International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 7 Issue 8, August 2020

ISSN: 2394-4404

Challenges Of Implementing Watershed Management Technologies: A Case Of Kibuon And Tende Catchments In South West, Kenya

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***Abstract:** Globally watershed degradation has become the most serious example of natural resource degradation that impacts negatively on environment and food security. Integrated Land and Watershed Management Project (ILWMKTP) was implemented in Kibuon and Tende catchments from 2009 to 2014. It focused on improvement of land productivity and water quantity in the catchments by using watershed management technologies. The study sought to determine challenges farmers faced during implementation of the technologies. It was conducted in Homa Bay, Nyamira and Kisii Counties which were purposively selected having implemented the project. It was an ex post facto research- design that adopted cross sectional survey approach which combined qualitative and quantitative data collection procedures. Target population of the study was 9,475 farmers who participated in the ILWMKTP project. Accessible population was 370 respondents who were selected proportionately through simple random sampling procedures and 9 key informants. Interview schedule and a questionnaire were used in data collection. There was a significant difference in scores on challenges which farmers faced; between 55-78.9 percent agreed that challenges did not affect uptake of technologies while between 19-21.4 per cent reported technology uptake having been affected by the challenges. Data analysis showed positive correlations an indication of high technology uptake if the challenges were alleviated. There was need for training on entrepreneurship for better management of alternative economic activities for improved returns and economic stability. Increase in income would reduce challenges such as lack of farm implements and lack of credit facility which affected technology uptake among some respondents.*

***Keywords:** Challenges, Watershed management technologies, Uptake, Catchments.*

I. INTRODUCTION

Across the world economies are expanding, towns and improved services are spreading and growing populations are enjoying good standards of living. Farmers in the rural grow food for domestic and commercial purposes at the expense of the natural resources which do not expand leading to over exploitation of soil and water, causing watershed degradation (Lenton & Muller, 2009). The degradation affects more than 20 percent of agricultural land, 30 percent of forest cover and 10 percent of grassland (Tamene, IKindu, Woldearegay & Aberra, 2014). Globally, watershed degradation has emerged as the most serious example of natural resource degradation impacting negatively on environment and socio-economic factors (Atnafe, Ahmed & Adane, 2015) but more common in developing countries Kenya included (Mesfin, 2010). Watershed degradation is a threat to food security and vulnerability to climate change (Mesfin, 2010; Kieti, Kauti &

Kisangau, 2016). Watershed management technologies have been piloted in many countries in the World as best solutions to water resource challenges but their implementation has not been successful due to various challenges (Wamalwa, 2009).

Kibuon and Tende catchments were characterized by soil and water degradation which resulted in reduced water base flow and increased poverty. Benefits of watershed management in any part of the world cannot be overstated, for that reason, an Integrated Land and Watershed Management Project in the catchments was initiated to reduce degradation in the catchments from 2009 to 2014. It aimed at increasing land productivity and improving water quality and quantity. The agricultural extension programme planning and implementation interventions applied an Integrated Project Extension Approach in Kibuon and Tende Integrated Land and Watershed Management Project (ILWMKTP). This aimed at promoting watershed management technologies in the catchments. Participating farmers were supported to implement and encourage their neighbours to also implement those technologies and continue using them. It is the most suitable approach for soil and water conservation measures among smallholder farmers who are not able to commit their limited resources to long term goals. This study was conducted to determine challenges which farmers faced during implementation of watershed management technologies in Kibuon and Tende watersheds. The study aimed at developing a strategy to enhance uptake of the technologies to alleviate the challenges to reduce watershed degradation in the watersheds. The research tested the null hypothesis; There was no statistically significant difference in challenges which farmers faced during implementation of watershed management technologies in the catchments.

II. LITERATURE REVIEW

A. GLOBAL DEGRADATION OF WATERSHEDS

Soil erosion contributes to watershed degradation which reduces productivity and water quantity in watersheds. Globally freshwater resources are affected by pressure due to population growth and increased economic activities (Gunya, 2009[1]). Through Florida Watershed Restoration Act, the State of Florida developed a Watershed Restoration Framework to address a holistic, eco-system based water protection programmes (Graham, Jain, & Mathews, 2010). Wide spread degradation and scarcity of land resources have affected many food production systems negatively around the globe causing a big challenge to feeding a world population expected to reach 9 billion people by 2050 (Manuelli, Hofer, & Vita, 2014).

B. DEGRADATION OF WATERSHEDS IN THE TROPICS

Watershed management is important in alleviation of food insecurity and poverty in any country. Watershed degradation is an ecological and economic constraint in Ethiopia and its management has been applied to facilitate effective use of natural and social capitals (Tiki, Kewessa & Wudneh, 2016[2]). Bhutan in Eastern Himalaya developed water related resources to sustain economic prosperity and restore environment (Tsering, 2011). According to Mesfin (2010) the decision to implement watershed management starts with perception of erosion as a problem since some of the structures take between 5-15 years before they start benefiting farmers.

