The Influence of High Value Crops Promotion on Soil and Water Conservation Practices in the Uluguru Mountains

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Abstract

In the western Uluguru Mountains, agricultural officers have introduced soil and water conservation (SWC) practices including terraces, contour strip cropping and agroforestry which, if properly followed, would conserve the soil and improve agricultural production. Various high value crops (HVCs) promotion activities and other incentives have been used to help achieve this objective. Despite these efforts, most farmers continue to use annual ridges which are not effective in SWC, and some other unsustainable agricultural practices. This study sought to determine the influence of HVCs promotion actions on investment in SWC in Mgeta Division, Mvomero District. Data were collected through structured and unstructured interviews as well as direct observations. Descriptive statistics and binary logistic regression were used to address study objectives. Results show that age, education and income, farm size and slope have significant influence on investment in SWC. Labour force and occupation were not significant. Land security was the most important incentive followed by agricultural sustainability, farm implements, irrigation improvement, labour sharing and suitability for growing HVCs. The least effective incentives were rewards/ prizes, market improvement, food-for-work and credit. The statistically significant variables that influence household's decision to invest in SWC were HVCs ($p = 0.005$), irrigation improvement ($p = 0.039$), land security ($p = 0.046$) and slope of the farm plot ($p = 0.083$). Extension efforts, market improvement and farm size were not statistically significant. It is therefore recommended to promote SWC measures such as ladder terraces which can be integrated into existing farming systems and to promote HVCs for cultivating on promoted SWC measures. In addition, SWC policies and programmes should improve land security in order to stimulate SWC adoption.

Keywords: Soil and water conservation, investment, high value crops, Uluguru Mountains

Introduction

The South Uluguru Forest Reserve (FR) is the source of water used in Dar es Salaam city and Morogoro municipality. Despite its significant importance to national development and conservation of biological diversity, encroachment into the forest in the search for virgin agricultural land and forest products is continuing. For example, Hymas (2000) asserted that in the Uluguru Mountains cultivation occurs up to the borders of the forest reserve and occasionally within the reserve. Today, in the Uluguru Mountains we see in most fields often annual ridges, the conventional way of farming which is not effective in soil and water conservation (SWC) and other forms of unsustainable agricultural practices such as cultivation on very steep slopes without soil conservation measures. According to Chamshama *et al.* (2009), inefficient land use practices are among the root causes of the threats that the Uluguru FR faces.

Experts and technocrats have introduced improved SWC practices which, if properly followed, would conserve the soil while at the same time facilitating options to improve agricultural productivity. Along with this, high value crops (HVCs) to be cultivated on conserved land were promoted. The hypothesis of the experts who introduced HVCs in the area was that HVCs increase profitability and require conserved land and hence form an incentive for adoption of SWC practices. In this regard, SWC implemented along with irrigation and HVCs, and thus more intensive farming, was seen as an innovative way of saving forest land from encroachment that had been done as a coping strategy (shifting cultivation) following declining productivity of available farmland under conventional farming practices. However, there is limited empirical evidence on relationship between HVCs promotion and household's decision to invest in SWC.

This study attempts to determine the influence of HVCs promotion on farmers' investment in SWC practices in the Uluguru Mountains. Specifically, the study had the following research questions:

- How do SWC practices differ between plots with HVCs and those with low value crops?
- What are the reasons for the farmers' investment in SWC practices?
- What are the cash crop promotion actions in western Uluguru Mountains?
- How do HVCs promotion actions influence investment in SWC?

Materials and Methods

Description of the study area

The study was conducted in the villages of Tchenzema, Nyandira and Vinile of Mvomero District, Morogoro Region. The villages are located in Mgeta Division, 50 km south-west of Morogoro Municipality on the western side of the Uluguru Mountains. Uluguru Mountains is part of the Eastern Arc Mountains located in central-eastern part of Tanzania, on latitude 7º01'-7º12'S and longitude 37º36'-37º45'E (Hymas, 2000). The mountains' landscape topography ranges from about 600 masl on the mountains' foothills to 2634 masl at the highest peak at Kimhandu in Uluguru South FR (Chamshama *et al.,* 2009). Due to favourable (cooler) climate in selected villages and in Mgeta in general, cultivation of vegetables and fruits goes on all the year round. The common vegetables namely tomatoes, round potatoes, cabbages, garden peas, cauliflower, salads, leeks, green beans and spinach; and fruits namely plums, peaches, apple and pears are produced at high altitude (900-2000 masl) areas. The favourable climate in the area attracts intensive production and therefore, as reported by Hymas (2000) and Bracebridge *et al.* (2005), cultivation occurs up to the borders of the forest reserve and occasionally within the reserve). Moreover, literature (Hymas, 2000; Paulo *et al.,* 2007) indicates that most communities in the landscape outside the forest reserve practice unsustainable agriculture. Efforts to address the problem, including conducting studies on incentives for implementation of SWC in Mgeta and the Uluguru Mountains at large are therefore needed.

