International Journal of Arts, Humanities, Literature and Science
Volume: 04 Issue: 05

ISSN: 2581 – 3641
Pages: 16 – 26

SOCIO-ECONOMIC FACTORS AFFECTING THE INTENSITY OF ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES IN THE WEST USAMBARA MOUNTAINS TANZANIA

Emmanuel Paul Mzingula[1]
[1]*National Medical University, Kyiv, Ukraine*
[1]*mzingula@yahoo.com*

Received 24 September 2019, Revised 10 April 2019,
Accepted 13 April 2020, Available online 15 April 2020

Abstract

In the West Usambara Mountains Tanzania, the problem of soil erosion and depletion of water resources will continue to be a phenomenon that contributes in the reduction of crop production and increase household poverty, if adoption of conservation practices on soil and water is not effective. In this region particularly in Lushoto District, farmers have been disseminated with improved soil and water conservation practices including bench terraces, cut-off drains, planting of trees, planting of improved grasses, contour farming and mulching by the Tanzania government and other organization dealing with development of agriculture. This study assessed socio-economic factors affecting the intensity of adaption of soil and water conservation (SWC) practices in Lushoto District in the West Usambara Mountains. The study used a cross-sectional design whereby the quantitative approach was used. Simple random sampling was used to select four villages including Mambo, Tema, Nkelei and Emao of Lushoto District which are located on hillslope of the West Usambara Mountains. A sample of 100 households involving in farming activities was picked by simple random whereby adult household members were the respondents. Survey method was used for data collection by using structured questionnaire. The findings show that adoption intensity of SWC practices ranged from 1 to 6 practices. The average number of adopted practices was 4. By using SPSS computer software, data was analysed through multiple linear regression to revealed socio-economic factors affecting adoption intensity of SWC practices. The study found that technical training (β=0.835, p=0.001), extension service (β=0.381, p=0.032) and land size (β=0.511, p=0.017) were significant and positive related to adoption intensity of SWC practices. The study concludes that land size is influencing high investment in SWC among farmers whereas access to technical training and extension services to famers influences conservation of mountainous agricultural lands. This study recommends government and agricultural development partners to provide more training on SWC in agriculture and improve extension services particularly by employing more extension workers.

Keywords: Adoption, Farmers, Soil and water conservation, Practices

1. INTRODUCTION

In the developing countries, most of populations rely on exploring the natural environment for subsistence living (Barbier, 2010). Most of these countries including Tanzania depend on revenues from agriculture exports. In spite of its potential contribution to the national economy, agricultural sector for many decades is regarded as main cause of

environmental degradation (Nkegbe & Shankar, 2014). Hence, a major challenge facing the developing countries is how they can maintain natural resource base while enhancing agricultural production.

Land degradation resulted from human activities is a development and environment problem in (Minderhoud, 2011). The degradation of vast land in these mountain ranges is mainly contributed by famers' use of unsustainable farming practices; accelerated soil erosion and loss of soil fertility. The impact of land degradation is directly on increased poverty of faming households, reduced crop productivity, increased food insecurity and more dependence on food aids, increase in malnutrition and community dependence on forest resources for survival (Mwihomeke, 2001; Johansson, 2001).

In the past especially beyond the 1980s, the West Usambara Mountains particularly in Lushoto District experienced severe deforestation which contributed in the depletion of natural resource base. People cleared forests in order to obtain lands for settlement, expand faming activities, poor practice of shifting agriculture and lack of education on the importance of forest conservation (Huwe, 1988). The consequences of degradation of forests are the decline in amounts of precipitation, increased incidences of severe run-off and floods as well as losses of biodiversity due to destruction of habitats and species (Mowo et al., 2002; Minderhoud, 2011).

