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RESEARCH ARTICLE

Sustainable Land Management: A Tool to trade-off the Production Cost in Tea Sector

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ABSTRACT

Escalation of production cost is a crucial factor, which drastically affects the production of tea smallholding sector in Sri Lanka. Therefore, it is important to suggest sustainable land management and soil conservation as an effective mechanism for long-term trade-off of the production cost. Therefore, this study was conducted as an attempt to identify the perspective (awareness and adoption) of local tea landowners on the concept. Liker scale survey questionnaire based structured interviews were carried-out as the technique for primary data collection. A sample of 100 tea small holders was selected through purposive sampling technique. Awareness and adoption indices used to analyze the perception of farmers on land management principles and, they were found to be in moderate level. Moreover, their awareness was an induction for adoption (r: 0.681, p≤ 0.01).Pearson coefficient was computed to identify the socio-demographical factors behind their perspective on the concept. Results indicated that their awareness was vastly depending on age(r: 0.32, p≤0.001), income (r: 0.23, p≤0.02), and property size (r: 0.22, p≤0.03). Moreover, income (r: 0.27, p≤0.007) and property size (r: 0.27, p≤0.007) were significant factors for their adoption. In addition, farmers' knowledge on land degradation and the extent of encountered problems of land degradation were significant for both awareness and adoption. To make a better inference, cost of soil erosion in tea lands was computed by considering the fertility depletion under replacement cost approach. Increased cost for additional fertilizer considered as the major indicator of land degradation. Estimated cost of erosion in large (>0.81 ha/2 ac) and small (<0.81 ha/2 ac) scale tea lands were LKR62, 892 and 60,418 ha/annum respectively. The study revealed that tea farmers have positive perspective to contribute to sustainable land management and soil conservation. Hence, study suggested it as a good agricultural practice to trade-off of the additional production cost in tea lands.

Key words: farmers' perspective, replacement cost, sustainable land management, tea smallholders

INTRODUCTION

As major plantation crop in Sri Lanka, tea provides two percent to total GDP. There are approximately 205, 000 ha of tea lands in 14 administrative districts, and provide employment opportunities around 2.5 mnof population [1]. Major producer of Sri Lankan tea is small holders, who represent 70 percent of total tea community [2]. Tea is grown in variety of soils but, the best is light, friable loam with porous sub-soil, which is mostly located in hilly areas [3]. In Sri Lanka, tea is majorly grown on *Ultisols*, which occurs in higher rainfall areas with high level of soil erodibility [4]. According to Anonymous [4], land degradation is severe in tea lands. He explained that soil under tea is exposing varying degree of erosion, depending on poor crop and soil management practices and steep topography. Anonymous [5] estimated that soil loss for tea plantations in Sri Lanka is around 100- 200 m/ha/year. Anonymous [4] discovered that around 43,000 ha of old tea plantations suffered from serious soil degradation in mid-country and up-country regions while, total around 20, 000 ha of mid-country tea lands have gone out of production, due to soil erosion [6]. Recent

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observations estimated that around 30 cm of top soil has been lost from upland tea plantations [4].Soil erosion is a common issue which directly affects to the fertility levels of cultivations. Anonymous [4] identified that 1 cm of top soil loss causes yield decline in 44 Kg/ha/year. However, continuous cultivation of the same crop, removing yield and residuals from the field and leaching of nutrients also cause to declining the existing fertility level of soil [7]. Because of this, it directly increases the additional fertilizer usage (more than the requirement) by farmers. Hence, it gradually increases the cost of production [2, 8]. By means of long term reduction in cost of production, Sustainable Land Management (SLM) is a worthy solution. It is explained as "combination of technologies, policies and activities, in order to reach environmentally friendly, economically viable and socially acceptable production goals" [9]. It involves with mitigation of soil degradation and enhancement of soil quality. By increasing soil moisture, it enables soil development functions. It contributes to increases the primary production through enhancement of nutrient cycling. Further, SLM involves with bio-diversity preservation at farm level through judicious land management practices. To orient farmers towards SLM, the country should have an effective mechanism. Therefore, it is vital to identify farmers' perception on the subject [10]. Yet, the country is still lack of efforts on the matter. This study was an attempt to fill the information gap of famers' perspective on SLM practices in tea smallholding sector-Sri Lanka.

