Factors Affecting the Soil Conservation Practices of Upcountry vegetable farmers in Sri Lanka

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Abstract This study mainly focuses on identifying the factors instrumental in soil conservation and investigating farmers' pro-environmental behaviours related to their soil conservation practices in upcountry vegetable cultivation. The majority of the vegetable growers are small-scale, intensive vegetable farmers. When considering the problems faced by vegetable farmers, nearly 90% of the vegetable lands in Nuwara Eliya district and 45% in Kandy are under the steep slope category. In this category 46% in Kandy and 34 % from Nuwara Eliya district. It was, observed, the soil texture is clay. These characteristics can have a weighty influence on cultivating lands resulting in reduced crop production and difficult land management. Varied soil conservation techniques are practiced in the study area: biological, cultural, and structural conservation techniques. Structural techniques and incorporating organic manure as amendments are popular among the farmers in the study area. With regard to soil moisture conservation practices, half of the population does not perform soil moisture conservation practices. It is highlighted the need for awareness programs on soil and water conservation. In both districts, the need for land improvements for farming activities was highlighted. Nearly half of the farming population follows an average level of soil conservation. A number of farmers who practice soil conservation at a poor level is lower than those who practice soil conservation at a good level. Factor analysis was applied separately to each sustainable land management practice (SLM) and erosion category with a unit cost of production. It is highlighted from the findings that land slope directly effect the cost of soil conservation practices and the cost of production. This study also aimed to pro-environmentally analyze farmers' concerns and behaviors towards soil conservation.

Keywords: Intensive vegetable cultivation, land degradation, soil erosion, soil conservation practices, pro-environmental behaviours

I. INTRODUCTION

Vegetable cultivation is a key sector in agriculture in terms of frugality and employment generation. The rapid growth experienced in the agricultural sector has led to resource degradation with an adverse impact on sustainability [1]. A major form of environmental damage associated with agriculture is land degradation; particularly intensive vegetable cultivation practices have caused soil erosion on the steeply sloping lands of Central Hills [2]. Policies and legislations protecting the land resources in the country were introduced following Independence. The existing institutional set-up lack vigour at the field level; hence the capacity building of the institutions with strong policies can be effective in preventing further degradation of land and water resources. This study mainly focuses on identifying the factors instrumental in soil conservation, and investigating farmers' pro-environmental behaviours related to their soil conservation practices, in order to suggest policy measures to enhance the upcountry intensive vegetable cultivation in Sri LankaMaterials and Methods

Both primary and secondary data were used. This study was conducted in the Central Province of Sri Lanka in 2021, and a sample of 384 farmers was surveyed. The primary data collection tool was a questionnaire survey. A multistage sampling technique was applied to derive the sample. Descriptive and inferential statistics identified the factors that influence the farmers' soil conservation practices the logistic regression analysis was applied for the above purpose. Factor analysis was applied separately to each SLM practice and erosion category with profit. The farmers' pro-environmental behaviours related to their soil conservation practices were investigated by examining the relationship between variables. The effect of two variables "attitude" and "social pressure" on the variable "soil conservation concern", and analysing the effect of the variable "soil conservation concern" on "soil conservation behaviour" was investigated. The reliability of the questionnaire relevant to the objective was calculated using Cronbach's alpha test for the variables measured by the Likert scale. To examine the relationship between variables, Pearson correlation was primarily used. The path analysis was used to determine the explanatory power of the variables.

II. RESULTS AND DISCUSSION

A. Present Status of the Soil Conservation Practices

The majority of farmers who cultivated interestingly in three sessions, this pattern of cultivation is significant in Nuwara Eliya. Farmers in Kandy (28%) and Nuwara Eliya (32%) districts cultivated vegetables in both Yala and Maha seasons. Among farmers who practised soil conservation practices, organic manure application and terracing are the most popular methods. More than 50% of the vegetable plots are suitable for agricultural activities (Considering the soil texture, proportion of sand, silt and the clay content).

Descriptive statistics are used to identify the factors affecting the soil conservation practices of the farmers. All practices come under sustainable land management practices (agronomic practices, vegetative methods, structural methods and cropping systems). Most of the farmers in the sample are following at least one method of soil conservation. Farmers used different techniques to conserve their soil (table 1). Structural techniques and incorporating organic manure as amendments are popular among the farmers in the study area. Adding organic amendments improves soil health. Most of the farmers Nuwara Eliya district constructing stone bunds and terracing are the most popular conservation methods.

