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FACTORS AFFECTING THE CHOICE OF SOIL CONSERVATION PRACTICES ADOPTED BY POTATO FARMERS IN NUWARA ELIYA DISTRICT, SRI LANKA

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ABSTRACT

Potato is an economically attractive crop, but it causes soil erosion in the hill country. Nuwara Eliya contributes about 27% of the national potato production and about 58% of the potato-cultivated land is prone to severe soil erosion. In spite of the seriousness of the soil erosion and the need for effective soil conservation practices, there is an absence of research on soil conservation practices and the level of adoption by potato cultivators. Therefore, the purpose of this research project was to find out the different soil conservation practices, level of adoption by potato farmers and influence of socio-economic factors on farmers' decisions in the Nuwara Eliya district. Data were collected from a multistage stratified random sample of 50 potato farmers in five Agrarian Service Centers (ASC) in the Nuwara Eliya district during 2007. Judgmental scaling method was used to assess the different levels of soil conservation methods adopted by the potato farmers. Multinomial Logit model was used to determine the choice of soil conservation practices. Likert - scaling method was used to assess the potato farmers' perception on adopting appropriate soil conservation methods. Results reveal that 30, 52 and 18% of the potato cultivators were practicing good, average and poor level of soil conservation practices respectively. Good level of soil conservation practices has increased the farmers'potato yield and income. The cost of cultivation inversely affected the soil conservation practices adopted by potato cultivators. The probability of adopting good level of soil conservation was affected positively and significantly by education and land size. About 60% of the potato farmers have a positive attitude towards the importance of improving soil conservation. Land ownership is a crucial factor for this. Appropriate training, extension and effective soil conservation subsidy are recommended to improve soil conservation for sustainable potato cultivation.

Key words: Potato Cultivation, Soil Conservation, Choice Model, Nuwara Eliya

INTRODUCTION

The agricultural sector plays a dominant role in the Sri Lankan economy, contributing to nearly 16.8% of the Gross National Product (GDP). It generates employment opportunities for more than one-third of the labour force and affects the livelihood of more than 800,000 farm families. The agriculture sector contributes to about 24% of gross exports and saves foreign exchange, provides inputs to the agricultural processing industry and contributes more to food security (Central Bank, 2007).

The fast growth in the agricultural sector in Sri Lanka has led to resource degradation, with adverse impact on sustainability. The major source of environmental damage associated with agriculture is land degradation, particularly soil erosion on the steeply sloping lands of central hills. At present, 44% of Sri Lankan agricultural lands are facing the problem of soil erosion (DOA, 2004). Chisholm (1999) have calculated erosion rates for the following cropping systems in intermediate and up country, Sri Lanka.

Tobacco-Fallow IM_3-Intermediate zone-70 t/ha
Vegetable-Vegetable WU_3 Intermediate up country .100 t/ha
Vegetable - Potato $IU_{2\&3}$ Intermediate up country - 100 t/ha.

Soil erosion is concentrated in hill country where watersheds of major rivers are located. District-wise, Nuwara Eliya shows the highest amount of soil erosion, about 58% of the potato-cultivated land found to be prone to severe soil erosion (Abeygunasekara, 2004).

Problem Statement

The hill country of Sri Lanka plays an important role in the economy of the country, producing a considerable amount of its vegetable and potato. In 2005, about 2,424 ha of lands were cultivated by approximately 25,000 farmers to produce 76,900 t