Land degradation in the West Usambara Mountains was documented for a long time since the nineteenth century after the arrival of European explorers. From that time, severe soil erosion has reported to contribute to high threat of food insecurity to the west usambara people who most of them depend on smallholder agriculture (Sanchez, 1994). The modern soil erosion and all sorts of conservation measures are thereafter become well disseminated and promoted for utilization in combating soil erosion and restoration of natural resources such as forests and water catchments (Kimaro et al., 2008; Lundgren, 1980). The improved land management practices which implemented in the past especially before launching of SECAP (Soil Erosion Conservation and Agroforestry Project) supported by Germany government in early 1980s in the usambara region particularly in Lushoto District, some few measures demonstrated success while many others didn't result into commendable conservation achievements (Tenge, 2005; Vigiak, 2005).

In spite of improved SWC practices being disseminated in the west usambara and promoted to farmers, soil erosion and drying of water resources downstream continued to be a serious problem in agriculture by reducing crop production (Minderhoud, 2011; Mowo et al., 2002). The adoption of multiple conservation practices is cost-benefit in areas where environmental degradation is high (Nkegbe & Shankar, 2014). In the west usambara, several studies have been conducted in exploring soil erosion, participatory appraisal to natural resource conservation and farmer's adoption incidence of SWC (e.g. Tenge, 2005; Mowo et al., 2002; Minderhoud, 2011; Vigiak, 2005). Despite these studies, still there is inadequate knowledge about adoption intensity of SWC practices among farmers and associated socio-economic factors in the west usambara. This study assessed socio-economic factors affecting the intensity of adoption of disseminated practices for soil and water conservation among farmers in the west usambara mountain region in Lushoto District Tanzania.

2. STUDY OBJECTIVES

I. To assess intensity of adoption of practices for SWC in the West Usambara Mountains.

II. To examine socio-economic factors affecting adoption intensity of practices for SWC in the West Usambara Mountains.

3. LITERTAURE REVIEW

3.1 Theoretical literature

Ervin and Ervin's modified model of conservation of soil and water in agriculture in 1982 as a modification of Diffusion of Innovation Theory which put was developed by Roggers in 1962. Ervin and Ervin's model accounts simultaneous influence of personal, physical, economic and institutional factors on farmers' adoption of SWC

practices, something was missing in previous conservation model explanations (e.g. Roggers, 1962; Rogers and Shoemaker 1971; Nowak 1983a; Pampel & van Es 1977; Heffernan 1984). In addition to that, Ervin and Ervin's model conceptualizes adoption as effort expended in conservation agriculture.

Adoption of multiple SWC practices (adoption intensity) among the farmers is an effort to soil conservation effectiveness (Nkegbe & Shankar, 2014). Hence, personal/social (e.g. education, sex, age, household size, extension service), physical (e.g. slope length and slope degree), economic (e.g land size, income, market) and institutional factors have simultaneous influence on adoption effort of soil conservation. This study adapted Ervin and Ervin's model of soil conservation to explore socio-economic factors affecting adoption farmers uptake of SWC practices in the west usambara Lushoto Tanzania.

3.2 Empirical literature review

Nkegbe & Shankar (2014) analysed socio-economic factors affecting the intensity of adoption of improved land management practices in smallholder agriculture in Northern Ghana. The research used cross sectional study design to gather information from smallholder farmers. Count data models were used for the analysis. Results reveal that access to information, social capital, per capita land holding and wealth are factors affecting smallholder producers' decision to intensively adopt SWC practices.

Mengstie (2009) assessed adoption behaviour conservation practices near Lake Tana in Ethiopia particularly in Koga watershed. A study used 100 smallholder farming households whereas 282 agricultural plots. The study used questionnaire survey and focus group discussion methods as methods of data collection. The data analysis was done through Tobit regression model to analyse factors influencing adoption intensity of SWC practices in addition to cross-tabulation and descriptive analysis. The results show education, number of livestock and plot size were significant and positively affect adoption of multiple SWC practices. Home to farmland distance, land to labour ratio and size of family were significant and negatively related to adoption intensity of SWC practices.

Nkegbe et al. (2011) examined determinants of SWC technologies in Northern Ghana. A study sample included 445 farmers from 15 communities. Data analysis was done by using multivariate probit model for six disseminated conservation practices in the area. The findings revealed that contacts with extension worker, affiliation in association, market distance and location of plot were significantly related to adoption of conservation practices. Policy implication drawn from the study is that making access to market and extension service can significantly boost uptake of land management practices.