The three main objectives of the research are:

1. To identify tea smallholders' perspective (awareness and adoption) on SLM practices and soil conservation.
2. To identify the affecting factors for farmers' perspective on SLM.
3. To investigate the on-site erosion cost in tea smallholding lands.

Methodology

The study was primarily designed to assess tea small holders' awareness and adoption on different SLM principles. In the study, it was considered the farmers who owned tea lands less than 10 acres as tea smallholders [2]. Research was conducted in Ratnapura district (low country, wet zone) because; the area consisted of considerable number of tea smallholders. Moreover, the area contributes nearly ¼ of total tea production of the country [1]. Data were captured from primary information sources as well as secondary sources. Structured questionnaire based focus group discussions and direct interviews were carried out with 100 tea small holders, who selected by following simple random sampling technique. To investigate tea smallholders' awareness and adoption, questionnaire was majorly focused on three major principles of SLM: plant nutrient management, build-up of Soil Organic Matter (SOM) and rain water management. In order to have more precise indication, some important practices related to above principles were listed out separately in the questionnaire. To investigate farmers' perception on the concept, awareness index and adoption index were employed for selected three different principles of SLM. As most of the criteria are qualitative, all the criteria were converted in to qualitative rank scale in order to use an appropriate and uniform analysis for all principles. Therefore, farmers' answers were taken into three point scale (0) not aware, (2) partially aware and (3) well aware. For the calculation of awareness (adoption) index, two steps were followed as first, it was calculated the awareness (adoption) indices for each practices related a principle by calculating the mean value of the scale, and second, the awareness (adoption) for each principle was calculated by the mean value of all practices relevant to the principle. For analyzing the relationship between awareness and adoption for each principle, Pearson correlation was employed. Further, to identify socio-demographical and economical factors affecting to farmers' perspective on SLM, Pearson correlation was employed between the factors and the calculated awareness and adoption indices. Statistical Packages for Social Sciences (SPSS) software was used for the analysis. To analyze the cost of degraded soil, mathematical procedure was followed using replacement cost approach. Application of chemical fertilizer amount (T-750: mature tea mixture) and yield removed from tea lands were considered for the calculation. It was separately calculated the amounts of Nitrogen, Phosphorus, and Potassium included in fertilizer mixture and yield, and it was found the limiting factor. In that case, N was the limiting factor. Next, total N amount was calculated in fertilizer mixture and yield separately. Subsequently, the difference between N added and removed by yield was considered as the eroded N amount, hence fertilizer loss from tea lands. This calculation was done under the assumption of 'natural processes (nutrient cycles) and soil formation were considered to be negligible'.

Cost analysis was followed by the below theory.

Nutrient added for tea land (A) , nutrients removed from tea land by yield (A').
If there is no erosion and degradation ,
A-A'=0
If there is soil erosion in the land,
A>A' , A-A' ≠ 0
Therefore, nutrient waste (wash-out) from soil erosion = A-A'
Therefore, nutrient can be save from soil erosion = A-A'
Cost of soil erosion = cost of A-A'
Cost can be trade-off from SLM = cost of A-A'

RESULTS AND DISCUSSION

1. **Socio-demographical characters of farmers**

   The majority of the sample was represented by male farmers (70%) and consisted of most ageing farmers of mean average age of 51 years, starting from 30 and oldest of 68 years. Education level of the sample is laid between grade 8-9 in schooling, varies at completely illiterate to graduate level. Their land extent of tea is in average of 1.15 acres with the mean annual income of LKR 82, 940 (Table 1).

Table 1. Background information of respondents

	Minimum	Maximum	Mean	Std. Deviation
Gender	0.00	1.00	0.7000	0.46057
Age (Years)	30.00	68.00	51.2400	9.58547
Education (Years)	0.00	17.00	8.9200	5.54628
Land Extent-Tea (Acres)	0.06	7.00	1.1581	1.17073
Income (Rs/Year)	10000.00	700000.00	82940.00	110602.74

2. **Farmers' perspective on SLM and soil conservation**.

   Plant nutrient management is essential to maintain soil fertility and crop productivity [11]. Yet, only 20 percent of respondents were in fully awareness on the principle. Calculated awareness and adoption indices for the principle of plant nutrient management are indicated in Table 2.

