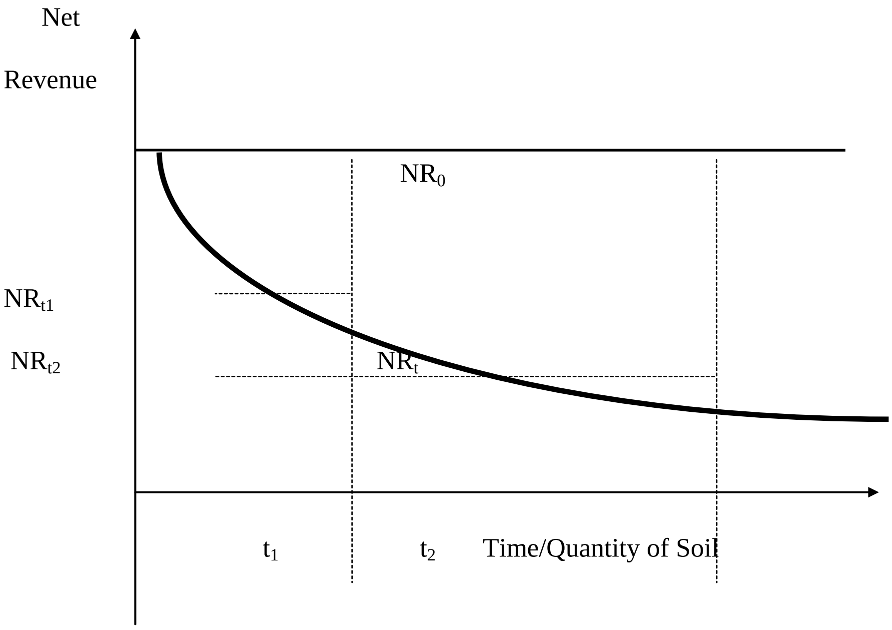

Figure 1. Marginal User Cost

economic depreciation of the land asset[2] . With well-defined property rights, a positive *MUC* will be incurred only when the current benefits from resource use exceed the associated decline in the present value of future benefits.

The *MUC* represents the true economic cost of soil resource use. It captures the value of soil loss (eroded) in terms of the impact on future production of the loss of soil nutrients, increased soil acidity, loss of soil depth and soil structural decline in the current period (Chisholm, 1995). Few studies have used the *MUC* as the on-site cost of soil erosion (Van Kooten *et al*, 1989; Smith and Shaykewich, 1990). *MUC* is also affected by several other parameters such as prices, costs and technology.

4. THE IMPORTANCE OF SOIL EROSION IN TEA

Tea is an important export crop for Sri Lanka and is a major foreign exchange earner. Tea is grown as a rainfed crop in an extent of about 195,000 ha in Sri Lanka. Around 45 percent of this area is under seedling tea while the balance is under high yielding varieties.

Sri Lanka's annual production of tea is now in the range of 280m. kg. per year. Around 97.1 percent of this was exported in 1998, and is the highest export earner for Sri Lanka (Central Bank, 1999). Tea is classified into 'low-country', mid-country' and 'up-country' on the basis of elevation. The up-country holdings are located above 1200 metres. The mid-country and the low-country

[2] Prices and technology are assumed constant.

holdings are located between 600-1200 metres and below 600 metres respectively. The teas produced in these regions are referred to as high-grown, mid-grown and low-grown teas respectively.

Until 1975, all tea holdings below 4 ha. were classified as smallholdings. After 1975, all holdings below 20 ha. were classified as smallholdings. The tea smallholder sector has increased by 16 percent during the 1982-92, while the plantation sector has declined. Tea smallholders are scattered in all tea growing districts. The Kandy, Galle and Badulla districts accounted for 25.3 percent, 22.8 percent and 8.3 per cent of smallholders respectively. The average farm sizes are small being 0.5 ha., 0.4 ha., and 0.5 ha. in the Kandy, Galle and Badulla districts respectively (Ministry of Plantation Industries, 1994). These three districts were selected for this study to represent the mid-grown, low-grown and high-grown tea respectively. Most plantations have their own tea factories for processing tea. The green leaf is withered, ground and then fermented in the tea factories until an appropriate fermentation level and colour has occurred. This becomes made-tea, which is packaged for export. One kilogram of made-tea requires 4.5 kg of green leaf.