Darkwah et al. (2019) determined the factors influencing agricultural conservation technologies in Ghana, evidence from Techiman Municipality of Ghana. The study used random sampling to select 300 maize farmers. Semi-structured questionnaire constructed from open and close ended questions was used as an instrument of data collection. The study used Poisson regression model for data analysis. The results revealed that credits, size of household, technical training and farm size were significant and positive related to farmers' adoption of agricultural conservation practices. On the other hand, adoption of SWC practices had significant effect and negative relation with perceived risks of pest and diseases, market distance and extension service.

3.3 Conceptual framework

The conceptual framework illustrated in figure 1 explains the relationship between independent variables (socio-economic factors) and dependent variable (adoption intensity of SWC practices). The adoption intensity conceptualized that package of SWC practices is very useful to farmers in maximising profits from hillslope agricultural land (Nkegbe & Shankar, 2014; Darkwah et al., 2019; Abdul-Hanan, 2017, Ervin & Ervin 1982). However, farmer's decision to adopt a package of conservation practices can be simultaneously influenced by socio-economic factors such as age, sex, education, marital status, household size, experience, training, contacts with extension worker, membership in farmers association, access to subsidies and access to market (Ervin & Ervin, 1982).

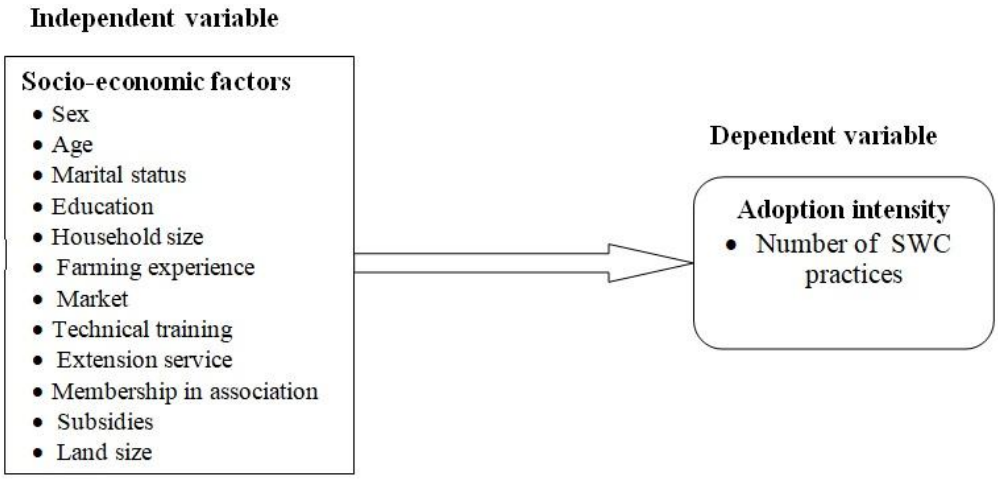

Figure: 1 The conceptual framework of the study

Source: Adapted from modified SWC model by Ervin & Ervin (1982)

4. MATERIALS AND METHODS

4.1 Study area

Geographically, Lushoto District which is located in the west usambara mountainous region. The district occupies 80% of the population of people residing in the West Usambara Mountain ranges (Mwihomeke & Chamshama, 2001). The district lies between latitudes 4^o 05' and 5^o 00' and longitude 38^o 05' and 38^o 40'. It has latitudes ranging from 600 m to 2300 m above sea level (Minderhoud, 2011). The district is characterized by the hills with slopes ranging from 18% to 60%. The annual rainfall ranges from 800mm to 1400mm (Mowo et al., 2002; Minderhoud, 2011). Lushoto District has a population of 492,444 people which comprise of 230,236 are males and 262 205 are females (URT, 2013).

4.2 Study design

The study adopted a cross-sectional design whereby quantitative approach was employed for data collection from farming households whose farms are located on slopes of the mountains.