Table 2. Awareness and adoption of practices of plant nutrient management

Practices of Plant nutrient management	Awareness Index	Adoption Index
I. Organic fertilizer use	1.37	1.22
II. Minimize nutrient loss	0.77	0.77
III. Judicious application of chemical fertilizer	0.99	0.98
IV. Tree legumes as shade trees and source of nutrients	1.09	1.12
V. Soil rehabilitation to build up organic matter	0.83	0.91

Organic fertilizer and judicious chemical fertilizer application to fill the nutrient gap, showed a high level of awareness than farmers' adoption. The existing trend of chemical fertilizer application and associate short-term benefits had increased the tendency on adoption for chemical fertilizers. Further, study revealed that for the principle, farmers' mean awareness and adoption indices were 1.01, 1.0 respectively. In addition, there was a strong positive co-relation between awareness and adoption, which was statistically significant ($r=0.671$, $p\leq0.01$). Similar to current findings, Anonymous [11] revealed that awareness on benefits of nutrient management is considerably low in farming society.Soil organisms are vital in building-up process of SOM. Sample showed a positive awareness on favorable soil organisms, mostly on macro fauna, which they can see (Table 3).

Table 3.Awareness and adoption of practices of buildup of SOM

Practices of Build up SOM	Awareness Index	Adoption Index
I. Mulching	0.85	1.24
II. Cover crops	0.60	0.48
III. Leaf manure	1.49	1.41
IV. Hand plugging of weeds	0.84	1.41
V. Shade tree maintenance	0.83	1.43

Ninety nine percent of the sample was partially or fully perceived them as their intimates (awareness index: 1.71). Similar to current findings, Anonymous [9] stated that some groups within the community understand and value soil life. Further, SOM act as a nutrient reservoir in soil, but most of farmers did not have a satisfactory knowledge on the benefit of nutrient reserving ability of SOM. Only 42 percent of farmers knew SOM is a nutrient reservoir. Moreover, farmers did not have a satisfactory knowledge on shade tree maintenance. Against to current findings, Anonymous [12] observed that farmers have sufficient knowledge on the practice, as they perceived benefits of it. For the principle of building-up of SOM, farmers' awareness was parallel to their adoption level (awareness/adoption index: 0.99) and, there was a positive co-relation between farmers awareness and adoption, which was statistically significant ($r: 0.445$, $p\leq0.01$).

AEXTJ, Sep-Oct, 2017, Vol. 1, Issue, 5

Because of the existing steep topography, rain-water causes to erode the soil and washout the nutrients in tea cultivated lands [4]. To slow down the flow of water, hence the reduction of carrying-away the soil particles that were bound to soil source, drains and paves are essentially to construct in these slope lands. Ninety nine percent of the sample used drains and paves for rain-water management as the most common erosion control method while, their consolidation with other methods like plant filling, mulching, mulching with shade tree lopping, terracing and proper spacing were comparatively less. In dry areas, water, not the land is the most limiting factor in agriculture production [12]. Therefore, harvesting and re-utilizing of rain water is crucial, but none of the sample reused the rainwater though they have encountered with some drought conditions. For all the principles, there was a strong positive correlation between farmers' awareness and adoption (r: 0.681, $p \leq 0.01$).Therefore, by improving their awareness on SLM, it can be increased their investments on the SLM.

3. Factors affecting to farmers' perspective on SLM and soil conservation

As preceding factors on tea smallholders' perspective, socio-demographic and economic factors were majorly concerned by the study. Moreover, awareness on land degradation and prevailing problems in their tea lands were considered as drivers to follow SLM. Results of the Pearson co-relation (Table 4) revealed that gender was not significant for their perspective. Pursuing results of Anonymous [13], younger farmers' perceived erosion as a problem because, they are keen on attend to meetings and innovative than older farmers. Property size and income were positively correlated factors for both awareness and adoption on SLM. Anonymous [14], observed the same result in his study. Anonymous [15] revealed that financial constraints to conservation are less with higher income. Further, Anonymous [16] observed that farm size is proportionate to farmers' perspective because, small plots sacrifice more space for conservation than large plots. This directly affects to their profit. However, large farms expect higher level of quality management [16]. Awareness on land degradation and negative experiences in cultivated lands are affecting to farmers' perspective because, they are crucial for the first step of decision-making effort of SLM [16]. Study also revealed that farmers' awareness on soil erosion and land degradation was positively co-related with their perspective on SLM. Moreover, when the associated problems of soil erosion and land degradation increasing in their tea lands, farmers were more likely to aware and adopt on good soil management practices.