Overview of organizations involved in promoting SWC in the Uluguru Mountains

Various organizations have been promoting SWC in the area. These include the German colonial administration in 1909, Uluguru Land Usage Scheme (ULUS) by the British Colonial Government from 1945 to 1955, Morogoro Women Agroforesty Project (MWAP) in 1980s, Sokoine University of Agriculture (through Uluguru Mountains Horticulture Development Project (UMHODEP), Uluguru Mountains Agricultural Development Project (UMADEP) from 1984 and Tanzania Agricultural Research Project (TARP II) from 1988 to date, Uluguru Mountains Environmental Management and Conservation Project (UMEMCP) of CARE International in Tanzania from 2004 to 2009, The National Network of Farmers Groups - Mtandao wa Vikundi vya Wakulima Tanzania (MVIWATA) from 1995 to date, Wildlife Conservation Society of Tanzania (WCST) from 1998 to 2005, DAI PESA from 2004 to 2007, University of Dar es Salaam in 1980s, Tanzania Forest Services (TFS) Agency and Mvomero/ Morogoro District Council from 1980s to date. Most of these organizations have worked in

collaboration with UMADEP.

UMADEP, TFS and Mvomero District Council are the organizations with interventions related to SWC in the area at the time of the study. For most of the mentioned organizations, their presence in the field lasted for less than five years. Also coordination among the organizations was minimal.

Interventions and tools for promoting HVC production in the Uluguru Mountains

UMADEP has been involved in a number of interventions intended to improve farmers' incomes while also conserving soil and water for sustainable production systems. The interventions include:

Improvement of traditional irrigation systems: The activity was seen as complementary with terracing because a farmer with terraces does not have to irrigate as frequently as the one without terraces since water seeps deeper on terraced land.

Promotion of high value crops (HVCs) to be grown on conserved land with irrigation: The HVCs in this regard are tomatoes, cabbages, garden peas and Irish (round) potatoes. Before UMADEP these crops were produced in the area but at subsistence level. In the course of promoting the HVCs, excavation of terraces was emphasized as a pre-condition for successful production of the crops. Moreover, farmers were organized into water user and marketing groups and an inputs shop established.

Extension services and training programmes: Training programmes involved theoretical and practical training, exchange visits conducted within and outside the Uluguru Mountains and on-farm visits by extension officers and other professionals.

Group formation: In the course of training activities, farmers were organized into conservation groups. Through the groups, labour pooling was organized in such a way that they helped to excavate terraces to at least one plot per member. The conservation groups were also networking with other farmer groups in the area for experience sharing.

Rural microfinance services: UMADEP has facilitated emergence of Savings and Credit Cooperative Societies (SACCOS) by facilitating the mobilization of financial resources from farmers, training of local clerks and SACCOS management committees as well as linking the SACCOS with service providers like auditing institutions.

Food-for-work: The food-for-work incentive referred to in this study is that of giving farmers food to be consumed at work when participating in training activities for conservation.

Research design

The study used cross-sectional design, whereby data were collected at one point in time. The design is suitable for descriptive analysis and for determining the relationships between and/or among variables.

Sampling

The target population consisted of farmers in Tchenzema, Nyandira and Vinile villages, UMADEP staff and government extension staff. The three study villages were selected purposively, the criterion being having had an intervention on HVCs promotion and SWC. Using stratified sampling method, farmer respondents were subdivided into two equal groups on the basis of whether or not one had invested in SWC measures. From the groups 120 farmers, 40 from each village were selected randomly. According to Bailey (1994), regardless of the population size but depending on the heterogeneity of the population, a sample of not less than 30 is the minimum acceptable size for rigorous statistical analysis. Additionally two UMADEP staff, one government extension staff and four farmers were selected as key informants, the selection criterion being having participated in the implementation of SWC and HVCs promotion initiatives in selected villages.