C. DEGRADATION OF WATERSHEDS IN KENYA

Major causes of watershed degradation include population increase, over-exploitation of natural resources, climate change and discharge of pollutants in the environment (GoK, 2014; Kieti, Kauti & Kisangau, 2016[3]; Gunya, 2009). Like many countries, Kenya is faced with inter-related constraints linked to poverty, food instability, environmental degradation and competition for natural resources (Heiner, K. , Shames, S. & Spiegel, 2016). The country is moving into " ecological overshoot" whereby natural resources are depleted faster than they are restored for example water scarcity due to over abstraction by horticulture and industries in Naivasha (World Bank, 2016). Thiririki watershed on the Eastern slope of Aberdares experiences logging for charcoal burning and agricultural activities. The middle part of the watershed is intensively used for extensive agricultural practices resulting in soil erosion and landslides while the lower part is densely populated with over extraction of water for cash crops and cut flowers contributing to sedimentation of Thiririka River (Benham, Yagow, Chaubey & Douglas-Mankin, 2011). Mount Elgon is a crucial watershed in Kenya as a source of major water sources in the region yet it is exposed to flooding, droughts, water scarcity, more soil erosion. Through Mount Elgon Integrated Watershed Management Project, farmers have been trained on sustainable agricultural land use management practices, protection of river banks, springs, agroforestry which have improved the quantity and its quality (Skogen, 2010).

D. CHALLENGES WHICH FARMERS FACED DURING IMPLEMENTATION OF WATERSHED MANAGEMENT TECHNOLOGIES

a. LACK OF LAND OWNERSHIP

Uptake of soil and water conservation technologies is dictated by the rights to own land. Therefore temporary owned land is rarely conserved in terms of soil erosion. Rehema (2014) in her study established that land ownership security motivated farmers to take up soil and water conservation practices and engaged in short and long term planning of watershed management. It encouraged sustainable use of land by increasing productivity through long term use of the technologies. Lack of land ownership influenced farmers negatively by not making a decision to investment in the technologies (Miheretu & Yimer, 2017). A study carried out in India established that investment in watershed management technologies was lower on leased land and on land that had restrictions on selling it (Kipngeno, 2007).

b. NATURE AND COST OF TECHNOLOGY

Watershed management technologies have varied costs in construction and establishment that may not allow farmers with limited resources to invest in. Kipngeno (2007), pointed out the need to develop a variety of affordable technologies in areas where benefits provided during project implementation will motivate farmers to invest in the technologies since benefits accrued are felt after a long time. It is important to take into account farmers' needs and simple technologies that can be taken up in watersheds than taking up classified ones imposed to them (Perez & Tschinkel, 2003). Cost, feasibility and anticipated benefits enhance taking up of watershed management technologies. There is high up take rate for technologies that are easy to use and have clear advantages like improved land productivity (Pino, Toma, Rizzo, Miglietta & Peluso, 2017). Technology attributes and their impact were found to enhance their uptake in catchments since farmers go for those with more benefits (Kipngeno, 2007). Benefits dictate the rate of uptake therefore the higher the returns the higher the adoption rate (Muchangi, 2016). Simple, testable technologies which are based on farmers' resources and innovations are highly adopted (Mercado et al., 2014). Complicated technologies have low uptake rate.

c. INADEQUATE INSTITUTIONAL APPRAISAL

It is crucial to understand institutions involved in the watershed, how they influence performance of activities, factors affecting them and identify the need for change for enhanced watershed management (Teketel, 2009). Extension officers need practical skills in what they have been trained on for better output. Mbogo, (2014) argued that extension evolved from supply to demand driven and it is more complex with informed stakeholders in agriculture sector. According to Teketel (2009) and Delaney (2012), Government institutions play a crucial role through provision of enabling environment for watershed management and settling conflicts thereby contributing to the success of project management. All institutions that can enhance the use of watershed management technologies should be invited to participate in implementation of the project. Extension agents are a source of technologies in soil and water conservation and well trained farmers have high uptake rate of the technologies (Miheretu & Yimer, 2017).

d. TECHNOLOGICAL CONSTRAINT

Knowledge and skills are key factor in uptake of soil and water conservation technologies. Lack of awareness on technical skills needed for implementation technologies impacted negatively to uptake of technologies (Asnake & Elias, 2017). Practical training correlates significantly with uptake of watershed management technologies therefore an increase in number of trained people contribute to high uptake of the technologies (Doran & Parkin, 2009). According to Kerse (2018), adequate trainings enhance the power to make a decision to engage in an activity or not. A review of factors that influenced conservation practice uptake in agriculture by Lesch and Wechenheim (2014), found out that education contributed to uptake of soil and water conservation practices. Level of education influences uptake of soil and water conservation practices in watersheds (Miheretu & Yimer, 2017) .

