IDENTIFICATION OF SOIL AND WATER CONSERVATION TECHNOLOGIES USED ON DIFFERENT LANDSCAPE POSITIONS IN MAZIBA SUB CATCHMENT

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Abstract. Soil and water resources are important for sustaining life on earth since they are the main components of sub-catchments. Despite the technologies that have been introduced in Maziba sub-catchment, farmers have variations in technology acceptance due to over cultivation of land, population pressure, and deforestation that accelerate soil erosion. The objective of the study was to characterize soil and water conservation technologies used at different landscape positions by farmers in Maziba sub-catchment. Descriptive statistics were used to analyze soil and water conservation technologies practiced in the study area. Probability sampling technique was used to select research respondents, who were selected to obtain predominantly used soil and water conservation technologies data, using semi-structured questionnaire. Statistical analysis of the data collected was done using special packages for social scientists (SPSS 17.0) statistical software and Microsoft Excel 2007. The study revealed that terracing (35%), mulching (21%) and trenching (13%) were the predominant soil and water conservation technologies reported. The study recommended formal education for non-educated farmers since the level of education influenced the use of soil and water conservation technologies in the study area.

Keywords**:** Soil and water resources technologies, Sub-catchment, landscape positions

INTRODUCTION

Soil and water conservation technologies play a pivotal management role in many catchments of the world (Ouedraogo & Tiganadaba, 2015). This is simply because soil and water are the main natural resources in catchment areas essential to sustain life on earth. The reliable and scientifically proven soil and water conservation technologies include; ridge planting, zero tillage, crop rotation, strip cropping, grass strips, mulching, agroforestry, terracing, contour planting, cover crops, water harvesting, tree planting, digging trenches among others worldwide World Overview of Conservation Approaches and Technologies (WOCAT, 2015).

In Kigezi sub-region in western Uganda, 85% of the total population depends on agriculture to sustain their livelihood which has increased cases of land degradation (NBI, 2014). This makes the area mostly affected than any other parts of the country. In a related study by FAO, (2011) reports that water catchment areas located in Kigezi highlands are hot spot zones for degradation because of raised terrain which is prone to soil erosion problems compared to relative flat areas.

In Maziba sub-catchment, soil and water conservation technologies are mainly practiced by a reasonable proportion of farmers (68%) (NBI et al., 2014). However, it is reported that the available technologies such as terracing are less effective leading to soil and water degradation (Ministry of Water and Environment, 2012). In addition, the sub-catchment is currently facing a problem of soil erosion due to lack of adequate knowledge on soil and water management practices suitable for protection of agricultural land and environment (National Environment Management Authority, 2012). Therefore, this study aimed at improving understanding of soil and water conservation technologies being used in Maziba sub-catchment, Kabale district southwestern Uganda.

MATERIALS AND METHODS

Study area

The study was carried out in Maziba sub-catchment, southwestern Uganda with a total area of 144 km^2 (Figure 3.1). The sub-catchment lies between the latitude of 1^{o}15.30" South and 29^o 59" East, towards the southern boundary of Uganda with Rwanda. It has a total population of 96,917 with 6,975 households (UBOS, 2014). Approximately 89% of the population are small-scale farmers (NBI, 2014). The sub-catchment has a mean annual temperature of 22^{o}C and experiences bimodal rainfall with less than 1200mm mean annual rainfall (NEMA, 2012).

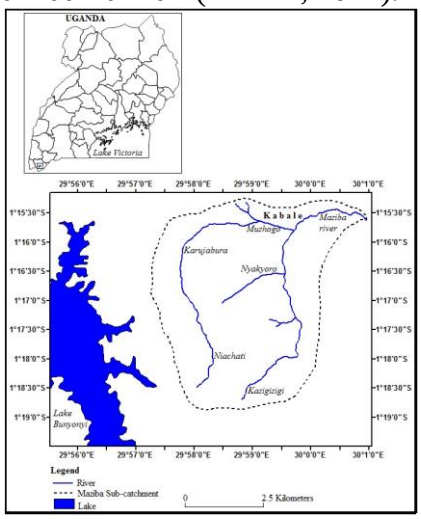

Figure 1: Map of Maziba sub-catchment in southwestern Uganda

Research design

The research involved field socio-economic survey. To characterize soil and water conservation technologies used by farmers in Maziba sub-catchment, the study used observation research guide (structured questionnaires to 99 farmers). Furthermore, a digital camera was used to capture predominantly used soil and water conservation technologies from the study area. This gave the researcher an opportunity to characterize the predominantly used soil and water conservation technologies in the study area.