Tea is a perennial crop, which is pruned periodically. Soil under tea gets exposed to varying degrees of erosion depending on the planting density, type of planting, method of pruning, and the extent of manual weeding using scrapers. The average rainfall in Galle, Kandy and Badulla are 2267mm., 1790mm. and 1672mm. respectively. The high intensity rainfall on steep slopes with varying degrees of soil exposure has added to the erosion of fertile topsoil. A total of around 20000 ha. of tea land in the mid-country of Sri Lanka have gone out of production due to soil erosion. Continued soil erosion threatens the long-term sustainability of the industry.

Soil erosion in tea growing areas in Sri Lanka has caused severe decline in productivity, leading to a decrease of net incomes. Declining net incomes lead to changes in crop mix and increased input use and in extreme cases, withdrawal of land from cultivation leading to marginalisation. Soil resource depletion has inter-generational implications. High rates of soil erosion, which surpasses the natural rate of regeneration, can deprive future generations of the current productivity levels assuming technological advancement will not offset the erosion damage. The smallholders ignore such temporal externalities and inter-generational considerations due to short planning horizons and high subjective discount rates (Thampapillai and Anderson, 1994). Though they can afford to disregard these in the short run, society cannot.

Estimates of soil loss of 100-200 t/ha/year have been reported in tea plantations with less than 40 percent ground cover (Stocking, 1992). An estimation based upon the universal soil loss equation reported that the soil loss in tea smallholdings in the Nuwara Eliya district in Sri Lanka is about 43 t/ha/year (Abeygunawardena and Samarakoon, 1993). Different methodologies have been used to estimate soil erosion in different areas. El- Swaify *et al*, 1983) is the only study where the same methodology was used to estimate erosion rates in the high-grown, mid-grown and low-grown tea in Sri Lanka. Hence El-

Swaify's values were used in this paper to estimate the *MUC*. The magnitude of soil loss caused by poorly managed tea cultivation seems to be equal to those of highly erosive crops such as tobacco and potato. The operators of such crops continue to 'mine' the soil by erosive practices, which may offer higher yields currently. Estimates of *MUC* are useful in designing policies to minimise erosion damage.

5. ESTIMATION OF MARGINAL USER COST OF TEA

The sections below discuss in detail the methods adopted in estimating the *MUC*, the method of data collection and the limitations.

5.1 Data Collection

Data were collected from a total of 77 tea smallholder farmers from three districts in Sri Lanka namely Badulla (high-grown), Kandy (mid-grown) and Galle (low-grown) selected using a two stage random sampling procedure (Ananda,1997). Given the time and resource constraints of the study, a survey of a larger sample was clearly not feasible. Further, given the absence of farm-specific data for the smallholdings population on the major variables relevant to soil erosion, a more sophisticated sampling procedure was not an option. The selected farmers were interviewed to collect data on socio-economic variables, production costs, output prices[3], soil conservation practices, labour use and costs and credit and depth of the topsoil. Returns to tea production were estimated using the cost of production of tea, product price and yields obtained during the interviews.

5.2 The Yield Damage Function

To estimate the marginal yield losses of tea due to soil erosion, a yield function is required. Empirically estimated relationships between soil loss and yield for tea are not available. Anandacoomaraswamy *et al* (1999) represents the only attempt at quantification of the relationship between soil loss and yield for Sri Lankan tea. However, since tea soils are different in terms of various physical parameters, generalisation of this function for all different tea soils in Sri Lanka may not be appropriate. Hence yield-soil relationships were estimated for the three different regions (high–grown, mid-grown and low-grown) separately in this study to address regional heterogeneity. A yield–soil relationship shows the relationship between crop yield and some parameter of soil erosion. Most yield functions have used yield as the dependent variable and top soil as the independent variable. The estimated yield-soil depth relationships were found to be linear at the initial top soil depth levels, and as the thickness of the top soil

[3] For smallholders unprocessed tea or green leaves are the final output.