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of consumer potatoes. Sri Lanka has imported 28,010 t of potatoes (40% of the national potato requirement) in 2005 (Department of Census and Statistics, 2005). Due to the economic attractiveness of potato cultivation, farmers tend to use steeply sloped lands, which are not recommended for potato like seasonal crop, while increasing soil erosion (Erabadupitiya, 2006). Both the climate and terrain are prone to soil erosion and serious damage to land and water resources are experienced in the cultivation of potato and vegetables. Damage is mostly due to inappropriate soil conservation measures. Owing to the high cost in soil conservation farmers do not adopt proper soil conservation measures which lead to land degradation in areas cultivated with potato. The impact of these improper cultivation practices has caused soil erosion and other environmental problems. It has been found that the soil erosion rate in Nuwara Eliya potato lands can be as high as 15 t/ha/year (Samarakoon, 2004). As a root crop, potato cultivation causes acceleration of soil erosion due to the ground being loosened in several cultivation practices such as land preparation, weeding, fertilizer application, earthning up and even harvesting. Samarakoon has further found that there is a relationship between soil erosion and potato cultivation. According to his study, the average soil replacement cost in Nuwara Eliya district potato lands was US$ 33/ha (Rs 3,343/ha). Most of the upcountry farmers apply soil conservation practices for their fields. They use either mechanical, biological or cultural conservation measures or a combination of those. However, according to Erabadupitiya (2006), for appropriate soil conservation, all mechanical, biological and cultural practices should be applied together, while following recommendations of Department of Agriculture. But, farmers who are facing similar soil erosion problems may adopt different combinations of soil conservation practices, to achieve different levels of soil conservation. It can be categorized as good, average or poor conservation, based on farmers' different socio-economic conditions.

Different farmers may have different attitudes towards soil conservation. Those attitudes may also affect the selection of soil conservation practices. Sometimes farmers who have good attitudes also may not practice soil conservation at a good level due to the socio-economic failures. Abeygunawardene and Gunathilake (1992) have studied the factors that influence soil conservation decisions of tobacco farmers. In 2004, Samarakoon, reported that there was an influence of socio-economic factors such as education, age, land ownership, debt and subsidies on farmers' decision to adopt soil conservation measures. But there are no studies that help to identify the level of soil conservation measures adopted by farmers and the influence of socio-economic factors on farmers' decision on those levels.

The research aimed to determine the socio-economic factors that influence the level of adoption of soil conservation practices by potato farmers in Nuwara Eliya district, with especial reference to the following specific objectives ;

1. To identify the level of soil conservation practices, adopted by potato farmers.
2. To find out the influence of those socio-economic factors on the choice of different levels of soil conservation practices.
3. To identify the perception of farmers towards soil conservation.
4. To suggest suitable strategies to overcome soil erosion problem in potato cultivation in the hill country of Sri Lanka.

MATERIALS AND METHODS

Study area

Nuwara Eliya district covers a total area of 1745 km^2 and is located in the central hills of Sri Lanka. According to the administrative division of the country, Nuwara Eliya district belongs to the Central Province. This district is subdivided into five divisional secretariats; Ambagamuwa, Nuwara Eliya, Kotmale, Hanguranketa and Walapane. Altitudes of the district vary from 300 to 2,000 m due to mountainous landscape. Out of the total lands, 78% is located on slopes more than 30% gradient and 15% of the lands on more than 60% slopes.

Following hypotheses were developed to achieve the objectives;

1.Farmers do not adopt conservation practices as recommended by the DOA.
2.The choice of adoption of soil conservation levels depends on socio-economic factors.
3.Farmers have neutral perception on soil conservation.

To identify the soil conservation levels adopted by potato farmers a judgmental scaling method was used. Each and every soil conservation practice adopted by a particular farmer was given marks according to the degree to which Department of Agriculture recommendations were followed and the percentage land in which each soil conservation practice was adopted. Then each biological, cultural and mechanical soil conservation technique was named as better, moderate and worst. According to that, each category of technique was given marks as 3, 2 and 1. The summed up marks were used to determine whether the respondent farmers' soil conservation is good, average or poor.

To achieve research objective two, a Binomial Logit model was constructed and estimated. The farmer will choose certain soil conservation level, only if the expected utility from the chosen soil conservation level is greater than the utility obtainable from other available alternatives.