Sample size

The study adopted probability sampling technique in which stratified random sampling was used to select sample population from the area of study. Then, simple random sampling was conducted from each stratum to select sample size. The basis of the study to form strata was the fact that the population within the sub catchment is distributed on different landscape positions which are foot slope, back slope and summit. The study employed Israel, (2012), formula to determine the sample size of the study population. The numbers of farmers was distributed into foot slope 27561 farmers (28%), back slope 45159 farmers (46%) and summit 24197 farmers (25%) in the study area UBOS, 2014.

Data analysis

The data obtained from the socio-economic survey was entered in Microsoft office Excel 2007 and imported to SPSS 17.0 for statistical analyses. Descriptive statistics were used to explain the soil and water conservation technologies in the Maziba Sub-Catchment.

Results

This section describes the predominantly used soil and water conservation technologies in Maziba Sub-catchment. The findings of the study revealed that majority of respondents were using terracing (35%). Other technologies reported include mulching (21%), trenching (13%), water catchment banks (07%), level ditches (05%), tree plantations (11%) and Grasses (07%) as shown in table 4.1.

A total of 35 % respondents reported that they use terracing on their land to conserve soil and water resources against soil erosion. Terracing as soil and water conservation technology was dominant at the foot slope, back slope, and summit of the sub-catchment. This is because the sub-catchment is located on the steep slopes and sharp sided valleys of Kigezi highlands which are prone to soil erosion. The high rate of using terracing in the study area

was reported by farmers desire to conserve water and land resources as a way of improving agricultural output since the area is one of the productive parts in Kabale district. These findings are in line with Kaliisa *et al.*, (2012), who reported that terraces (53%) were the dominant form of mechanical SWC technology along the different slope positions of Bufundi Sub-catchment in Kabale district. Amsalu and Graaff, (2006) also revealed that terraces are a good measure for conserving soil and water resources in Ethiopian highland watersheds.

Plate 2: Terraces (Source: Author 2016)

A total of 13% respondents reported that they use trenches to collect runoffs that can result in soil erosion on their land hence conserving soil and water resources against soil erosion. Trenches were commonly used on the foot and back slopes in the study area to control the effects of runoff, erosion on the foot slope, the back slope increases soil stabilization. The study further revealed that trenches were being used because they are cheap and simple to construct, effective in controlling soil erosion, maintains soil moisture and collects sediments and runoffs. The results of the study are in agreement with Beijing, (2002) and Okeyo *et al.* (2014), who reported that trenches reduce water rate, promotes water infiltration and soil moisture on different landscape positions of Kenyan highlands and Kigezi highlands, respectively. Plate 4.2 shows one of the newly constructed trenches on the foot slope in the study area.

Plate 3: Trench constructed on foot slope (Source: Author 2016).

Furthermore, 07% of respondents reported that they use water catchment banks to reduce runoff speed that can result in soil erosion on their land, therefore, conserving soil and water resources against soil erosion. Water catchment banks were predominantly practiced on foot slope and back slope in the study area to reduce runoff speed for the purposes of improving water infiltration, soil moisture conservation, and controlling soil erosion. Additionally, the study revealed that water catchment banks collect runoff and the soils collected from water catchment banks are very rich with nutrients which are suitable for crop farming to improve yields. Results from the study are in line with Geremu *et al.*, (2016) and Mugonola *et al.*, (2015), who reported that water catchment banks are crucial in reducing water rate that promotes soil erosion in Daro Labu District, Ethiopia, and Rwizi sub-catchment Mbarara district, Uganda. Plate 4.4 illustrates one of the water catchment banks witnessed during field study survey.

Plate 4: Water catchment banks (Source: Author 2016).

The study findings further revealed that 05 % of respondents use level ditches to reduce water rate that can result into soil erosion on their land hence conserving soil and water resources against soil erosion. Level ditches were commonly used on summit and back slope to promote water infiltration in the study area. As shown in plate 4.5, level ditches are augured in such way that it collects water from runways, buildings so that water penetrates into the soil. The study further revealed that level ditches are effective in reducing soil erosion in hilly slopes and improve water infiltration hence recharging groundwater sources. "If well maintained and protected, the collected water can be used for other purposes such as domestic use, watering crops and animals" key informant reports. The study results are supported by Bashaasha *et al.,* (2006) and Tang *et al.,* (2014), who reported that level ditches play a significant role in controlling soil erosion and soil moisture conservation in Kigezi highlands and Yangtze River Basin china, respectively.