Data collection

Collection of primary data was done through face-to-face interviews and observations. An

interview schedule combining qualitative and quantitative questions and a checklist of questions were used. A checklist of questions was used for interviewing the key informants. Field observations were used to validate the information on existing SWC measures as well as to distinguish types of crops grown on conserved and non-conserved plots. Each respondent had at least two plots under routine crop production with some cultivating up to seven plots. Thus field observations were done at all such plots. The plots were numbered according to economic importance attached to them by the respondents, starting from plot one denoting the plot most relied upon. The researcher was assisted by three interviewers who underwent three days training and participated in pre-testing the research tools. The pre-testing was conducted in Nyandira village and involved interviewing key informants and ten farmers. Secondary data were collected from Sokoine University of Agriculture (SUA), Wageningen University in the Netherlands and Mvomero and Morogoro District Council offices.

Data processing and analysis

Qualitative data from key informant interviews were summarized and used to supplement the information on SWC efforts and HVCs promotion actions. Indices and ranking were used to explore farmers' attitudes to particular incentives as well as their willingness to implement particular SWC measures. Quantitative data were processed and analyzed using the Statistical Product and Service Solutions (SPSS). Descriptive statistics namely frequencies, percentages and means were employed to describe the influence of household and farm characteristics on investment in SWC, distribution of farm plots by SWC and crop type, and the influence of various incentives on investment in SWC. Binary logistic regression model was used to test the likelihood of households to invest in SWC measures in the presence of HVCs vis-à-vis the likelihood of households to invest in SWC measures in the absence of HVCs. As Agresti (2002) asserted, the model is ideal for variables in which the dependent one is a dichotomy, like investment in SWC (1) and non-investment in SWC (0) in this research, and the independent variables are of any type. In this study, decision to invest in SWC is based on a set of crop promotion interventions or incentives, which include among others promotion of HVCs to be cultivated on conserved farm plots. The model was specified as follows:

Logit (pi) = log (p_i/1-p_i) = $b_0 + b_1x_1 + b_2x_2 + \ldots$ + bjxj (Agresti, 2002; Powers and Xie, 2000), where:

Logit (pi) = ln (odds (event)), that is the natural log of the odds of an event occurring
pi = prob (event), that is the probability that the event will occur
1-pi = prob (non-event), that is the probability that the event will not occur
b0 = constant of the equation
b1 to bj = coefficients of the independent (predictor) variables
k = number of independent variables
x1 to xj = independent variables entered in the model, which were:
x1 = high value crops
x2 = irrigation improvement
x3 = extension efforts
x4 = market improvement
x5 = land security
x6 = farm size
x7 = slope of farm plot

The dependent variable is a dummy of investment in SWC, whereby non-investment in SWC was 0 if a household had not adopted SWC measures and investment in SWC 1 if a household had adopted SWC measures. This dependent variable was regressed on the above seven independent variables to find the impact of each of them on the dependent variable. The interest was on the impact of x1 on the dependent variable.

Results and Discussion

Background characteristics of respondents

Averaging the results from both SWC adopters and non adopters in Table 1, shows that many (43.3%) of the respondents were of young age (22-36 years) and fairly literate (85% had primary education). 55.4% of the households

were composed of 1-3 persons, often implying labour shortage. Farm size was on average 4.4 acres divided over 5 plots scattered inside and sometimes outside village boundaries. Majority (58.1%) of the plots had slopes that could be described as steep. More than half (64.2%) of the respondents had annual income ranging from 50 000 - 475 000 Tshs (30 - 288 USD). This implies that many persons were living below the poverty line of 1 USD per day.

Table 1: Chi-square tests for the background characteristics of respondents by adopters and non-adopters of SWC

Variable	Description	Adopters n = 60	Non adopters n = 60	χ^2
Age (years)	22 – 36	24(40.0)	28(46.7)	24.275*
	37 – 51	26(43.3)	21(35.0)	
	52 – 66	8(13.3)	7(11.7)	
	67 – 81	2(3.3)	4(6.7)	
Education (years)	No formal education (< 1)	5(8.3)	6(10.0)	24.399**
	Primary (5 – 8)	51(85.0)	52(86.7)	
	Secondary (9 - 12)	4(6.7)	2(3.3)	
Household size	1 – 3	28(47.5)	38(63.3)	16.667*
	4 – 6	26(41.1)	16(26.7)	
	7≤	5(8.5)	6(10.0)	
Labour force	1 – 3	57(95.0)	58(96.7)	ns
	4 – 6	3(5.0)	2(3.3)	
Occupation	Farming	60(100)	58(96.7)	ns
	Salaried employment	0(0)	2(3.3)	
Farm size (acre)	0.1 - 4.0	36(60.0)	32(53.3)	46.373**
	4.1 – 8.0	19(31.7)	21(35.0)	
	8.1 – 12.0	5(8.3)	5(8.3)	
	12.1 – 16.0	0(0)	2(3.3)	
Number of farm plots owned	1-2	2(3.3)	7(11.7)	ns
	3-4	19(31.7)	25(41.7)	
	5-6	29(48.3)	19(31.7)	
	7≤	10(16.7)	9(15.0)	
Income (Tshs)	50 000-475 000	35(58.3)	42(70.0)	ns
	475 001-900 001	11(18.3)	6(10.0)	
	900 002-1 325 001	7(11.7)	5(8.3)	
	1 325 002≤	7(11.7)	7(11.7)	
Slope of farm plots (per cent)	Gentle (5 – 12)	11(39.5)	16(60.5)	ns
	Moderate (12 – 35)	28(56.0)	22(44.0)	
	Steep (35 – 55)	16(58.1)	11(41.9)	
	Very steep (55<)	5(56.2)	4(43.8)	