Table 1. Estimated Yield Functions

Region	Yield Damage Function
1. High Grown	Y_{hg}= 3497 + 9040 (1-0.85^{Dt})
2. Mid Grown	Y_{mg}= 1551 + 4166 (1-0.85^{Dt})
3. Low Grown	Y_{lg}= 3919 + 10015 (1-0.85^{Dt})

declines, the relationship takes a non- linear form (Smith and Shaykewich, 1990; Lal, 1987; Walker, 1982; Walker and Young, 1986; Van Kooten *et al*, 1989; Van Vuuren, 1986). The Mitscherlich-Spillman (M-S) function has found favour in a number of applications to describe the soil loss-yield relationship (Pawson *et al*, 1961; Segarra and Taylor, 1987; Gunatilake and Abeygnawardena, 1993).

The functional form used in this study is given in equation (2)

$$Y^{t} = a + b\,(1 - R^{Dt}) \qquad (2)$$

Where Y^{t} is crop yield in time *t*, *a* is the per acre crop yield (theoretical) when top soil depth is zero; *a*+*b* is the asymptotic value of crop yield when lim $D_t \rightarrow \alpha$; *R* is the constant ratio of marginal product of the top soil depth in time *t* + 1, D_{t+1} to marginal product of the top soil depth in time *t*, D_t. This is a new approach to develop a yield-soil depth relationship using subjectively elicited yield data from farmers (Segarra and Taylor, 1987; Gunatilleke and Abeygunawardena, 1993).

The choice of the M-S functional form was influenced by data availability. Erosion data based on direct physical measurement generally do not exist for smallholders farms. The M-S function is parsimonious in data requirements and hence was preferred. Subjective approaches can be further justified since farmers make important decisions on the basis of their perceptions (Saliba, 1985). The values of *a* and *b* are derived using subjective yield elicitation methods. These functions are non-linear and show that yield drops rapidly when the soil depth declines after a critical depth is reached (Table 1). Further details of the empirical estimation of the functions are described in Ananda *et al* (2001).

Y_{hg} , Y_{mg} and Y_{lg} = Green leaf Yield (kg/ha/yr) for high, mid and low-grown areas respectively.

D_t = Depth of top soil in time *t* (cm)

In estimating the *MUC*, the losses in tea yield due to reduction in soil depth were evaluated using these yield functions for each district. The initial soil depths of 450mm, 335 mm and 355mm for high-grown, mid-grown and low-grown areas respectively were used. These topsoil depth values were obtained from farmer interviews. When the depth of top soil begins to fall from these initial depths, the yield functions provide an estimate of the yield losses, which were then converted into lost income using the prices of tea obtained in the survey. The prices used were Rs. 11.00, 8.63 and 11.77 per kilogram for low, mid and high-grown tea

Table 2. Estimated Marginal User Costs for Tea Soils

Region	Marginal User cost[a] (Rs/cm/ha)[b]
1. Low-grown	489.44 (3.76)
2. Mid-grown	238.08 (1.83)
3. High-grown	81.28 (0.62)

[a] At 10 per cent discount rate
[b] Figures in parenthesis are in rupees per metric ton of soil

respectively. The costs of production were assumed to be constant over time. A discount rate of 10 per cent was used as the base case, following studies conducted by others (Samarakoon and Abeygunawardena, 1992; Bishop and Allen, 1989; Magrath, 1990). Here new technology such as clonal tea was assumed to affect all three regions equally so that the yield effects of new technology will cancel out.

The analysis does not incorporate the natural yield variations due to the ageing of the tea bush. In general, in tea, after reaching their maximum yield around year six, yields in both seedling and vegetatively propagated (VP) tea tend to decline slowly. It is noted that the yield of VP tea declines faster than that of seedling tea. However, these yield reductions are negligible when acompared to yield losses due to soil erosion at critical topsoil depths.

5.3 Marginal User Cost Estimates

*MUC*s were estimated by calculating the present values of future yield losses resulting from soil erosion, discounted in perpetuity. The future benefits forgone were calculated by multiplying the marginal yield loss by output price. In this sense, the approach is very similar to that used by Van Kooten *et al* (1989). Table 2 shows the *MUC* figures for the three regions at a discount rate of 10 per cent. Low-grown tea smallholdings have the highest *MUC* of Rs. 489.44 per cm of topsoil lost, compared with Rs. 238.08 per cm for mid-grown tea, Rs. 81.28 per cm. for high- grown tea. Low-grown tea lands have the highest green leaf yield. The high *MUC* for Low-grown tea soils can be attributed to higher yield damage at the current topsoil depth and the higher output price. As the topsoil depth declines, the *MUC* rises in all three regions. This can be attributed to soil erosion having a multiplicative impact on crop yield.