Observed Y = Choice j if U (alternative j) > U (alternative k)

The general form of the multinomial Logic model is:

$$prob.\ choice = \frac{e^{\beta_j x_{jt}}}{\sum e^{\beta_j x_{jt}}}$$

Where,'t' indexes the observation, or individual farmer and j indexes the choice.

The dependent variable Y is coded 0, 1…, j (alternative soil conservation levels). The empirical logistic model to examine the choice of soil conservation levels by the farmers is;

CHOICE = β_0 + β1EDU + β_2INCO + β_3EXP + β_4SLOP + β5EXT + β_6LAN

Where, EDU is education in years, INC is income from potato cultivation in Rs per farmer, EXP is experience in potato cultivation years, EXT is extension scale dummy and LAN is extent of potato cultivation in ha.

Farmers' perception was tested using a ranking method. A Llikert scale was used to give marks to each farmer. Then mean and standard deviation of marks were used to separate participants into poor perception, medium perception and higher perception.

Poor perception---------- < (Mean- SD)
Medium perception-- (Mean-SD)..(Mean+SD)
Higher perception ----------> (Mean + SD)

Multistage stratified random sampling technique was used to select the sample. Nuwara Eliya district was purposively selected as the study site, because potato is grown in Nuwara Eliya district in larger extent and it is the district that has been recorded as the district where soil erosion is the most severe. There are five divisional secretariats in Nuwara Eliya district. Out of those five, three were chosen based on the extent of potato cultivation. Those are Ambagamuwa, Kotmale and Nuwara Eliya. From those three divisional secretariats, five Agrarian Service Centres were purposively selected; again, the basis was the extent of cultivation. Fifty potato cultivators from five ASC divisions were randomly selected through a stratification based on the yield performance of the farmers.

Secondary data necessary for the study was obtained from different relevant sources. The Department of Agriculture and Department of Census and Statistics were the two main sources of secondary data. Moreover, Natural Resource Management Centre, Divisional Secretariats and Land Use Division of Nuwara Eliya district were used to collect more detailed data required by the study. The nature of the study required detailed primary data and information on soil conservation practices and farmers. Therefore, a questionnaire focused on soil conservation practices, household information, land characteristics, cost of production and other socio-economic characteristics of farmers, was used in the interview. The respondents were the current farm operators, the head of the farm households who make land use decisions.

RESULTS AND DISCUSSION

Potato cultivating farmers in Nuwara Eliya are middle-aged people who are around 44 years (Table 1). They have obtained education up to Ordinary Level. The overall view of the annual income of the farmers highlights that they are middle-income people earning annually about US $ 14,656 (Rs.1.5 million). The income highly varies between US $ 375.94 and 575.94. More than half of the farm families show a dependency ratio of less than one. Two-thirds of the farming population own more than one acre of land, maintaining potato cultivation in a commercial level. More than half of the population have about 25 years of experience in potato cultivation. Therefore, it can be said that the experience on potato cultivation among farmers is at a good level.

Soil conservation practices

Most of the farmers in the sample are following at least one method of soil conservation. Among farmers, organic manure application and terracing are the most popular conservation methods. Fallowing is not popular among potato farmers, because these lands are highly valuable in converting provided inputs to money through potato and vegetables. Therefore, they are trying to use the lands as efficient as possible even without fallowing. They also poorly practice biological soil conservation techniques. Only live fences can be seen in the fields as biological methods, but theyare not properly maintained.

Table 1: Socio-economic characteristics of potato cultivators in Nuwara Eliya district

	Mean	Maximum	Minimum
Age (Years)	44.3	62	21
Experience (Years)	23.6	40	6
Family Size	4.4	7	3
Land Extent (ha.)	1.1	4.86	0.05
Annual Income (US$)	14,656	2,631	375

Farmers are following different combination of mechanical such as terrace, drains and bunds, biological such as live fence and cover cropping and cultural methods such as contour farming, and crop rotation levels of soil conservation practices at good, average and poor levels. More than half of the farming population (52%) follows an average level of soil conservation. Number of farmers who practice soil conservation at a poor level is lower than those who practice soil conservation at a good level.