χ^2 = Pearson based chi-square, * = Significant at 0.1 level, ** = Significant at 0.05 level, ns = Not significant. In parenthesis for adopters and non adopters columns are percentages

Soil and water conservation practices existing in western Uluguru Mountains

The majority (80.3%) of the households had adopted annual ridges (a conventional farming method in the study area) in at least one of their farm plots. A study conducted by Leeuw (2009) in the Uluguru Mountains found that ridging is not a sufficient measure against soil erosion and that terraces are more effective in that regard.

Arranged in order of decreasing adoption by the respondents, the SWC practices existing in the study area were excavated (bench and ladder) terraces (15.8% of the respondents), fanya juu terraces (2.6%), agroforestry (0.7%) and contour strip cropping (0.5%). Therefore, investment in SWC in the study area covers only about 20% of the respondents.

Higher extent of adoption of excavated terraces than other conservation measures was expected since it is one of the earliest promoted measures in the area. This means people have had a long time (before 1950s) to learn and test the technology. Moreover, excavated terraces especially ladder terraces are more compatible with existing experiences and needs because the method of preparation and essence of annual ridges, the conventional practice are similar to those of ladder terraces. Although the latter practice is more effective in SWC, it requires more labour and is more susceptible to yield reduction during the first three years resulting from more exposure of the subsoil compared to annual ridges.

Influence of household and farm characteristics on investment in SWC

Based on Chi-square test (Table 1) , variables with statistically significant influence on investment in SWC are four household characteristics namely age ($p < 0.1$), education ($p < 0.05$) and household size ($p < 0.1$); and one farm characteristic namely farm size ($p < 0.05$). Labour force and occupation on the other hand did not have a statistically significant effect on investment in SWC.

Many (43.3%) of the respondents who had invested in SWC belonged to the age group of 37-51 years. With regard to education, 91.7% of the SWC adopters had formal education. This is logical because education is necessary for access to information related to SWC. As for age, since returns to investment in SWC are usually expected after some years of working on the farm, it is more likely for younger farmers who have a longer planning horizon to invest in SWC than for the old ones.

With regard to farm size, most (60.0%) of the adopters of SWC were those who owned farms with a size ranging from 0.1 to 4.0 acres. The trend depicted by the results is that investment in SWC decreases with increasing farm size. The negative effect of farm size can be explained in terms of labour requirements for implementing conservation measures. With regard to slope, the respondents whose plots were steep (35-55% slope) were the most responsive to investment in SWC as there were more adopters (58.1% compared to 41.9% non-adopters) in this category. The findings can be explained in terms of the perceived need for conservation by land users based on physical characteristics of the farm plots where with a steep slope, one can see proneness to erosion and/or erosion symptoms while with gentle slope it is harder to perceive the possibility of erosion.

Results show further that labour force and occupation of the farmer had no significant effect on investment in SWC. With regard to labour force, the study area experienced a labour shortage, the average labour force being 2 persons and hence the available data for labour force bear little statistical influence. Occupation of the majority (98.3%) of the respondents was farming, thus the influence of the rest (1.7%) could hardly show up in empirical analysis.