e. LABOUR SHORTAGE

Labour is considered very crucial in implementation of soil and water conservation. A slight shortage results in low uptake. In Rwanda labour is a problem in technologies that have minimal external support (Drechsel,Adeoti, Thiombiano, Barry & Vohland, 2015). Further, urban rural migration of youth has reduced labour force that would participate in uptake of watershed management technologies. According to Asnake and Elias (2017), labour shortage influenced adoption of soil conservation measures negatively in Woreda in Ethiopia. A study findings in Damota watershed in Ethiopia indicated that availability of labour influenced uptake of soil and water conservation technologies (Kerse, 2018). According to Wolka and Negash (2014), labour influenced uptake of watershed technologies positively when soil erosion is viewed as a constraint thereby increasing the adoption of the technologies and providing labour for construction and maintenance of the structures on the farm. Labour shortage influences uptake of soil and water conservation practices negatively through low uptake of the practices (Miheretu & Yimer, 2017).

E. SPECIFIC OBJECTIVE

- ✓ To establish challenges which farmers faced during implementation of watershed management technologies in the catchments.

III. RESEARCH METHODOLOGY

A. GEOGRAPHICAL DESCRIPTION OF THE STUDY AREA

The survey was conducted in rivers Kibuon and Tende catchments which cover Homa Bay, Kisii and Nyamira Counties in South West Kenya. According to the census for 1999 in African Water Facility, (2008) total beneficiaries were 1,884,000 farmers but the Integrated Land and Watershed Management Project in the catchments covered 9,475 farmers. The study area has bimodal rainfall pattern; Homa Bay County lies between low land midland 1 (LM_1) to low land midland 4 (LM_4) agro ecological zones and receives 450-1000 mm of rain per year. Kisii County falls in low land midland 1 (LH_1), low land highland 2 (LH_2) and low land highland 3 (LH_3) agro ecological zones and receives between 1500 mm to 2000 mm of rain per year. Nyamira lies between low land highland 1 (LH_1) to upper midland 2 (UM_2) agro ecological zones and receives between 1500 mm to 2000 mm of rain per year. Kibuon and Tende catchments run from the upper parts of Nyamira and Kisii Counties through Homa Bay County to Lake Victoria. The catchments were divided in upper, middle and lower parts of the catchments hence the numbers 1-3. Kibuon catchment was divided in; Kibuon (K1), Kabondo

(K2) and Kasipul (K3) sub catchments. Tende catchment was also divided in three sub catchments; Tende (T1), Isanta (T2) and Mogusii (T3). The catchments run through Nyamira South, Nyamira North, Kitutu Chache, Marani, Rachuonyo North, Rachuonyo South and Rangwe Sub Counties.

B. RESEARCH DESIGN

The design was an *ex post facto* research design with cross sectional survey approach combining qualitative and quantitative data collection. *Ex post facto* is a systematic empirical enquiry without direct manipulation of independent variables since they have already taken place (Manjunath, 2014). Primary data was collected from respondents and key informants through interview schedule and a questionnaire respectively. The study also used observation for additional information. Secondary data was collected from reports, policy documents and books from Government institutions..

C. POPULATION OF THE STUDY

The study targeted a total of 68 community based organizations (CBOs) with a membership of 9,475 farmers in the project area. The accessible population was 370 members of 34 CBOs.

D. SAMPLE SIZE AND THE SAMPLING TECHNIQUES

The study area was selected purposively for having implemented a watershed management project. Multiple-stage cluster sampling method was used proportionately. It was divided into 6 sub catchments and each sub catchment was represented by a number of CBO members. Through proportionate simple random sampling, 50 per cent of the CBOs were sampled for the study. Simple random sampling was used to get respondents proportionately in each CBO. From 68 CBOs, 34 CBOs were systematically selected each member was selected through simple random sampling procedures. The study covered 370 respondents and 9 staff who participated in implementation of the project.

E. INSTRUMENTATION

The study applied interview schedule and questionnaire to respondents and key informants respectively. The tool sought to find responses for questions based on challenges faced; land ownership, complex technology, technology cost, inadequate partnership involvement, labour shortage, many trainings and seminars, shortage of farm implements and lack of credit facility. The tools were suitable because the researcher asked for additional information and clarification from respondents who were not able to write.

F. DATA COLLECTION PROCEDURES

A research permit was sought from National Commission of Science, Technology and Innovation (NACOSTI) through Kisii University. Department of agriculture in the study area was informed. Data was collected from respondents through face to face interview.

G. DATA ANALYSIS

Data was analyzed using descriptive and inferential statistics. Level of significance for inferential statistics was set at 0.05%. Descriptive statistics, ANOVA, Tukey post hoc and Pearson correlation were used in data analysis.