4.3 Sampling procedures and sample size

The study used simple random sampling to select 100 farming households from 4 randomly chosen mountainous villages. These villages are Mambo, Tema, Emao and Nkelei. Survey was used as method of data collection. Heads of households were used as respondents of the survey. Semi-structured questionnaire constructed from open and close ended questions was used as an instrument of data collection.

4.4 Variables and measurements

Dependent variable: The dependent variable of the research is adoption intensity which measured by number of SWC practices used by a farmer. Independent variables: These are socio-economic factors which may influence farmer's adoption of package of SWC practices, including; X_1= age (years), X_2= sex (1 if male, 0 if otherwise), X_3= marital status (1 if married, 0 if otherwise), X_4= household size (number of members), X_5=education (years spent in school), X_6= technical training (1 if attended, 0 otherwise), X_7= extension service (number of contacts per year), X_8= land size (acre), X_9= market distance (walking minutes), X_{10}= subsidies (1 if access to subsidies, 0 otherwise), and X_{11}= membership in farmers' association (1 if member, 0 otherwise).

4.5 Data analysis

Similar to Agwu et al. (2008) and Enujeke & Ofuoku (2012), multiple linear regression was used to analyse socio-economic factors influencing farmers' adoption intensity of SWC practices. Multiple regression was used for the analysis of socio-economic factors that affect adoption o number of SWC practices by applying Statistical package for social science (SPSS). The regression model is shown below.

$$Y = \beta_0 + \sum_{i=1}^{n} \beta i Xi + \varepsilon i$$

Whereby;

Y stands for a number of conservation practices adopted by a farmer (dependent variable).

β_i stands for coefficients (β_1, β_2…. β_{11}) that measure a corresponding change in Y brought by a unit change in X_i

β_0 and ε_i stand for an intercept and error term respectively.

X_i stands for independent variables.

5. RESULTS AND DISCUSSION

5.1 Socio-economic characteristics of farmers

The sample size of the study was 100 farming households whereby each household was represented by head of household. However, out of 100 respondents, 98 filled and returned the questionnaire. Through survey, the following socio-economic attributes of farmers revealed as shown in Table 1.

Variable	Measurement
Sex:	
Male	*(56)57.1%*
Female	*(42)42.9%*
Marital status**:**	
Married	*(88)89.8%*
Otherwise	*(10)10.2%*
Age:	
20-39 years	*(25)25.5%*
40-59 years	*(48)49%*
60-79 years	*(25)25.5%*
Education:	
Non-formal education	*(8)8.2%*
Primary education	*(86)87.8%*
Secondary education	*(4)4%*
Household size:	
1-5 members	(45)46%
6-10 members	*(51)52%*
11-15 members	*(2)2%*

Note: *Numbers in brackets are frequencies*

Table: 1 socio-economic attributes of farmers

From the findings in Table 1, majority (57.1%) of survey participants comprised of males, females constituted about 42.9%. Most of the respondents were married (89.8%). Based on the literacy, 87.8% of respondents had formal education since they attended either primary (87.8%) or secondary (4%) schools. A few respondents (8.2%) had never attended formal education. The age distribution of respondents indicates that most of respondents (49%) had

40-59 years while others had 20-39 years (25.5%) and 60-79 years (25.5%). Moreover, more than a half number of respondents (52%) belong to households of 6 to 10 members.

5.2 Farmers' adoption intensity of soil and water conservation practices

The survey identified that seven SWC practices are utilised by farmers on hillslopes plots for soil and water conservation. These practices include bench terraces, contour ridges, *fanya juu*, mulching, planting of trees, grass strips and cut-off drains. Results regarding the adoption of SWC packages are shown in Table 2. Farmers have invested in packages of conservation practices in order to reduce the adverse impacts of land degradation in agriculture and natural resources by increasing plot productivity and conservation of water resources.