Adoption of SWC measures based on type of crops cultivated

Study findings indicate that HVCs grown in western Uluguru Mountains include tomatoes, cabbages, round potatoes, peas, beans, leeks, onions, carrots and bananas. Maize and cocoyam are good examples of the crops considered of low market value. When asked which of the HVCs they cultivate 20.8% of the respondents

mentioned tomatoes. Banana was ranked the second (8.3%) followed by cabbages (5.0%) and round potatoes (5.0%). Ranking crops based on farmers' preference, 47.5% of the respondents ranked maize the first in terms of importance. According to farmers, maize is the staple food in the area and hence very important. Similar results were reported by Chamshama *et al.* (2009) who found that in the Uluguru Mountains 94.3% of the maize produced is mainly for home consumption and that maize is not considered as a cash crop. Tomato, cabbage and round potatoes were considered the first, second and third most important cash crops respectively since they generate high revenues. Other cash crops are beans, peas, banana, carrots, leeks and onions.

Relating existing SWC measures with types of crops grown, the results show that it was mainly the HVCs' plots that were conserved. For example 36.0% of tomato farm plots were conserved, mainly by excavated terraces, compared to only 19.0% of the maize plots. Similar results were reported by Leeuw (2009) whose study in the Uluguru Mountains revealed that food crops are not as highly valued as cash crops and therefore SWC measures are mostly implemented on plots with cash crops. It is therefore implicit that farmers conserve mainly for production of HVCs. According to Mkoba (2001), in north-western part of the Uluguru Mountains, bench and ladder terraces are exclusively used for growing vegetables. Furthermore, this confirms the assertion by de Graaff et al. (2008), that the implementation of SWC measures should always be accompanied with measures and motivating activities that improve the future prospects of increasing income for the farm household.

Incentives for investing in SWC

From the results 83.2% of the respondents mentioned land security as the number one incentive that stimulated them to invest in SWC. Logically, one would hardly invest in SWC for the land he/she does not legally own due to lack of security with the conservation benefits, which are usually long-term. According to Boyd *et al.* (2000), farmers who rent rather than own land are less likely to invest in SWC. Though it takes time for some SWC practices to start improving yields, the good thing is that SWC provide sustained high yields. This is probably the reason for respondents to rank sustainable future production the second (81.5%) incentive.

Support in the form of farm implements, extension services and SWC programmes (training, demonstrations, exchange and on-farm visits) were ranked the third (81.5%), fourth (80.7%) and fifth (79.0%) respectively. Provision of farm implements reduces the cost of implementing conservation measures and mitigates the loss in case of failure. According to Hatibu *et al.* (2000), risk of failure is a major constraint against adoption of SWC especially where large labour inputs are necessary. No wonder the respondents ranked extension efforts and SWC programmes among the top five because as Howeler *et al.* (2007) observed in Asia, by spending several days together during training, farmers and extension staff get to know each other well and are encouraged to help other farmers within their community in conducting trials or with the adoption of the new technologies.

Improved irrigation efficiency (76.0%) was ranked the sixth while labour sharing (farmer groups) (71.0%) and suitability of conserved land for growing HVCs (71.0%) were ranked the seventh. SWC measures enhance water use efficiency by checking water loss during irrigation on steep slopes and by improving water retention. Improved irrigation and plant nutrient maintenance renders the terraces best suited for HVCs production. The crops perform better on terraces than on non-conserved land and hence the reason for farmers to find HVCs and irrigation improvement a motivation for them to invest in SWC. The importance of farmer groups can be explained by the observation by Howeler *et al.* (2007) that farmers decide to form SWC groups after realizing that effective soil conservation practices can best be done collectively. Through the group farmers decide on collective action, gain confidence and become more self-reliant.

Based on the ranking done by the respondents the

four lowest incentives for investment in SWC include credit availability (63.0%), food for work (67.0%) and rewards and prizes (70.0%). These are direct incentives, which according to Posthumus (2005), have a discriminating effect where only adopters benefit from them while indirect incentives affect the whole community whether they adopt the new technology or not. It is therefore logical that it was only the farmers who had been exposed to these incentives who supported their use in stimulating farmers to invest in SWC. De Graaff (1996) asserts that credit for investment in SWC measures, with their long term impact, is not always an appropriate option.

Crop promotion interventions in western Uluguru Mountains

Interviews with key informants including progressive and elderly farmers, UMADEP and government extension officers in the study area show that since 1909 various interventions for SWC and agriculture development have been implemented in the area. Interventions that aimed specifically at promoting SWC include promotion of terracing technologies namely excavated terraces (more emphasis given to bench than ladder terraces), and developed terraces (fanya juu terraces and contour strip cropping), laying down of weeds and grass in ridges along the contour (trash lines), intercropping, agroforestry and tree planting. Other crop promotion actions include introduction and/or promotion of HVCs, irrigation improvement, production and use of farmyard manure and hence improvement of livestock keeping, promoting organic farming practices, promoting inputs supply and small scale fruit processing, market linkages and infrastructural development, enhancing extension services, rural micro finance services, formation of farmers groups, and introduction of donkeys for facilitating transportation of crops to market.