IV. RESULTS AND DISCUSSIONS

A. SOCIAL AND DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

The study interviewed 370 respondents who comprised of 63.2 percent men and 36.8 percent women. Majority of those who implemented the programme (234) out of 370 were men while 136 were women. Most women participated in biological and alternative economic enterprises that did not require a lot of energy to establish for example poultry, goat production and fish farming in the catchments. Men made decisions on how land should be utilized and provided labour for tedious work in terms of terrace construction.

Majority of the respondents (74.3 percent) were above 40 years of age and most of them were between 50-60 years old while 5.7 percent were below 40 years of age. Respondents below 30 years represented the lowest percentage (1.4) of the total sample size. Data analysis indicated that participation in watershed management technologies was influenced by age because most of the respondents in the survey were above 40 years old. Older people valued land more than young people therefore made the decision to participate in soil and water conservation activities to conserve the watersheds to improve soil fertility and translated in increased productivity. This is in line with findings by Bayard, Jolly and Shannon (2006) in their study on " Adoption and Management of Soil Conservation Practices in Haiti:" which indicated that age influenced participation in soil and water conservation whereby uptake increased with progression in age.

Most of the respondents interviewed were married (99.5 percent). Married men had more labour for technology implementation provided by wives and children unlike those who were not. Men made decisions on which technology to be taken up on their farms while women implemented decisions made by men through provision of family labour. This was confirmed in this study in which 99 percent were married. The women participated in watershed management to restore their farms and improve on productivity in maize, milk and forage for improved household income. Rehema (2014) reported similar observations in her study on "Factors Influencing Adoption of Soil Conservation Measures in Mbeya rural District in Tanzania" which established that married women participated in soil conservation to increase family income although decisions on technologies were made by men. Level of education for majority of the respondents attained primary level followed by secondary level of education and the least percentage (1.4 percent) of respondents attained tertiary level. This analysis showed that farmers participated and implemented the technologies as long as they had basic education and were taken through trainings on soil and water conservation technologies. Respondents who had more than 5 family members were (70 percent), followed by 5 members (23.8 percent), then the rest had between 2- 4 family members. A high number of households provided labour that was required in participation of watershed management technologies in the catchments which agreed with a study by Mutuyimana (2015) in her findings on "Effects of integrated soil and water management on livelihoods of smallholders in Burega sector, Rwanda" which reported family size being important for active participation by farmers in soil and water conservation. Land sizes ranged from ½ an acre to more than one acre. Half of the respondents (49.7 percent) owned more than one acre, thirty nine point nine percent (39.9 percent) owned one acre and 10.8 percent had less than one acre of land. Most of the respondents had more than 1 acre of land because some of the technologies required more space for construction while those with smaller pieces of land put one retention ditch on the upper part of their farms and invested in cover crops and agroforestry along the fence. These findings were also reported by Tadesse and Belay (2004) on "Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia" who reported size of land being positive and significantly influenced uptake of soil conservation technologies.

B. A FREQUENCY TABLE ON CHALLENGES

A frequency table for the challenges was drawn to establish respondents who agreed to the positive statements on the constraints:

Those that affected the study;

- ✓ Land ownership- 19 percent
- ✓ Complex technologies- 21 percent

Those that did not affect the study

- ✓ Technology cost -55 percent
- ✓ Inadequate stakeholder involvement -65 percent
- ✓ Labour shortage- 67 percent
- ✓ Many trainings and seminars- 79 percent
- ✓ Shortage of farm implements- 68 percent
- ✓ Lack of credit facility- 69 percent

C. LAND OWNERSHIP

Data gathered was subjected to descriptive statistics, ANOVA, Tukey post hoc and Pearson correlation. Descriptive statistics indicated that Kibuon K1 had the highest mean of 2.47 and a standard deviation of 1.727, Kasipul K3 had a mean of 2.22 and standard deviation of 1.689. Mogusii T3 had a mean of 2.05 and a standard deviation of 1.669. Kibuon K2 had a mean of 1.63 and a standard deviation of 1.27, Tende T1 had a mean of 1.63 and standard deviation of 1.316 while Isanta got a mean of 1.17 and standard deviation of .670. High number of respondents in Kibuon K1 reported that land ownership affected technology uptake due to a fairly high mean while comparatively many respondents in Isanta reported land ownership affecting technology uptake. The ANOVA analysis results indicated that there were significant differences at $F = 4.422$, $p = 0.001$ on the level at which land ownership affected technology uptake in different sub catchments. Tukey post hoc test showed that Isanta T2 reported significantly lower rate of uptake of soil and water conservation technologies due to lack of land ownership compared with Tende T2, Kibuon K2, Mogusii T3, Kasipul K3 and Kibuon K1. Tende T1 and Kibuon K2 were not significantly different from any sub catchment (Table 1).