Number of adopted SWC practices	Number of farming Households	Percent
1-3	43	43.9%
4-6	55	56.1%
Total	**98**	**100%**

Table: 2 Farmers' uptake of SWC practices in the West Usambara

Results regarding the adoption improved land conservation practices shown in Table 2 reveal that majority of farmers (55%) adopted 4 to 6 SWC practices. Other farmers (45%) adopted 1 to 3 practices as a conservation effort to retain their farms from soil erosion and loss of water. The minimum number of adopted SWC practices was 1 while the maximum was 6. In average, farmers have adopted 4 SWC practices on their hillslope farms. The findings justify that there is commendable effort of farmers in adopting the multiple practices for soil and water conservation the west usambara region particularly in Lushoto District.

5.3 Socio-economic factors affecting adoption intensity of practices for soil and water conservation

The assumptions of linearity, normality, multicollinearity and homoscedasticity were tested to identify if the multiple linear regression model (MLR) is relevant for data analysis. Multicollinearity assumption was checked by using Variance Inflation Factors (VIF). The findings show that the mean VIF is 1.7 is recommended according to Gujarat and Porter (2010) for acceptance of MLR because it is less than 10. Therefore, the revealed mean VIF confirms that there is no serious problem of multicollinearity among the independent variables. Moreover, normal P-P plot of regression standardized residual shown as Figure 2 demonstrates that there is diagonal and linear arrangement of data with regard to observed and expected cumulative probabilities in a regression model. This proves the linearity and normality assumptions of multiple linear regression models.

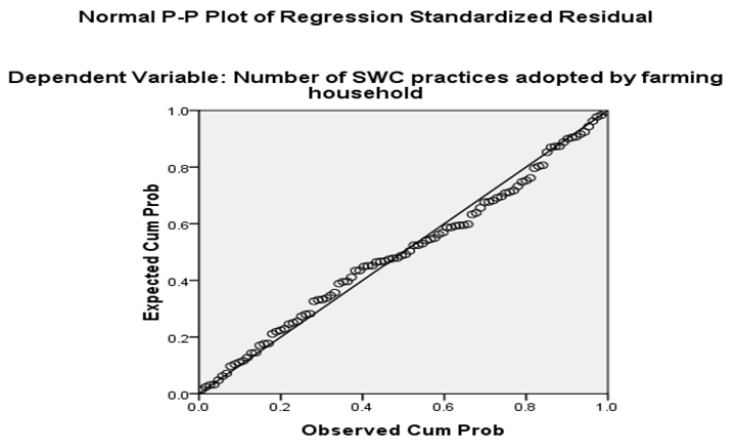

Figure: 2 Normal P-P plot of standardized residual showing normal distribution and linearity of data in a regression model

Homoscedasticity demonstrates that the variance of errors does not differ across all levels of the independent variables used in the multiple linear regressions. Osborne and Waters (2002) state that if the variance of errors differs at different values of the independent variables, heteroscedasticity is indicated. Osborne and Waters (2002) put forward that the histogram of normal distribution is used to verify homoscedasticity by checking the results of standardized regression residues if they obey normal distribution of the variance of the errors. Figure 3 proves the assumption of homoscedasticity since there is evenly distribution of variance of errors of the independent variables in the regression model. The histogram is less skewed and characterised by light peak (i.e. less kurtosis) demonstrating normal distribution of the variance of errors of the regression standardised residual.

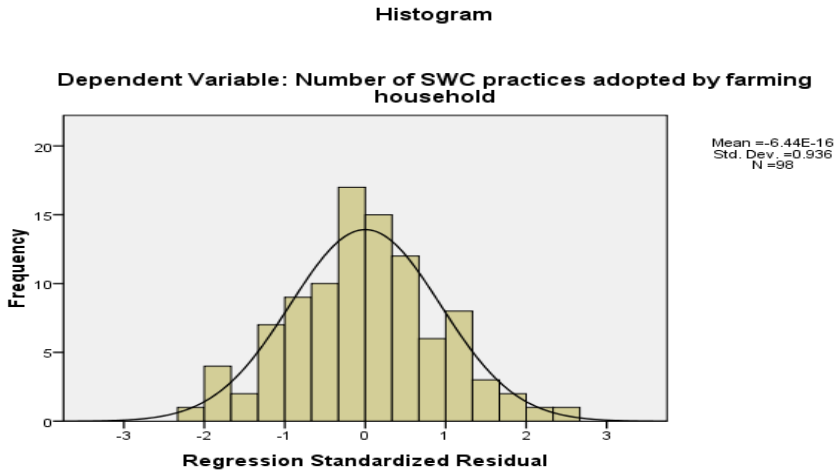

Figure: 3 Histogram demonstrates homoscedasticity in a multiple linear regression