The *MUC* figures of all three regions are significant from an economic point of view. These results reveal that future benefits forgone due to soil erosion, depends on location. Thus, the investment that the farm operator undertakes to compensate for the damage, may vary from region to region. It is clear that low-grown tea smallholders have a greater need to adopt soil conservation measures.

Table 3. Sensitivity Analysis of Marginal User Cost Estimates

Scenario	**Low-grown (Rs/cm/ha)**	**Mid-grown (Rs/cm/ha)**	**High- grown (Rs/cm/ha)**
1. Price sensitivity @10 per cent discount rate			
(a).25 per cent price reduction	367.08	178.50	60.98
(b).25 per cent price increase	611.80	297.67	101.59
2. Soil loss sensitivity @10 per cent discount rate			
(a).40 tons/ha./year	150.60	87.91	7.50
(b).75 tons/ha./year	282.36	164.82	14.07
(c) 200 tons/ha./year	753.00	439.57	37.52
3. Discount rate sensitivity			
(a). 5 per cent	978.88	475.80	162.50
(b).20 per cent	244.69	119.04	40.64
4. Yield sensitivity @10 per cent discount rate			
(a).10 per cent yield reduction	440.50	214.28	73.16
(b).10 per cent yield increase	538.39	261.89	89.41

Table 4. Sensitivity of Marginal User Cost to Topsoil Depth

Topsoil depth (Mid point) (cm)	**Low-grown (Rs./cm)**	**Mid-grown (Rs./cm)**	**High-grown (Rs./cm)**
>90	0	0	0
80	0.37	0.12	0.36
70	1.89	0.62	1.83
60	9.62	3.14	9.29
50	48.87	15.95	47.20
40	248.25	81.02	239.77
30	1260.96	411.52	1217.88
20	6404.92	2090.26	6186.07
10	32533.00	10627.21	31421.39
5	73321.19	23928.53	70815.90

[a] For a 10 per cent discount rate

5.4 Marginal User Cost Sensitivity Analysis

Sensitivity analyses were carried out for the *MUC* estimates derived from the yield equations. Table 3 provides a summary of the sensitivity analysis. *MUC*s

Table 5. Estimates of Marginal User Cost for the Total Smallholder Sector [a]

Item	Low-grown	Mid-grown	High-grown	Total
Area of Smallholdings (ha.)	28,154	34,023	13,588	75,765
User Cost (Rs./tons/ha.) for 1996	3.76	1.83	0.62	6.21
Total User Cost (Rs. Million/year)	15.6	6.5	3.5	25.6
User Cost- All tea soils (Rs. Million/year)	40.5	15.8	16.8	73.1

Notes: [a] Using potential soil erosion rates i.e. 147, 105 and 412 tons/ha/year for low, mid and high-grown areas respectively and 10 per cent discount rate.

[b] Tea areas are from the report of the Census of Tea Smallholdings, 1984.

depend on the output price, soil loss, topsoil depth and discount rate. Sensitivity analyses indicate that *MUC*s vary considerably with changes in the magnitude of all the variables tested. The estimated *MUC*s are sensitive to changes in the product prices. The changes appear to be fairly significant both for increase and decrease in prices. Even with moderate levels of soil loss (soil loss of 40 tons/ha./year), the *MUC* estimates are high, except in high-grown tea. For low-grown tea holdings, *MUC* varies from Rs.150.60 to Rs. 753.00 when the soil erosion rate increases from 40t/ha/yr to 200t/ha/yr. For the same range of soil loss, *MUC* for mid-grown tea varies from Rs. 87.91 to Rs. 439.57. High-grown tea holdings show the smallest range from Rs. 7.50 to Rs. 37.52.

The sensitivity of *MUC* to changes in topsoil depth given in Table 4. It shows that for topsoil depths greater than 90 cm, *MUC* is zero, implying that at such topsoil depths the soil resource is not a limiting factor in production. Up to a topsoil depth of about 40 cm, the *MUC* estimates are very low. An exponential growth of *MUC* values can be seen when topsoil depth declines below 40 cm. As the yield-soil loss function captures the cumulative effects of topsoil decline, the *MUC*, and the value farmers place on soil, increase rapidly after a critical topsoil depth is reached.