Sub catchment	N	1	2
Isanta T2	47	1.17	
Tende T1	148	1.63	1.63
Kibuon K2	70	2.05	2.05
Mogusii T3	39		2.05
Kasipul K3	51		2.22
Kibuon K1	15		2.47
Significant			.076

Table 1: Tukey Post Hoc Results on Land Ownership

Positive Pearson correlation indicated that if land ownership rights were addressed, farmers would take up many technologies while the negative ones implied that if farmers did not own land, uptake of technologies would reduce. Many respondents from Kibuon K1 reported that land ownership did not affect uptake of technologies compared to Isanta T2 which reported slightly lower than Kibuon K1. Tende T1 and Kibuon K2 were not significantly different from any sub catchment. Mean values for sub catchments were low an indication that land ownership affected many respondents negatively and those who leased land did not implement soil and water conservation technologies. The findings also implied that there was a slightly high level of soil conservation technology uptake in Kibuon K1 compared with Isanta T2. Soil conservation technologies were not established on leased farms. This agreed with findings by Karidjo, Wang, Boubacar and Wei (2018) in their research on "Factors Influencing Farmers' Adoption of Soil and Water Control Technology (SWCT) in Keita Valley, Semi-Arid Area of Niger" which reported that farmers who had rights to land and resources were significant and a positively correlated with soil and water conservation activities

D. COMPLEX SOIL CONSERVATION TECHNOLOGIES

Through descriptive statistics Kibuon K1 had the highest mean of 2.53 with a standard deviation of 1. 356, Kibuon K2 had a mean of 2.51 and a standard deviation of 1.604. Mogusii T3 had a mean of 2.13 and a standard deviation of 1.418, Kasipul had a mean of 2.12 and a standard deviation of 1.418, Tende T1 had a mean of 1.77 and a standard deviation of 1.381. The ANOVA analysis results indicated that there was significant differences at $F = 4.042$, $p = 0.001$ on the level at which farmers in different sub catchment took up complex technologies. Tukey post hoc results indicated Isanta T2 had high rate of technology uptake by having a small mean (1.57) compared to Kibuon K1 which took up a few (2.53). Isanta T2 took up many complex technologies compared to Tende T1, Kasipul K3, Mogusii T3, Kibuon K1 and Kibuon K2. Tende T1, Kasipul K3 and Mogusii T3 were not significantly different from any sub catchment (Table 2).

Sub catchment	N	1	2
Isanta T2	47	1.57	
Tende T1	148	1.77	1.77
Kasipul K3	51	2.12	2.12
Mogusii T3	39	2.13	2.13
Kibuon K2	70		2.51

Kibuon K1	15		2.53
Significant		.515	.166

Table 2: Tukey Post Hoc Results on Complex Technologies

Through Pearson correlation all the eight technologies had negative correlations significant at various levels. The negative correlation implied that an increase in technology complexity reduced technology uptake. Lower mean values indicated that slightly more respondents took up complex technologies in Isanta T2 while in Kibuon K1 there was low uptake. There was slightly more uptake of the complex technologies in Isanta T2 and Tende T1 because being in upper (1) and middle part of the catchments (2) they receive more rain which calls for construction of retention ditches and terraces as opposed to Kibuon K1 which is in the upper part of the catchment and probably due to inadequate skills they were not able to construct some of the complex structures like terraces and retention ditches. Low uptake of complex technology was reported by all the six sub catchments indicated by low mean values. This agreed with findings by Kerse (2018) in his study on "Factors Affecting Adoption of Soil and Water Conservation Practices in the Cases of Damota Watershed, Wolaita Zone, Southern, Ethiopia" which reported inadequate easiness and inappropriateness in technology implementation as a deterrent in uptake of soil and water conservation technologies.

E. TECHNOLOGY COST

Descriptive statistics produced the following means and standard deviations; Kasipul K3 had the highest mean of 3.82 and standard deviation of 1.307, Tende T1 had mean of 3.51 and a standard deviation of 1.464, Mogusii T3 had a mean of 3.28 and a standard deviation of 1.234. Isanta had a mean of 3.17 and a standard deviation of.816, Kibuon K2 had a mean of 3.01 and a standard deviation of 1.707 while Kibuon K1 had the least mean of 2.53 and a standard deviation of 1.457. The ANOVA analysis results indicated that there was a significant different at F = 3.507, p = .004 on the level at which farmers in different sub catchments took up costly technologies. Through Tukey post hoc results, (Table 3), Kibuon K1 was significantly different from Kasipul K3 by taking up more costly soil conservation technologies. Kasipul K3 took up fewer costly soil conservation technologies compared to Tende T1, Mogusii T3, Isanta T2, Kibuon K2 and Kibuon K1. Kibuon K2, Isanta T2 and Mogusii T3 were not significantly different from any sub catchment.