The regression analysis revealed the coefficient of determination, R^2 of 40.1% as shown in Table 3. Such value of R^2 justifies that socio-economic factors simultaneously explained the occurrence of farmer's adoption of conservation package by 40.1%.

R	R^2	Adjusted R^2	Std Error of the Estimate
0.633	0.401	0.317	0.912

Table: 3 Regression model summary

The ANOVA was given out concurrently by regression analysis whereby F statistic used to test model fitness. Results in Table 4 show that F statistic = 4.745 and p<0.001. Hence, F statistic is significant at 5% level and verified that regression model is a good fit to the data.

Model	Sum of Squares	df	Mean Square	F	Sign
Regression	47.334	12	3.944	***4.745	0.001
Residual	70.666	85	0.831		
Total	118.000	97			

***Significance at p<0.001

Table: 4 Analysis of Variance in a regression model

Since MLR model obeys assumptions of linearity, normality, no multicollinearity and homoscedasticity, and the regression model is a good fit to the data, the regression analysis was run so as to identify socio-economic factors affecting adoption of package of SWC practices in the study area. The factors examined include sex, marital status, age, household size, education, farming experience, access to technical training, size of land, extension service, affiliation in farmers' association, access to subsidies and access to market. Results revealed by multiple linear regression analysis are shown in Table 5.

Variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% C.I for β		Collinearity Statistics
	β	Std. Error	Beta			Lower C.I	Upper C.I	VIF
(Constant)	1.358	0.788		1.724	0.088	-0.209	2.925	
Sex	-0.187	0.227	-0.084	-0.823	0.413	-0.637	0.264	1.484
Marital status	0.052	0.368	0.014	0.141	0.888	-0.680	0.783	1.462
Age	0.014	0.013	0.171	1.023	0.309	-0.013	0.040	3.965
Household size	0.022	0.048	0.042	0.452	0.653	-0.074	0.117	1.243
Education	0.075	0.049	0.166	1.508	0.135	-0.024	0.173	1.728
Experience	0.002	0.011	0.025	0.166	0.869	-0.021	0.025	3.151
Training	0.835	0.231	0.388	3.616***	0.001	0.376	1.294	1.633
Ext. service	0.381	0.175	0.195	2.179*	0.032	0.033	0.729	1.131
Land size	0.511	0.210	0.213	2.438**	0.017	0.094	0.929	1.086
Market	0.001	0.004	0.031	0.330	0.742	-0.007	0.010	1.244
Subsidies	0.145	0.241	0.061	0.603	0.548	-0.333	0.624	1.450
Association	0.144	0.227	0.063	0.633	0.528	-0.308	0.595	1.413

***significant at p<0.001; **Significant at p<0.01; *Significant at p<0.05

Table: 5 Results of MLR showing socio-economic factors affecting adoption of packages of SWC practices

Findings from MLR show that access to technical training, land size and extension services have significant influence and positive relation with number of conservation practices adopted (Table 5). Other assessed factors were

not significant in influencing farmers' adoption of number of practices for soil and water conservation in upland agriculture.

The effect of technical training on the intensity of adoption revealed that one unit increase of technical training increases farmer's intensity of adoption of SWC by multiple of 0.835 (β=0.835, $p<0.001$). The study found that the lower confidence interval (C.I) is 0.376 and upper C.I is 1.294. When farmers are trained on improved land management with a focus of mountainous agriculture, they usually become aware of advantages of investing on multiple practices of SWC and ultimately adopt a number of practices disseminated including terraces, mulching, planting trees, grass strips and cut-off drains.