Table 1: SLM Practices Followed by Upcountry Vegetable Farmers and their Adaptability

Management Practices	Kandy				Nuwara Eliya			
	Highly adopted	Moderately adopted	Poorly adopted	Not adopted	Highly adopted	Moderately adopted	Poorly adopted	Not adopted
Mulching	0.90	8.11	43.24	47.7	10.00	20.00	20.00	50.00
Biological hedges	0.00	13.16	14.04	72.8	27.59	31.03	20.69	20.69
Lock and spill drains	2.48	26.45	29.75	41.3	29.63	40.74	25.93	3.70
Contour planting	14.05	23.14	11.57	51.2	63.33	30.00	3.33	3.33
Grass hedges	2.61	12.17	14.78	70.4	25.71	51.43	14.29	8.57
Stone bunds	1.72	11.21	10.34	76.7	54.24	33.90	6.78	5.08
Zero tillage	0.00	4.59	5.50	89.9	9.52	19.05	4.76	66.67
Cover crops	3.85	28.46	21.54	46.1	30.43	39.13	21.74	8.70
Soil bunds and drains	13.25	30.46	12.58	43.7	48.89	48.89	2.22	0.00
Application of organic fertilizer	1.68	14.29	26.89	57.1	15.00	25.00	30.00	30.00
Fallowing period	0	2.1		86.6	0	1.88		89.1
SALT technique	4.35	6.96	3.48	85.2	5.88	29.41	0.00	64.71

Source: Author's survey data, 2021

Each SLM practice was rated as highly adopted, moderately adopted, and poorly adopted and not adopted based on the Department of Agriculture (DOA) recommendations that consist of different levels and sublevels.

Accordingly, gender, number of family members, land ownership and nature of slope were significant predictors for the production of vegetables at 95% CI. None of the other variables considered for the model was significant predictors according to the sample analyzed.

B. Different Soil Erosion Control Techniques used to conserve the Water Flowing out of the Farm Land

Soil erosion control techniques used to minimize the water flowing out of the farmland (off-farm) is a very important activity in topsoil conservation. This is a very important aspect we have observed during our data collection. Because a significant amount of soil eroded from the farmland due to the mismanagement of a proper drain water system out of the farm field to the main waterway. More than 70% of farmers in both districts used those methods. However, still, more than 25 % of farmers in both districts are not adopting these methods. This accelerates the topsoil erosion.

C. Constraints in Soil Conservation and Awareness of Soil and Water Conservation Practices

Further, sloping lands accelerate topsoil erosion. Poorly drained fields or those within lowlying areas can become waterlogged during periods of excessive rains. Such conditions cause diseases, reduce plant health and yield, and under extreme situations can cause plant death.

Cultivation on extremely high eroded lands according to the erosion category. In Nuwara Eliya District all the land area under this category is occupied for intensive vegetable cultivation. As per the soil texture, 46% in Kandy and 34 % from Nuwara Eliya, we have observed the clay soil on extremely highly eroded lands. When irrigation water or rainfall slowly penetrates through the soil it is evident the area is not well-drained. According to the United States Department of Agriculture (USDA) water drainage classification in well-drained soil, water is removed from the soil readily but not rapidly). Poorly drained soils (water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods) are often high in clay, in low-lying areas, or compacted. Soils have poor drainage when rainfall or irrigation water cannot easily enter (infiltrate) or move downward through the soil (percolation).

According to the results reviewed about the Extension services received, more than half of the study population has not received any extension service granted by the government during the last two years. Most farmers are not satisfied with the advisory service from 2020 to 2021 while a great majority has not received any state guidance within the last two years.

D. Effects of existing SLM practices and erosion category on profit

Two-way factorial ANOVA was applied separately to each SLM practice with profit. According to the analysis profit proportionately increases with the soil conservation adaptability. High eroded areas with soil conservation practices offered a significant profit. It is highlighted from the findings land slope directly effect the cost of soil conservation practices and the cost of production. The cost of production proportionately increases with the increasing land slope. According to the analysis profit proportionately increases with the soil conservation adaptability.

E. Pro-Environmental Analysis Farmers' Concerns and Behaviours towards Soil Conservation

The results of the analysis regarding the effects of independent variables on the variables "soil conservation behaviour" and "soil conservation concern" indicated that, among the variables affecting these two variables, the variable "attitude towards soil conservation "was the most powerful predictor of "soil conservation concerns" and the variable "social pressures on soil conservation" predicted farmers' "soil conservation behaviours" enhanced. Similarly, the independent variables used in this research could predict 30% of the variance in terms of soil conservation concern and 20% of the variance in terms of soil conservation behaviour. These outcomes can be applicable for executive officials since, instead of making efforts to directly change the behaviour, they can first focus on conceptual changes and persuasive changes like changing attitudes towards soil conservation.

III. CONCLUSION

The use of descriptive and inferential statistics helps identify the factors affecting the soil conservation practices used by farmers. The farming population (42%) follows an average level of soil conservation. The land slope has a direct effect on the cost of soil conservation practices and the cost of production. Observed soil erosion control techniques used to conserve the water flowing out of the farmland (off-farm) is a very important activity in topsoil conservation. A silt trap is a very important method to collect nutrient-rich topsoil, but farmers do not practice these methods. In the upcountry region farmers did not apply modern technology for tilling, watering, cultivating, and harvesting, which makes the processes time-consuming. A wide range of technologies is available for soil and water conservation in cultivation activities. Farmers are unable to use the high machinery system due to land elevation. Therefore, the constraints in technology application have limited their land productivity to a great extent and highlighted the need for strong extension activities. It is highlighted from the findings land slope directly effect the cost of soil conservation practices and the cost of production. The results of the analysis identify the farmers' pro-environmental behaviours can be related to their soil conservation practices.

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