The above results show that soil resource can bear depletion up to a point or a critical topsoil depth and thereafter, rapidly productivity changes occur. This is due to the use of the exponential yield damage function.

The on-site economic cost of soil erosion for the whole smallholdings sector in each district is estimated using the estimated *MUC* values. These are given in Table 5. These estimates are made by multiplying the *MUC* figures for each production region by the total smallholding tea area in the region. These estimates are only approximations however. Low-grown tea soil erosion incurs the highest on-site cost (40.5 Rs million), followed by high-grown and mid-grown tea with on-site costs of 16.8 Rs and 15.8 Rs million, respectively.

Samaratunga (1996) estimated the *MUC* of soil erosion in the up-country of Sri Lanka using the same theoretical approach. He computed the *MUC* for poorly managed, well-managed and vegetatively propagated tea. He obtained *MUC*s of .Rs. 18.09/ ha. – 21.70/ ha for poorly managed tea, Rs.3.63/ha. – Rs.7.23/ha. for well managed tea and Rs 2.44/ha- Rs.4.88/ha for vegetatively propagated tea. These figures are very low compared to the findings of this study. This is due to a number of reasons. First, he uses a linear soil loss-yield relationship.[4] This clearly ignores the multiplicative effects of topsoil loss in sloping tea lands and causes an underestimation of erosion-induced yield impacts. We have noted in this paper, that soil loss-yield relationship is non-linear at least for the highly eroded soils, and the soil resource can bear erosion up to a certain topsoil depth after which marked declines in yield is observed.

Second, he uses highly conservative soil erosion rates, which again underestimate the erosion-induced yield losses. Third, he incorporates yield variations (non-erosion induced) with time, which is absent in our study. Further, his analysis was carried out for the larger plantations. There are significant differences between large tea plantations and smallholder plots and the user costs estimates presented in Samaratunga (1996) cannot be directly compared with our results.

The *MUC* estimated in this study are also generally low and hence the figures should be interpreted with caution. This study alone would not be sufficient to generalise the nature of the *MUC* as low or high. One should take note of the assumptions made on prices, costs, technological change and the use of subjective information. It is only through cumulative studies that the generality of the results could be established.

6. CONCLUSIONS AND IMPLICATIONS

This study shows that *MUC*, which reflect the on-site costs of soil erosion, in this study are not high. The lower marginal user costs of soil erosion could explain why soil conservation practices are not widely adopted by farmers. However, poor current prices, poor prospects of higher tea prices in the future and various subsidies may lower *MUC*. Further, the yield-soil depth relationship is nonlinear (the marginal product of soil increases as soil depth falls) and the most severe impacts occur after some erosion has already occurred. This may obscure the importance of initiating soil erosion control measures early, which is necessary if we are to avoid serious losses later on. This aspect is particularly important for peasant farmers who have short time horizons and high discount rates. The dilemma for planners is whether farmers use their high subjective discount rates or lower subsidised commercial rates in making long term decisions involving the soil resource. The former will enhance use of erosive practices and the latter will lower the rate of extraction. This is an important

[4] The study is confined only to the up country tea soils. The linear soil loss-yield relationship used was 1cm loss of soil is equivalent to reduction of yield by 7kg/ha.

issue that awaits an answer from an empirical perspective.

The *MUC*s are affected by prices of the commodities (both input and output), the topsoil depth and the discount rate. When the product price is higher, the losses for future generations are high and that future generations may be seriously disadvantaged. This implies that if administratively determined tea prices are higher, it may lead to greater soil erosion. Common policies such as fertiliser subsidies and soil conservation subsidies lower input costs thereby increasing the *MUC*. Further, fertiliser subsidies may obscure the adverse yield impacts of soil erosion and may encourage farmers to postpone erosion control measures. Soil conservation polices may help restore yields and at the same time may not jeopardise future generations. The subsidies should thus be reviewed critically from this perspective. Higher fertiliser usage is a feature among plantations but these practices have been adopted by smallholder tea farmers as well aided and abetted by subsidies. There is considerable soul searching to do on government support programs, which have been formulated more, for political reasons than for long-term preservation of important natural resources. The *MUC* reflect only the on-site damage. There is considerable off-site damage due to soil erosion, which has not been considered. If these costs are included, the total damage costs may be very high which makes erosion control an urgent need. From an economic perspective there may still be a case to view the problem seriously and implement remedial measures.

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