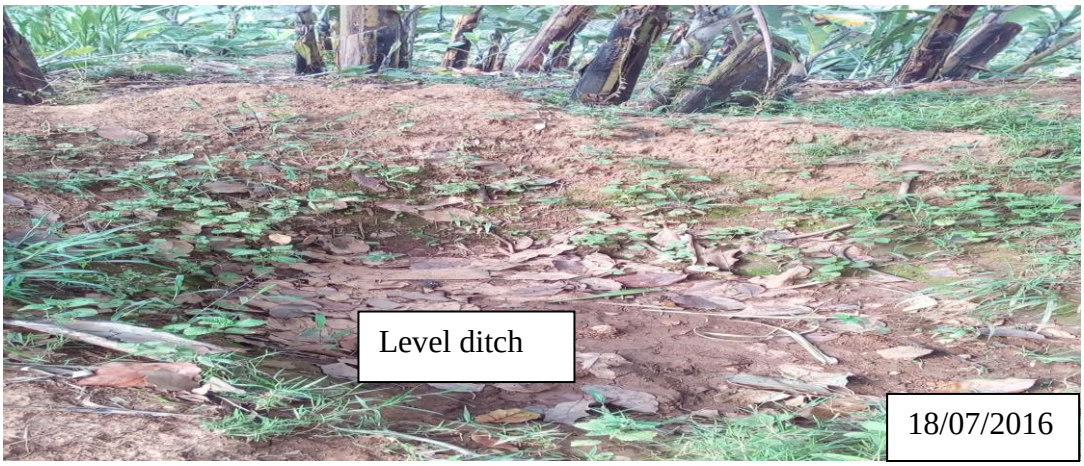

Plate 5: Level ditch (Source: Author 2016)

The study findings indicated 11% of respondents were using tree planting to stabilize the fragile hilly areas by reducing

water rate that can result in soil erosion on their land hence conserving soil and water resources against soil erosion. Tree planting was one of the technologies reported in promoting soil and water conservation in the sub-catchment most especially in summit and back slopes. Some of the tree species that were commonly planted in the sub-catchment were pines, eucalyptus trees, and avocado trees. These tree species play crucial roles in improving soil properties, erosion control, and supply of tree products such as firewood, timber, construction materials like poles. The findings of this study are in line with Beijing, (2002); Bashaasha *et al.* (2006); Kaliisa *et al*. (2012) and Alufah *et al*. (2012), respectively who found out that 10 %,13%, 28 % and 61 % of the farmers in Kigezi highlands and Ngaciuma sub-catchment were using level ditches as soil and water conservation technology to control soil erosion and water harvesting.

Plate 6: Tree plantations (Source: Author 2016).

The study findings again indicated 07 % of respondents were using grasses in the study area to stabilize terraced lands by promoting water infiltration and reducing water rate that can result into soil erosion on their land hence conserving soil and water resources against soil erosion. Grasses were commonly planted at the back slopes. This technology was largely used by farmers simply because grasses stabilizes soils on terraced land, promotes water infiltration, offer cheap and large quantities of fodder to feed livestock, and maintains soil moisture alongside controlling soil erosion. The major grasses identified in the study area were Napier, stalia and Guatemala grasses (Plate 4.7). These findings are supported by Atampugre, (2014) and Bashaasha *et al.*, (2006) who reported that Napier grass provides enough fodder for livestock and control erosion on steep slopes of Kenyan and Kigezi highlands, respectively.

Plate 7: Distribution of Napier grasses (A) and Stalia grass (B) (Source: Author 2016)

The study findings revealed that 21 % of respondents reported they use mulching to reduce soil erosion rate that can result in a runoff on their land, therefore, conserving soil and water resources against soil erosion. The reported benefits of mulching were; it controls erosion and runoffs from washing off the top soils, soil fertility management, improve soil properties, reduce evaporation, soil moisture retention and promote infiltration (Table 4.1). Zhang *et al.,* (2016) asserted that mulching is effective in controlling soil erosion once integrated with other technologies such as terracing. In a related study, Mtambanengwe *et al.* (2015) observed that 51 farmers did not adopt *Tephrosia candida* because it was only used as mulch and had no direct benefit as fodder.

Plate 8: Distribution of grass Mulches in banana plantation

Table 1: Farmers response on benefits of soil and water conservation technologies in percentages

SWC Technologies	Soil fertility	Promotes infiltration	Maintains soil moisture	Control erosion	Collects runoffs	Improve soil properties	Percent (%)
Terraces		5		22	9		36.4
Mulching	9	2	1	4	2	3	21.2
Trenches		2	2	4	3	2	13.1
Level ditches		1	1	1	1		4.0
WCBs		2	1	2	2		7.1
Tree planting		2		4	2	3	11.1
Grasses	2		1	2	1	1	7.1

Table 2: Soil and water conservation technologies identified in the study area

Soil and water conservation technologies identified	Frequency	Percent (%)	Cumulative percent (%)
Terraces	35	35.3	35.3
Trenches	11	11.1	46.4
Mulching	21	21.2	67.6
Water catchment banks	07	07	74.6
Level ditches	05	05	79.6
Grasses	07	07	86.6
Tree plantations	13	13	100
Total	99	100	

Conclusions

The study findings reported that majority respondents were using terracing and mulching as the soil and water conservation technologies. It was also revealed that technologies such as water catchment banks, level ditches terraces were also used to a small extent in the study area. The study further confirmed that landscape positions significantly influence the type of soil and water conservation technologies used on farmland.