Significance of crop promotion interventions on households' decision to invest in SWC

Results of the binary logistic regression (Table 2) show that the value of Hosmer and Lemeshow chi-square obtained was 4.306 and was not significant ($p = 0.829$). Typically, in any case where the Hosmer and Lemeshow chi-square value is greater than 0.05, the goodness of fit is desirable (Garson, 2008). Thus the model used in this study fitted the data adequately. Moreover, Garson (2008) notes that Nagelkerke R^2 is normally higher than Cox-Snell R^2 and is the most-reported of the pseudo R^2 estimates. Therefore, based on the results in Table 2 which show that Nagelkerke R^2 was 0.253, it means that the independent variables entered in the model explained 25.3% of variance in the dependent variable.

According to the results (Table 2), the statistically significant variables that influence household's decision to invest in SWC measures are HVCs ($p = 0.005$), irrigation improvement ($p = 0.039$), land security ($p = 0.046$) and slope of the farm plot ($p = 0.083$). The B values of these variables are positive suggesting that they increase chances of households to invest in SWC, as discussed below.

High value crops (HVCs): The result that HVCs promotion increases chances of households to invest in SWC was expected since HVCs perform better on conserved land than on non-conserved land and sell better in the market and hence increasing returns from SWC. Moreover, HVCs promotion has an awareness raising effect. This takes place when a farmer participates in the HVCs promotion programme and learns also about SWC as a pre-condition for successful crop production. Thus, with HVCs promotion, farmers see a reason for investing in SWC because this way they become aware of the profitable crop to be grown on the land they are conserving. According to Posthumus (2005), terracing will only result in increased production if it is combined with intensified crop management or with crops of high market value.

Irrigation improvement: Positive and significant contribution of irrigation improvement to household's decision to invest in SWC can be explained by the fact that success in production of HVCs hinges not only on implementation of SWC measures but also on availability of

Table 2: Binary logistic regression analysis - estimating crop promotion interventions that influence investment in SWC measures (n=120)

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
High value crops	1.225	0.434	7.961	1	0.005***	3.406	1.454	7.978
Irrigation improvement	1.996	0.966	4.270	1	0.039**	7.359	1.108	48.860
Extension efforts	-0.949	0.787	1.455	1	0.228	0.387	0.083	1.809
Market improvement	-0.804	0.581	1.913	1	0.167	0.448	0.143	1.398
Land security	2.744	1.373	3.996	1	0.046**	15.552	1.055	229.246
Farm size	-0.074	0.072	1.065	1	0.302	0.929	0.807	1.069
Slope	0.806	0.465	3.005	1	0.083*	2.239	0.900	5.572
Constant	-3.546	1.487	5.690	1	0.017	0.029	-	-

Pseudo R^2 = 0.190 (Cox and Snell) & 0.253 (Nagelkerke); (Hosmer and Lemeshow) = 0.829
*, ** and *** denote significance at 10%, 5% and 1% levels respectively.

irrigation means. With irrigation possibility it is more likely for a farmer to increase farm productivity and hence justifying investment in SWC. Moreover, it is easier to irrigate on conserved farm plot than it is to irrigate on steep, non-conserved plot.

Slope: The depicted positive effect of slope means that decision to invest in SWC is likely to increase with increase in slope of the plot. Implementation of SWC measures makes more sense to a farmer when confronted with steep slope because with steep slopes problems like difficulties of irrigation, loss of rain and irrigation water and erosion symptoms such as top soil removal and crop yields decline are more conspicuous than on gentle slope. Hence a steep slope prompts a farmer to intervene. Similar findings were reported by Kessler (2006) who observed that major SWC investments are made on fields with steeper slopes.

Land security: According to the results, land security improvement increases the chances of households to invest in SWC. Logically, one would hardly invest in SWC for the land he/she does not legally own due to lack of security to the conservation benefits, which are usually long-term. According to Boyd *et al.* (2000), farmers who rent rather than own land are less likely to invest in SWC.

Extension efforts, market improvement and farm size are not statistically significant and their B values are associated with negative signs. This implies that in addition to lack of significant contribution to the model, the variables are likely to reduce chances of households to invest in SWC. As for farm size, the negative B value implies that chances of household's decision to invest in SWC are likely to decrease with increasing farm size. Small farm sizes necessitate intensification in order to earn sustained returns from the same small piece of land, the objective which can only be achieved through investing in SWC. A study conducted in western Uluguru Mountains by Magayane (1995) revealed that individuals with large farm size are less likely to adopt conservation practices compared to individuals with smaller farms.