There is a significant difference in mean yield, income and cost under different levels of soil conservation. That difference show, the farmers who follow good level of soil conservation can obtain a higher yield of 7.5 t/ha (standard deviation 1.01) compared to 6.2 (sd 2.01) and 5.2 t/ha (sd 2.2) in average and poor soil conservation levels of adoption.(Fig 1). Moreover, farmers who adopt a poor level of soil conservation obtain a low amount of yield. Thereby, income from potato is same as the yield under different levels of soil conservation. Cost of production shows an inverse relationship with the level of soil conservation. That means the unit cost of production is lower ($ 0.41/kg) with good level of soil conservation due to soil enrichment influence in increased yield. While cost per unit of production ($ 0.61/kg) is higher with poorer soil conservation practices as a result of reduced yield due to high soil erosion.

Potato cultivation is a costly activity. Cost components are seed potato, fertilizer and other chemicals, irrigation, machinery, labour and soil conservation. They can be categorized as input cost, labour cost, cost for power and soil conservation cost. The mean cost of potato cultivation is US$ 11,374.58/ha of which input cost is the largest fraction (47%). Soil conservation cost is 10 % of the total cost (Fig 2)

Factors affecting soil conservation

The socio-economic and topographical characteristics determine the soil conservation decisions by farmers. The results of the Multinomial Logit analysis of the potato farmers are shown in Table 2. The effect coefficients are estimated with respect to the average level of soil conservation, as the base case. Therefore, the inference from the estimated coefficients for each choice category is made with reference to the base case. The chi-square test statistic for the estimated model is 48.88 with 49 degrees of freedom. The null hypothesis of non-intercept coefficients are jointly zero is rejected at 0.05 levels. The pseudo R^2 value is 0.4840 (Table 2). This means that the empirical Logit model is significant in explaining the soil conservation choice by potato farmers.

The probability of good level of soil conservation is seen to increase with the education level of farmers. This reflects the fact that formal education supports the farmers' decision to manage the soil better. When education moves from lower to higher level, probability of adoption of poor level of soil conservation is decreasing. Land extent also has a significant positive impact on good level of soil conservation. The probability of good level of soil

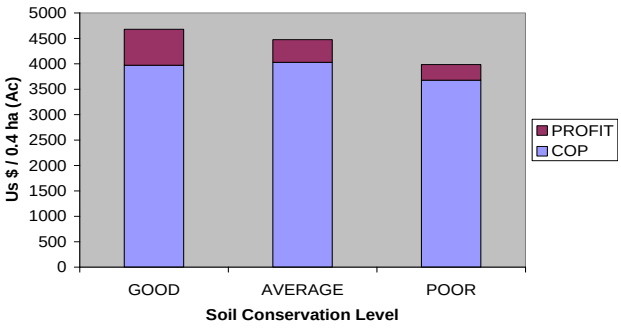

Fig 1:Yield, Income, Cost of Production, Soil Conservation Cost of Potato under different soil conservation levels in Nuwara Eliya District

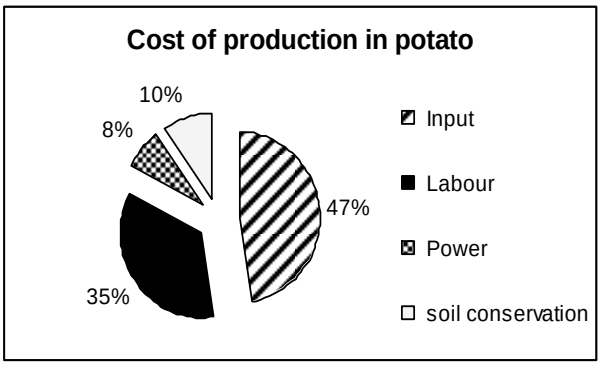

Figure 2: Cost Components in Potato Production

Table 2:Multinomial Logit Estimates for soil conservation choice of Potato Farmers (95% confidence interval)