REFERENCE

Amsalu, A., & Graaff, J. De. (2006). Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed, 1–9. http://doi.org/10.1016/j.ecolecon.

Atampugre, G. (2014). Cost and Benefit Analysis of the adoption of Soil and Water Conservation methods , Kenya, *4*(8), 1–14.

Bashaasha, B., Ssembajjwe, W., Place, F., Centre, W. A., & Coast, G. (2006). Determinants of land use in the densely populated kigezi highlands of sout h western uganda Authors, 1–16.

Beijing, I. C. (2002). An Investigation of Soil and Water Conservation Related Problems in the Kigezi Highlands of Uganda.

FAO, (2011). The State of the World's Land and Water Resources: Managing Systems at Risk. London, Earth scan.

Geremu, T., Ararso, E., Mamo, D., Ayela, G., Diriba, A., Muleta, B., & Hussen, D. (2016). Effects of negarim and semi-circular structures on growth and yield of banana in moisture deficit area of Daro Labu District, West Hararghe Zone, Ethiopia, *8*(4), 32–36. http://doi.org/10.5897/JHF2016.0428

N. B. I, Equatorial, N., Subsidiary, L., Program, A., River, K., & Management, B. (2014). Kagera River Basin Management Project Maziba sub-

catchment management plan, Kabale district , Uganda.

Kaliisa, B. R., Muk, B., No, R. E. G., Submitted, T., Fulfilment, P., Management, I. W., & Sciences, A. (2012). Determinants of Soil Water Conservation and Nutrient Flow Management in Bufundi Sub- Catchment , Kabale District , Uganda.

Ministry of Water and Environment (2012), Guidelines for integrated & participatory water resource planning at the catchment Level, DWRM, Draft version, July 2012

Mtambanengwe, F., Nezomba, H., Tauro, T., Chagumaira, C., Manzeke, M., & Mapfumo, P. (2015). Mulching and Fertilization Effects on Weed Dynamics under Conservation Agriculture-Based Maize Cropping in Zimbabwe. *Environments*, *2*(3), 399–414. http://doi.org/10.3390/environments2030

Mugonola, B., Deckers, J., Poesen, J., Isabirye, M., Mathijs, E., Mugonola, B., Isabirye, M. (2015). Adoption of soil and water conservation technologies in the Rwizi catchment of south western Uganda,*5903*. http://doi.org/10.1080/14735903.2012.744906

NEMA, 2012 State of the environment report for Uganda 2010, National Environment Management Authority, Kampala, Uganda,.

Alufah, S., Shisanya, & Obando, J. (2012). Analysis of Factors Influencing Adoption of Soil and Water Conservation TechObando, J. A., Alufah, S., & Shisanya, C. A. (2012). Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. African. African Journal of Basic & Applied Sciences. Retrieved from http://ir-library.ku.ac.ke/handle/123456789/7775

Okeyo, A. I., Mucheru-Muna, M., Mugwe, J., Ngetich, K. F., Mugendi, D. N., Diels, J., & Shisanya, C. A. (2014). Effects of selected soil and water conservation technologies on nutrient losses and maize yields in the central highlands of Kenya. *Agricultural Water Management*, *137*, 52–58. http://doi.org/10.1016/j.agwat.2014.

Ouedraogo, S., & Tiganadaba, L. (2015). Adoption of water and soil conservation technologies : determinant factors in the central plateau of burkina faso, *5*(2)

Tang, Q., He, C., He, X., Bao, Y., Zhong, R., & Wen, A. (2014). Farmers' Sustainable Strategies for Soil Conservation on Sloping Arable Lands in the Upper Yangtze River Basin, China, 4795–4806. http://doi.org/10.3390/su6084795

UBOS (Uganda Bureau of Statistics), (2014). Statistical abstract. Accessed on 25th March 2015.Website: http://etutoring.gayazahs.sc.ug/uploads/ebooks/1336061902.pdf.

WOCAT (World Overview of Conservation Approaches and Technologies). (2015). Where the land is greener–case studies and analysis of soil and water conservation initiatives worldwide. Editors: Hanspeter Liniger and William Critchley.

Zhang, Y., Li, H., He, J., Wang, Q., Chen, Y., Chen, W., & Ma, S. (2016). Effect of mulching with maize straw on water in fi ltration and soil loss at different initial soil moistures in a rainfall simulation.