Table 4. Factors affecting to farmers' perspective on SLM and soil conservation

Factor	Awareness	Adoption
Gender	p=0.38, r=-0.89*	p=0.727, r = -0.035
Age	p=0.001, r= -0. 323**	p= 0.232, r= -0.121
Income	p= 0.019, =0.234*	p=0.007, r=0.269**
Property size	p=0.029, r=0.218*	p=0.007, r=0.270**
Awareness on land degradation	p=0.000, r=0.729**	p=0.000, r=0.479**
Problems experienced in land degradation		
i. Soil erosion	p=0.000, r=0.461*	p=0.000, r=0.335**
ii. Moisture retention	p=0.000, r=0.508**	p=0.000, r=0.439**
iii. Fertility depletion with time	p=0.000, r= 0.613**	p=0.000, r=0.402**

4. Cost of soil erosion

Since irrigation majorly depends on the rainfall, fertilizer was the major input in selected area. Therefore, application of chemical fertilizer was considered for the investigation of on-site erosion cost in tea lands (Table 5).

Table 5. Cost of soil erosion

	Small tea lands (Less than 1 acre)	Large tea lands (More than 1 acre)
Components of T750 fertilizer (mature tea mixture) $(NH_4)_2SO_4$ - 500 parts P_2O_5 - 100 parts K_2O -100 parts Mg -50 parts T750 application of tea lands	533.15 Kg/ Ac/Year	553.17 Kg/Ac/Year
Average fertilizer adding for tea lands	N-74.641Kg/ Ac/Year P-30.923Kg/ Ac/Year K-35.721Kg/ Ac/Year	N-77.443 Kg/ Ac/Year P- 32.084 Kg/ Ac/Year K-37.062 Kg/ Ac/Year
Average nutreint removal by yield	N-6.177Kg/ Ac/Year P-0.533Kg/ Ac/Year K-2.574Kg/ Ac/Year	N-6.177 Kg/ Ac/Year P-0.533 Kg/ Ac/Year K-2.574 Kg/ Ac/Year
Nutrient waste by erosion	N-68.464 Kg/ Ac/Year P-30.390 Kg/ Ac/Year K-33.147 Kg/ Ac/Year	N-71.226 Kg/ Ac/Year P-31.531 Kg/ Ac/Year K-34.448 Kg/ Ac/Year
Cost of soil erosion	24 451 LKR/Ac/ Year	25 452 LKR/Ac/Year
Cost of soil erosion	60,418 LKR/ha/year	62,892 LKR/ha/year

Calculated replacement cost of soil erosion for small tea lands (<2ac/0.81 ha) and

large lands (>2 ac/0.81 ha) were LKR 60,418 and 62,892 ha/annum respectively. Previous findings of Anonymous [17] in Uva high lands-Sri Lanka, has stated that the repacement cost as 18,011 LKR/ha/annum.However, their computed nutrient wastages were similar with the present calculation. By emphathizing farmers on related issues of land degradation, considerable proportion of respondents showed positive perception on SLM. They realized that it is important tosustain long term yield because, farmers have a view-point that, it can increase vegetative growth of plants. From the respondents, 38% was agreed with the argument of SLM can trade-off their additional production costs. Further, farmers agreed to sacrifice their yield in short-term,by reducing chemical fertilizer application to achieve long-term benefits from organic fertilizers.

CONCLUSION AND RECOMMENDATIONS

The study revealed that tea smallholders' perception on SLM and soil conservation was in moderate level. In this attempt of eliciting awareness and adoption for three major principles, 'tea plant nutrient management' showed a higher degree of perspective than two other major principles considered by the study. In addition, farmers' age, property size and most fundamental economic factor of income were influencers for awareness while, their awareness on land degradation and the extent of the experiencing problems of land degradation have been driven them to be more aware on SLM. Furthermore, property size and income were driving them to adopt on SLM, while awareness on land degradation and the extent of problems experienced of land degradation were accelerated the adoption. The costs of erosion in small and large tea lands were LKR60, 418 and 62,892 ha/annum respectively. The study proclaimed that although large landowners had associated with more SLM practices than small landowners, their erosion cost was found to be higher. According with the results, study suggested improving tea smallholders awareness should be undertaken by government and other related institutes for a better investment in soil conservation. Moreover, the significant factors, which affect to soil conservation should be taken in to account when formulation the policies for soil conservation. Ultimately, SLM could be suggested as the most precise practice for long-term trade-off of production cost in the sector.

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