Sub catchment	N	Mean	Standard deviation
Kibuon K1	15	2.52	1.457
Kibuon K2	70	3.01	1.707
Kasipul K3	51	3.82	1.307
Tende T1	148	3.51	1.464
Isanta T2	47	3.17	.816
Mogusii T3	39	3.28	1.234
Total	370	3.35	1.430

Table 3: Means on Technology Cost

Pearson correlations coefficient two tailed test result indicated that there was a significant correlation between cost of technology and uptake. The negative correlation implied that an increase in technology cost reduced uptake technologies. A slightly high number of respondents from Kibuon K1 took up less costly soil and water conservation technologies while very few in Kasipul K3 took up few technologies due to their costs. About 80 percent of the key informants reported that technology cost affected their uptake. The findings indicated that when a technology was expensive, it was taken up by few respondents which agreed with a study by Asfaw and Neka (2018) in their study on "Factors Affecting Adoption of Soil and Water Conservation Practices in Woreda (District) in Ethiopia" which reported economic constraint being a major constraint in soil conservation technology uptake.

F. INADEQUATE PARTNERSHIP INVOLVEMENT

Data collected was subjected to descriptive statistics and Tende T1 had a mean of 3.86 and a standard deviation of 1.232, Kasipul K3 had a mean of 3.80 and a standard deviation of 1.167, Isanta T2 had a mean of 3.66 and a standard deviation of .731. Kibuon K2 had a mean of 3.60 and a standard deviation of 1.276, Tende T1 had a mean of 3.60 and standard deviation of 1.27, Mogusii T3 had a mean of 3.26 with a standard deviation of 1.253 while Kibuon K1 had a mean of 3.13 and a standard deviation of 1.356. The ANOVA test result indicated that there were significant differences in the level of technology uptake at different level of partners participation in different sub catchments. The constraint affected uptake of soil and water conservation technologies more in Kibuon K1 compared with Mogusii T3, Kibuon K2, Isanta T2, Kasipul K3 and Tende T1. Tende T1 took fewer technologies due to inadequate partnership involvement compared to Kasipul K3, Isanta T2, Kibuon K2, Mogusii T3 and Kibuon K1 (Table 4).

Sub catchment	N	1
Kibuon K1	15	3.13
Mogusii T3	39	3.26
Kibuon K2	70	3.60
Isanta T2	47	3.66
Kasipul K3	51	3.80
Tende T1	148	3.86
Significant		.101

Table 4: Tukey Post Hoc Results on Inadequate Partnership Involvement

Pearson correlation coefficient two tailed test indicated a positive correlation between technology uptake and level of partners' participation. This implied that an increase in partnership involvement contributed to an increase in technology uptake while negative correlations indicated that a reduction in partnerships, contributed to reduced uptake of technologies. There was a slightly higher uptake in Tende T1 compared with Kibuon K1. Probably respondents in Kibuon K1 needed more partners to support uptake of technologies while Tende T1 took up a higher number regardless of partnership involvement. Key informants (66.6 percent) confirmed that inadequate involvement affected technology uptake. Karidjo et al. (2018) in their study on "Factors Influencing Farmers' Adoption of Soil and Water Control Technology (SWCT) in Keita Valley, Area of Niger" reported involvement of partners from different institutions increased uptake of technologies.

G. LABOUR SHORTAGE

Through descriptive statistics; Tende T1 had a mean of 3.95 and standard deviation of 1.157, Isanta T2 had a mean of 3.81 and a standard deviation of .970, Mogusii T3 had mean of 3.56 and a standard deviation of 1.429, Kibuon K1 had mean of 3.27 and standard deviation of 1.280, Kasipul K3 had a mean of 3.25 mean and a standard deviation of 1.440 while Kibuon K2 had a mean of 2.79 and standard deviation of 1.658. The ANOVA analysis results showed that there were significant differences at F = 8.462, p = 0.000 on the level at which labour shortage affected uptake of technologies in different sub catchments. Tukey post hoc test results reported Kibuon K2 having taken up many technologies despite labour shortage compared to Tende T1. Kibuon K2 adopted more compared with Kasipul K3, Kibuon K1, Mogusii T3, Isanta T2 and Tende T1. Kasipul K3, Kibuon K1 and Mogusii T3 were not significantly different from any sub catchment (Table 5).