The negative influence depicted for market improvement and extension efforts is against expectations. Possible explanation could be that with market improvement, that is improved access to the market and increase in crop prices, farmers see SWC as an option which delays them from grabbing the opportunity of increased crop prices resulting from market improvement. The results regarding extension efforts could be explained by the assertion made by Rutatora *et al.* (1996) on conservation efforts that over time, people have accumulated poor learning experiences and resentments towards

the government in general, and the extension workers, in particular. Similar findings were reported by Hella (2003) who observed that extension had negative and non-significant influence to farmers' willingness to invest in SWC.

Conclusions and Recommendations

The general objective of the study was to determine the influence of high value crop promotion on household's investment in soil and water conservation practices in the Uluguru Mountains. Based on the findings of the study, the following conclusions and recommendations can be made:

Conclusions

(i) The majority of farmers in western Uluguru Mountains were practicing annual ridges, a conventional farming method which is not an effective SWC measure. The existing SWC measures like excavated terraces, fanya juu terraces and contour strip cropping were undertaken mainly for the production of HVCs while for other (low value) crops farmers were using annual ridges.

(ii) The most important reasons for investing in SWC measures by farmers was to use irrigation and improve its efficiency and to facilitate the production of HVCs like tomatoes, round potatoes and cabbages. Use of the right set of conservation incentives therefore does stimulate investment in SWC. Indirect incentives such as land security and promotion of HVCs to be grown on conserved land are very effective in that regard.

(iii) Since the early 1900s to date, various cash crop promotion actions have been implemented by various organizations in western Uluguru Mountains. The interventions include promotion of SWC practices (terracing, contour strip cropping, trash lines, agro-forestry and tree planting), introduction of HVCs, improvement of traditional irrigation systems, agricultural credit and input supply, crop processing, packaging and marketing, improvement of extension services and farmers organizational capacity building.

(iv) Promotion of HVCs to be grown on conserved land has a significant influence on household's decision to invest in SWC. It is an indirect way of promoting SWC as in this way farmers consider SWC a pre-requisite to successful production of HVCs. Likewise, irrigation improvement is important as it increases chances for a farmer to increase farm productivity and hence justifying investment in SWC. Slope of the farm plot influences the perceived need for conservation by land users. With steep slope, one can see proneness to erosion and/or erosion symptoms while with gentle slope it is hard to perceive the possibility of erosion.

(v) With this kind of intensification of production, the pressure on the forest land in the vicinity will be reduced, which will contribute to biodiversity conservation in the Uluguru Mountains.

Recommendations

For enhanced SWC and sustained agricultural production and productivity in sub-tropical mountainous areas in general and in western Uluguru Mountains in particular the following recommendations are made:

To SWC programmes:

(i) Promote SWC measures which can be integrated into existing farming system. In western Uluguru Mountains, the study advocates promotion of ladder terraces and fanya juu terraces depending on farm characteristics and farmers' production objectives. When farmers go for banana production, fanya juu is the appropriate option. At any rate SWC measures should be combined with improved agronomic practices and high value crops.

(ii) Introduce and promote HVCs to be cultivated on conserved land. This is a necessary incentive for investment in SWC as it tends to increase the net returns that farm households obtain from SWC activities. Improve irrigation, this being an important factor in production of HVCs, especially during the dry season Increased returns from HVC production in turn

improves farmers' ability to invest in SWC.

(iii) Use of incentives. SWC results benefit not only the land user but also the society in general (e.g. through downstream effect). This justifies the use of incentives. Therefore, SWC programmes need incentives to influence farmers' behaviour. It is important to consider the fact that farmers often do not prioritize SWC. They might decide to participate in the programme because they want, for instance, to get access to seed subsidies and then learn also about SWC. This gives them an avenue for testing the technology (initial adoption). For continued adoption, incentives should be accompanied by awareness creation to beneficiaries as to why they receive the incentive and when it ends.

To policy makers:

(iv) Improve security of land ownership as this has an influence on the planning horizon of a land user and hence on the level of investment to commit to SWC.

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References

Agresti, A. (2002). Categorical Data Analysis (2nd Edition). John Wiley and Sons Inc., New Jersey. 710pp.

Bailey, K.D. (1994). Methods of Social Research (Fourth Edition). The Free Press, New York. 345pp.