Access to agriculture extension services through one unit increase in number of contacts between extension workers and farmer led to an increased of number of adoption of SWC practices by times 0.381 at 5% level (β=0.381, p=0.032). More findings revealed that the lower C.I is 0.033 and the upper C.I is 0.729 for occurrence of adoption intensity. Therefore, if farmers have frequent contacts with extension worker, they will have more knowledge regarding the advantages of adopting a multiple of practices disseminated for effective soil and water conservation on their hill slope farms and frequently visited for advice.

In the study area, the maximum land size is 2 acres for a household and average of 0.6 acre with standard deviation 0.5. The study revealed that land size located on mountain slope possessed by farmer has positive significant relation with famer's adoption of numbers of SWC (β=0.511, p=0.017). An increase in one unit of land size increases by times 0.511 the adoption of conservation package at 5% level of significance. The lower and upper C.I of occurrence of adoption intensity as an outcome of increase in land size is 0.094 and 0.929 respectively. From the findings, the study justifies that farmers are motivated to invest on SWC practices when have larger land sizes located on hill slopes.

6. CONCLUSION AND RECOMMENDATIONS

For many years back especially from early 1980 when Soil Erosion Control and Agroforesrty Project (SECAP) was launched by Tanzania government in collaboration with German government as donor and technical support agency, farmers in Lushoto District in the West Usambara motivated to make effort to restore the degraded land and improve agriculture through adoption of disseminated sustainable SWC practices. The SWC effort done by farmers demonstrated that there is high adoption of practices disseminated by SECAP. The main disseminated conservation practices include bench terrace, contour ridge, cut-off drain, tree planting, mulching, grass strips and fanya juu. In responding the government conservation initiatives, each farmer is currently utilizing more than four practices among the main seven disseminated conservation practices on their upslope agricultural lands.

The adoption conservation package among farmers in the study area is determined by socio-economic factors. Farmers' access to SWC training, contacts with extension worker and size of land owned are socio-economic factors which have positive effect on farmers' uptake of conservation practices. Farmers attended a kind of SWC managed to invest a larger number of conservation practices on the upslope farms than those who never attended training. Moreover, the conservation effort in upland smallholder agriculture is highly commendable among farmers who have frequent contacts with extension workers. Through advice and acquired knowledge from extension workers, farmers become motivated to increase their effort to adopt SWC practices. Although farmers possess small pieces of land, the number of conservation practices increases with increase in land size as an effort to effectively control soil erosion, minimize soil water losses and enhance hillslope agriculture.

The study recommends conservation agriculture stakeholders including the government and organizations promoting sustainable agriculture to continue with disseminating more knowledge and area specific conservation practices in the west usambara through agriculture extension workers. Different knowledge dissemination and adoption strategies can be used including farmer field schools and farmer-to-farmer visit using sufficient number of extension

workers. Adoption of improved SWC technologies will help famers control soil erosion and hence, increase agricultural production and ensure food security.

REFERENCES

[1] Barbier, E. B. (2010). Poverty, development and environment. *Environment and Development Economics*, 15(6):635-660.

[2] Burton, R. (1860). *The Lake Regions of Central Africa.* Longmans Green, London.

[3] Darkwah, K.A., Kwawu, J.D., Agyire-Tettey, F. & Sarpong, D.B. (2019). Assessment of the determinants that influence the adoption of sustainable soil and water conservation practices in Techiman Municipality of Ghana. *International Soil and Water Conservation Research*, 7:248 – 257.

[4] Duff, S. N., Stonehouse, D. P., Brown, D. R., Baker, K. M., Blackburn, D. J., Coyle, D. O. & Hilts, S. G. (1990). Understanding Soil Conservation Behaviour: Critical Review, The Centre for Soil and Water conservation, University of Guelph. *Technical Publication*, 90:1-72.

[5] Enujeke, E. C. & Ofuoku, A. U. (2012). Determinants of adaptation to climate change among arable crop farmers in Edo State, Nigeria and its implications for extension service. *International Journal of Advanced Biological Research*, 2(2):220-227.