Variable	Good	p> |z|	Poor	p> |z|	Mean
Education	2.657	0.03	-0.431	0.05	2 (up to O/L)
Experience	-0.341	0.56	0.014	0.82	23.64
Land extent	0.570	0.03	-2.962	0.05	2.72
Slope	0.015	0.99	-2.427	0.15	2 (moderate slope)
Extension	2.189	0.09	-0.253	0.84	1 (Receiving)
Income	4.060	0.25	-1	0.19	14,485.37

Likelihood ratio test statistics	-26.0559
n	50
LR chi square	48.88
Prob> chi square	0.000
Pseudo R^2	0.4840

conservation is seen to increase with the land extent cultivated. Moreover, when land extent is increasing, probability of adoption of poor level of soil conservation is decreasing significantly. The predicted coefficients of income, experience, extension and slope variables are insignificant. Farmers are reluctant to give true information about their income. To over come this problem several cross check were done. It may be the reason for insignificance of income variable in Bimomial Logit model. Whatever the experience, it is not associated with soil conservation, because education is more dominant than the experience. Even though the extension services are satisfactorily available, farmers are not following the advice given by the extension officers, because they believe that they are more experienced and knowledgeable than the extension officers. Therefore, extension is also an insignificant variable in the model. Though the expectation was to find the slope as a phenomenon factor in soil conservation, it is also found to be an insignificant variable, because the ownership of the land affects the adoption of soil conservation.

Farmers' perception on soil conservation

Some farmers who are cultivating potato in Nuwara Eliya district believe that soil conservation is not a necessary issue for their fields. But, as an overall picture, they have a good perception on soil conservation. Some farmers even agree to prohibit the cultivation in more than 60% sloped lands (Table 3).

More than 90% of the farmers strongly agreed with the statement "Government subsidy is essential for soil conservation" (Table 3). They believe that the soil conservation is a beneficial thing that gives higher benefits to individual farmer as well as for the society. Further it is shown that the farmers who have medium perception is higher. The mean marks that farmers obtained for perception was 18, it is higher than the median value of 15. The marks range from 5 to 25. That implies that the farmers' perception is more towards the good adoption of soil conservation.

CONCLUSION

The study revealed that most farmers are cultivating potato with the average level of soil conservation. Good level of soil conservation increases the farmers' potato yield and income while keeping the cost of production at lower level. However, farmers who follow poor level of soil conservation need to incur higher cost, but the obtained yield and income are very low compared to good level of soil conservation.

The empirical results from the multinomial Logit analysis show that the choice of a soil conservation level is positively influenced by farmers' formal education level and the land size.

Whatever the farmers' adoption level of soil conservation they have neutral perception towards the soil conservation. Therefore, a government intervention is needed to treat the farmers' weaknesses on soil conservation practices. An appropri-

Table 3: Perception of potato farmers on soil conservation

Statements	Percentage of Potato Cultivators Reporting				
	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree
1.Gives sustainable benefits	51.3	26.2	8.1	5	9.4
2.Gives benefits to the society	23.1	12.5	18.2	18.4	27.8
3. Rotation with soil enriching crop is important	42.4	21.5	5.2	15.9	15
4.Government subsidy is important	90.5	3	0.3	6.1	0.1
5.More than 60% slope to be prohibited for cultivation	12.8	27.3	45.4	10.5	4

ate subsidy system is urgently needed to improve farmers' adoption of soil conservation. Training on soil conservation practices is an essential issue. Information should be made available to the farmers, especially about impact of soil erosion, importance of soil conservation and modern low-cost soil conservation techniques.

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