Boyd, C., Turton, C., Hatibu, N., Mahoo, H.F., Lazaro, E., Rwehumbiza, F.B., Okubal, P. and Makumbi, M. (Eds.) (2000). The contribution of soil and water conservation in sustainable livelihoods in semi-arid areas of sub-Saharan Africa. Agricultural Research and Extension Network (AgREN). Network paper No. 102. 16pp.

Bracebridge, C., Fanning, E., Howell, K. M., Rubio, P. and St. John, F.A.V (Eds.) (2005). Uluguru component biodiversity survey 2005. (Volume II): Uluguru South Forest Reserve. Society for Environmental Exploration and the University of Dar es Salaam; CARE-Tanzania, Conservation and Management of Eastern Arc Mountains (CMEAMF): Uluguru Component, Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism, GEF/UNDP:URT/01/G32.150pp.

Chamshama, S.A.O, Iddi, S. and Mvena, Z.S.K. (2009). Uluguru Landscape Management Framework. Conservation and Management of the Eastern Arc Mountains Forests Project, Uluguru Project Component, Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism, GEF-UNDP-URT/01/00015426. 121pp.

Garson, G.D. (2008). Logistic regression. [http://www2.chass.ncsu.edu/garson/PA765/logistic.htm] site visited on 1/7/2015.

Graaff, J. de, Amsalu, A., Bodnar, F., Kessler, A., Posthumus, H. and Tenge, A. (2008). Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries. Applied Geography 28: 271-280.

Graaff, J. de (1996). The price of soil erosion: An economic evaluation of soil and watershed development. PhD Thesis, Wageningen University, The Netherlands. Mansholt Studies 3. Backhuys Publishers, Leiden. 298pp.

Hatibu, N., Mahoo, H.F., Lazaro, E and Rwehumbiza, F.B. (2000). Rethinking natural resource degradation in semi-arid Africa: Implications for policy. ODI, AgREN. 84pp.

Hella, J.P. (2003). Economic analysis of the relationship between smallholder farming strategies and soil degradation in semi-arid central Tanzania. Thesis for Award of PhD Degree at University of Gent, Belgium. 277pp.

Howeler, R.H., Watananonta, W. and Ngoan, T. N. (2007). Farmer participation in research and extension: The key to achieving

adoption of more sustainable cassava production practices on sloping land in Asia and their impact on farmers' income. In: Monitoring and Evaluation of Soil Conservation and Watershed Development Projects. (Edited by Graaff, J. de, Cameron, J., Sombatpanit, S., Pieri, C. and Woodhill, J.), Science Publishers, USA. pp 435 - 476.

Hymas, O. (2000). Assessment of the remaining forests of the Uluguru Mountains and the pressures they face. A report for CARE Tanzania and Uluguru Mountains Biodiversity Project. 45pp.

Kessler, C.A. (2006). Moving people – towards collective action in soil and water conservation. Experiences from the Bolivian mountain valleys. Thesis for Award of PhD Degree at Wageningen University, The Netherlands. 208pp.

Leeuw, B. de (2009). Cost and benefits of soil and water conservation in the Uluguru Mountains, Tanzania. Dissertation for Award of MSc Degree at Wageningen University, The Netherlands. 56pp.

Magayane, F.T. (1995). Farmers' adaptive effort to soil erosion and land productivity decline: The case of the Uluguru Mountains, Tanzania. Thesis for Award of PhD Degree at Graduate College of the University of Illinois at Urbana-Champaign, USA. 139pp.

Mkoba, A.P. (2001). Effectiveness of fanya chini terraces on soil properties and crop yield in the north-western part of Uluguru Mountains. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 128pp.

Paulo, W., Madoffe, S.S., Kajembe, G.C., Luoga, E.J., Nduwamungu, J., Ngowi, S. and Katani, J.Z. (2007). Extent and constraints of local people's involvement in biodiversity conservation of the Uluguru Mountains, Morogoro, Tanzania. Journal of the Tanzania Association of Foresters 11: 55-68.

Posthumus, H. (2005). Adoption of terraces in the Peruvian Andes. Dissertation for Award of PhD Degree at Wageningen University, The Netherlands. 216pp.

Powers, D.A. and Xie, Y. (2000). Statistical Methods for Categorical Data Analysis. Academic Press, California. 305pp.

Rutatora, D.F., Mafu, S.T.A. and Lulandala, L.L. (1996). The importance of farmer participation in rehabilitating degraded Uluguru Mountain slopes: the experiences from Magadu and Towero villages in Morogoro Region, Tanzania. African Study Monographs 17(3): 117-128.