[6] Ervin, C. A. & Ervin, D. E. (1982). Factors affecting the use of soil conservation practices: Hypothesis, Evidence and Policy Implications. *Land Economics*, 58:277-292.

[7] Heffernan, W. D. (1984), Assumptions of the adoption-difussion model and soil conservation. In: English Burton C., James A Maetzold, Brian R. Holding, and Earl O. Heady (eds), *Future Agricultural Technology and Resource Conservation*. Ames: Iowa State University Press.

[8] Huwe, C. (1988). *Half yearly report of the SECAP Research Department*, the West Usambara Mountains, Lushoto.

[9] Johansson, L. (2001). *Ten million trees later, Land use change in the West Usambara Mountains*. The Soil Erosion and Agroforestry Project in Lushoto District, 1981 – 2000, 163 pp.

[10] Kimaro, D. N., Poesen, J., Msanya, B.M. & Deckers, J.A. (2008). Magnitude of soil erosion on the northern slope of the Uluguru Mountains, Tanzania: Interrill and rill erosion. *Catena*, 75:38-44.

[11] Lundgren, J. (1980). Comparison of surface runoff and soil loss from runoff plots in forest and small-scale agriculture in the Usambara Mountains, Tanzania, Geografiska annaler, Series A. *Physical Geography*, 62:133-148.

[12] Mengstie, F. A. (2009). Assessment of adoption behaviour of soil and water conservation practices in the Koga Watershed Highlands of Ethiopia. A thesis submitted for the award of degree of Master of Professional studies, Cornell University.

[13] Minderhoud, P. S. J. (2011). Historical soil erosion in the West Usambara Mountains, Tanzania: A study based on hillslope deposit. Dissertation for award of MSc. degree in physical geography, Utrecht University.

[14] Mwihomeke, S.T. & Chamshama, S.A.O. (2001). *Fuelwood production by different tree species in a contour strip agroforestry practice in Lushoto West Usambara Mountains, Tanzania.* Paper to be submitted in the Regional Agroforestry Conference, Pretoria, South Africa, May 2002.

[15] Mowo, J. G., Mwihomeke, S. T. & Mzoo, J. B. (2002). *Managing natural resources in the west Usambara mountains: A Glimmer of Hope in the Horizon*. Paper prepared for Mountains High Summit Conference for Africa, Nairobi, 6 – 10 May 2002.

[16] Nkagbe, P. K., Shanker, B. & Cedia, G. M. (2011). *Smallholder adoption of soil and water conservation practices in Northern Ghana.* Paper prepared for presentation at the EAAE 2011 congress, August 30 to September 2, 2011, Zurich, Switzerland.

[17] Nkagbe, P.K. & Shankar, B. (2014). Adoption intensity of soil and water conservation practices by smallholders: Evidence from Northern Ghana. *Bio-based and Applied Economics*, 3(2):159 – 174.

[18] Nowak, P. J. (1983a). Adoption and diffusion of soil and water conservation practices. *Rural Sociologist*, 3(2):83-91.

[19] Osborne, J. & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research and Evaluation*, 8(2):1-20.

[20] Pampel, F. Jr. & J. van Es. (1977), Environmental quality and issues of adaptation research. *Rural Sociology*, 42(1):57-71.

[21] Rogers, E. M. (1962). *Diffusion of innovations*, Glencoe, Illinois: Free Press.

[22] Rogers, E. M. & Shoemaker, L. F. (1971). *Communication of innovations: A cross-cultural approach*, New York: Free Press.

[23] Sanchez, P. (1994). Alternatives to slash and burn: a pragmatic approach for mitigating tropical deforestation, J. R. Anderson (ed.), *Agricultural Technology Policy Issues for the International Community*, CAD International, pp. 451–480.

[24] Tenge, A. J. M. (2005). Participatory appraisal for farm-level soil and water conservation planning in the west Usambara highlands, Tanzania. Thesis for award of PhD at Wageningen University, the Netherlands.

[25] Vigiak, O. (2005). Modelling spatial patterns of erosion in the West Usambara Mountains of Tanzania. Doctoral Thesis Wageningen University, Tropical Resource Management Papers 64.