Sub catchment	N	1	2
Kibuon K2	70	2.79	
Kasipul K3	51	3.25	3.25
Kibuon K1	15	3.27	3.27
Mogusii T3	39	3.56	3.56
Isanta T2	47		3.81
Tende T1	148		3.95
Significant		.100	.184

Table 5: Tukey Post Hoc Results on Labour Shortage

Positive Pearson correlation showed that a decrease in labour shortage resulted in high technology uptake which contributed to decreased productivity while negative correlation indicated that an increase in labour shortage translated in a decrease in uptake of soil conservation technologies. Tende T1 took up fewer soil conservation technologies due to shortage of labour while Kibuon K2 implemented many despite the labour shortage. This was an indication that in Kibuon K2 farmers either used family labour or had resources to hire labour to assist in implementation. Tende T1 may have taken up a few technologies due to land size that does not allow for construction of many technologies while Kibuon K2 has more land in the lower parts of the sub catchment hence more space for technology development. One hundred percent of key informants reported that labour shortage did not affect technology uptake among farmers. Kammer (2014) in his study on "Factors influencing the Adoption of Soil and Water Conservation Technologies in Rural Ethiopia" reported that labour intensive technologies did not appeal to farmers leading to low uptake of the technologies.

H. TRAININGS AND SEMINARS

Through descriptive statistics Isanta had a mean of 4.19 and standard deviation 0.924, Tende T1 had a mean of 4.18 and a standard deviation of 1.050, Kasipul K3 had a mean of 4.08 and a standard deviation1.017, Mogusii T3 had mean of 3.97 and a standard deviation of 1.112, Kibuon K2 had a mean of 3.66 and a standard deviation of 1.512 while Kibuon K1 had a mean of 3.33 and a standard deviation of 1.291. The ANOVA analysis results showed that there were statistically significant differences at F= 3.301, p = .000 on the level at which trainings and seminars affected technology uptake in different sub catchments. Tukey post hoc test results showed that, Kibuon K1 took up many technologies while Isanta T2 reported low uptake because according to them farmers who attended many trainings and seminars had higher uptake rate. Kibuon K2, Mogusii T3, and Kasipul K3 were not significantly different to any sub catchment. Isanta T2 took up fewer technologies compared to Tende T1, Kasipul K3, Mogusii T3, Kibuon K2 and Kibuon K1 (Table 6).

Sub catchment	N	1	2
Kibuon K1	15	3.33	
Kibuon K2	70	3.66	3.66
Mogusii T3	39	3.97	3.97
Kasipul K3	51	4.08	4.08
Tende T1	148		4.18
Isanta T2	47		4.19
Significant			.316

Table 6: Tukey Post Hoc Results on Many Trainings and Seminars

Positive Pearson correlations showed that an increase in trainings and seminars contributed to increase in uptake of technologies. Negative correlations implied that a decrease in trainings and seminars resulted in reduced uptake of technologies due to less knowledge on technology implementation. The findings showed that many trainings and seminars had a significant relationship with technology uptake. Fewer respondents in Kibuon K1 indicated that uptake of technologies was not affected by trainings and seminars while in Isanta T2 many respondents reported many trainings and seminars affecting technology uptake. Most key informants (88.9 percent) reported that farmers who attended many trainings and seminars had high uptake rate which agreed with findings by Asfaw and Neka, (2018) in their research on "Factors Affecting Adoption of Soil and Water Conservation Practices Woreda (District) in Ethiopia" established that in Malawi low uptake was caused by inadequate training for farmers on technology and inadequate extension service provision.

I. SHORTAGE OF FARM IMPLEMENTS

Through descriptive statistics, sub catchments presented different means and standard deviations. Tende T1 had a mean of 3.99 and a standard deviation1.212, Isanta T2 had a mean of 3.85 with a standard deviation of 1.268, Mogusii T3 had a mean of 3.85 with a standard deviation of 1.387. Kibuon K1 had a mean of 3.67 and a standard deviation of 1.397. Kasipul K3 had a mean of 3.14 and a standard deviation of 1.414 while Kibuon K2 had a mean of 2.67 and a standard deviation of 1.631. The analysis of variance results showed statistically significant differences at F = 10.648, p = 0.000 on the level at which shortage of farm implements affected technology uptake in different sub catchments. Tukey post hoc test results showed that Kibuon K2 taking up fewer technologies because of farm implements shortage while Tende T1 took up many technologies despite shortage of farm implements. The constraint seriously affected uptake in Kibuon K2 compared to Kasipul K3, Kibuon K1, Mogusii T3, Isanta T2 and Tende T1.

ISSN: 2394-4404

Kasipul K3 was not significantly different to any sub catchment (Table 7).

Sub catchment	N	1	2
Kibuon K2	70	2.67	
Kasipul K3	51	3.14	3.14
Kibuon K1	15		3.67
Mogusii T3	39		3.85
Isanta T2	47		3.85
Tende T1	148		3.99
Significant		.658	.068

Table 7: Tukey Post Hoc Results on Shortage of Farm Implements

Positive Pearson correlations implied that a decrease in shortage of farm implements contributed to an increase in uptake of technologies whereby farmers mobilized resources to buy their own. Negative correlations implied that an increase in shortage of farm implements contributed to a low uptake of the technologies where farmers depended on external support for farm implements. Respondents in Tende T1 implemented soil conservation technologies despite shortage of farm implements while Kibuon K2 had less technology uptake due to shortage of farm implements. Possibly respondents in Tende T1 borrowed farm implements from neighbours or bought them when a shortage arose. The findings agree with a study by Porras, Grieg-Gran and Meijerink (2007) in their research on "Green Water Credits Farmers' adoption of soil and water conservation. Potential role of payments for watershed services" which reported that inadequate farm tools for construction of terraces was a hindrance to uptake of in Upper Tana catchment.

J. LACK OF CREDIT FACILITY

Descriptive statistics was used to establish means and standard deviations. Isanta T2 had a mean of 4.11 and standard deviation of .866, Tende T1 had a mean of 4.05 and a standard deviation of 1.86. Mogusii T3 got a mean of 3.59 and a standard deviation of 1.332, Kibuon K1 had a mean of 3.47 and standard deviation of 1.356, Kasipul K3 had a mean of 3.37 and a standard deviation of 1.483 while Kibuon K2 had the least mean of 2.96 and a standard deviation of 1.628. The ANOVA analysis results indicated that there were significant at differences at $F = 8.231$, $p = 0.000$ on the level lack of credit facilities affected technology uptake in different sub catchments. Tukey post hoc Tests results showed that Kibuon K2 took up fewer technologies due to lack of credit while Isanta T2 implemented many technologies regardless of credit availability. Isanta T2 took up many technologies compared to Tende T1, Mogusii T3, Kibuon K1, Kasipul K3 and Kibuon K2 sub catchments. Kasipul K3, Kibuon K1 and Mogusii T3 were not significantly different to any sub catchment.

Sub catchment	N	1	2
Kibuon K2	70	2.96	
Kasipul K3	51	3.37	3.37
Kibuon K1	15	3.47	3.47
Mogusii T3	39	3.59	3.59
Tende T1	148		4.05
Isanta T2	47		4.11
Significant			.137

Table 8: Tukey Post Hoc Results on Lack of Credit Facility

The positive Pearson correlations indicated that a decrease in unavailability of credit facility contributed to high technology uptake. Negative correlation implied that an increase in unavailability of credit facility contributed to a reduction in uptake of the technologies. Many respondents in Isanta T2 implemented many soil conservation technologies despite lack of credit facility while in Kibuon K2 a few took up technologies because of lack of credit facility. Probably in Isanta T1, respondents mobilized their own resources on the farm to implement the technologies without credit facility hence the high mean value. About 88.9 percent of key informants reported that lack of credit facility did not affect implementation of technologies since farmers were able to borrow from those who had them and were willing to assist which disagreed with findings by Asfaw and Neka (2018) in their research on "Factors Affecting Adoption of Soil and Water Conservation Practices in Woreda (District) in Ethiopia" which reported that economic factors affected uptake of soil and water conservation technologies.

K. SUMMARY FOR THE OBJECTIVE

Those who agreed to positive statements of the challenges were between 55 percent and 78.9 percent for 6 challenges while between 19 and 21.4 percent disagreed in 2 challenges. Through Pearson correlation, positive correlations implied that if the challenges were addressed technology uptake would increase while the negative ones showed that if the challenges were not addressed technology uptake would reduce. Since there were significant differences in the challenges famers faced during project implementation, the null hypothesis was rejected.

L. CONCLUSIONS

Respondents who agreed to the positive statements of challenges which farmers faced scored between 55% and 79% in 6 challenges except for land ownership and complex soil conservation technologies which scored 19 and 21 percent respectively. The findings indicated that more than 50 percent of the respondents were able to implement soil conservation technologies with minimum challenges although land ownership and complex technologies hindered uptake of the technologies.

M. RECOMMENDATIONS

There was need to enhance the use of integrated extension project approach in dissemination of watershed management technologies to enhance their uptake and also train respondents on entrepreneurial skills for better management of alternative economic enterprises to reduce the fear of loosing funds invested in soil and water conservation technologies.

Challenge	SD	D	N	A	SA	(Agreed- A + SA)
Land ownership	76.5	2.4	2.2	9.5	9.5	19
Complex technologies	60.3	11.6	6.8	10.3	11.1	21.4
Technology	17	12.4	15.9	27.6	27	54.6

cost						
Inadequate partnership involvement	10.3	6.8	17	35	30	65
Labour shortage	16.2	7.3	8.9	40.8	26.5	67.3
Trainings and seminars	6.2	7.6	7.3	36.5	42.4	78.9
Shortage of farm implements	17	8.6	6.5	35.4	32.4	67.8
Lack of credit facility	13.8	7.8	8.9	35.1	34.3	69.4

Table 9: A Frequency Table for Scores on Agree and strongly Agree on Challenges which Farmers Faced during Project Implementation

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