

## Adoption of Water Conservation Technologies among Small Scale Farmers in Lwengo District – Uganda

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### Abstract

This study identified and characterised the dominant water conservation technologies (WCT) employed by small scale farmers in Malongo and Kyazanga sub-counties in Lwengo district. It employed a cross sectional household survey design, using systematic sampling to obtain 380 household samples. A quantitative analysis, Multiple Correspondence Analysis (MCA) and Logit regression model were used to analyse these data to identify and characterise the dominant WCT and establish the most significant factor affecting the adoption of the technologies. Results indicated that mulching was the most dominant WCT employed, followed by Valley dams/reservoirs, terracing, tied ridges, deep tillage and infiltration pits. The Logit model indicated that out of seven factors, five had a significant positive influence namely: access to credit (1.3); farm slope location (0.7); farm size (0.4); access to agricultural inputs and investment subsidies (0.4); and level of income (0.2). One factor had a significant negative influence (engagement in other economic activities/off-farm employment activities) and only one was found to be insignificant (access to market). It is recommended that the significant water conservation techniques be upscaled, and that emphasis also be placed on the most significant factors in order to strengthen the adoption of water conservation in the area.

**Keywords:** Adoption, water conservation technologies, semi-arid areas, Lwengo district

### Introduction

While the world may possibly have enough water to support the current population, these water resources are unevenly distributed in both time and space (Mustafa 2017; Nsubuga *et al.* 2014). These imbalances in global and local water resource distribution affects mainly arid and semi-arid regions (Kibona *et al.* 2009). In such areas, quantities of water fall below the threshold to support and sustain both households and agricultural water requirements, (Mvungi *et al.* 2005). This is mainly due to global warming (Vörösmarty *et al.* 2000) and population pressure through urbanisation, agricultural intensification and land degradation (Pesaresi *et al.* 2017). In the Ankole-Masaka corridor where Lwengo district lies, the unreliable rainfall problem is increasing the pressure on water resources. Population pressure, unpredictable rainfall and diverse sparse vegetation qualifies the area to be a region of great difficulty in view of frequent scarcity of water resources (Rugadya 2006). For this reason, stakeholders have devised several water conservation technologies to conserve water received during the short rainy season for farm and domestic use during the long dry spell for small-scale farmers.

Water conservation technologies involve actions which are intended to prevent or at least mitigate water resource depletion (Rugadya 2006). The government of Uganda, through the

district agricultural officer and district water engineer together with concerned individuals, introduced various water conservation technologies with the intention of solving the eminent problem of water scarcity for small-scale farmers. Amongst them were valley dams, strip catchment tillage, infiltration pits, tied ridges, terracing and underground and surface water tanks. However, although these promising technologies have been introduced in the area, their adoption by small scale farmers in Malongo and Kyazanga sub-counties is still limited. Adoption of innovations is the decision to apply an innovation and to continue to use it (Rogers and Shoemaker 1971).

Like any other innovation, different factors determine the adoption of different water conservation technologies (Akudugu *et al.* 2012). Factors, such as level of income, level of education, risks involved in the technology, access to credit, access to market, and cost of the innovation amongst other things are identified in literature and believed to be influencing the adoption of these water conservation technologies but these may differ from one place to another and their level of significance may also differ. This study therefore explored the factors influencing farmers' adoption of these technologies.

### **Methodology**

A cross-sectional survey design was used in the study. Malongo and Kyazanga sub-counties were purposively chosen as a sample in Lwengo district. In order to identify and characterise the dominant WCT and analyse the factors influencing adoption of these WCTs, questionnaires were administered to 380 households where 180 households were selected from Kyazanga sub-county and 200 households from Malongo sub-county. Malongo and Kalagala parishes were selected from Malongo sub-county, while Lyakibiriizi and Bijaaba parishes were selected from Kyazanga sub-county (Figure 1). In each of the selected parishes, five villages were purposively selected on the basis of having small scale farmers and the presence of WCTs in the area.

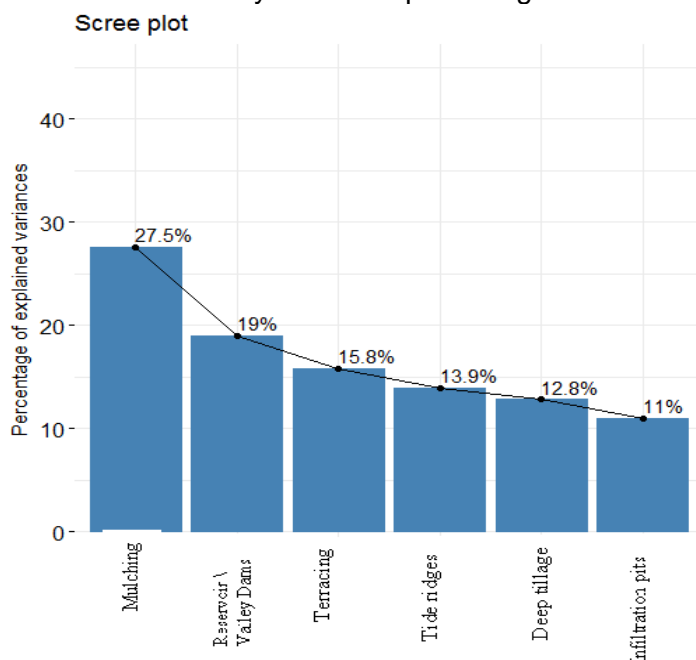
Using systematic random sampling, 20 households were selected from each of the villages of Malongo sub-county and 18 households from each of the villages of Kyazanga sub-county. To characterise the dominant water conservation technologies employed by small scale farmers and to classify these farmers according to the water conservation technologies they use, MCA and in particular a scree plot was used to compare the strength of the dependent variables (WCTs) before they were grouped together. This also helped in reduction in the data dimension but without losing any information of the variation in the factor correspondences, (Johnson and Wichern 2006). A biplot was used to analyse the pattern of relationships of several categorical dependent variables. A binary Logit model was run to establish the most significant factors influencing the adoption of these WCTs.



The results in table 1 revealed that 29.8 percent of the respondents were using mulching, 23 percent valley dams, 13.5 percent terracing, 10.7 percent tied ridges, 9.5 percent deep tillage, 5.2 percent infiltration pits, 3.2 percent pitting, 2 percent strip catchment tillage, 2 percent rill run off utilisation, 0.7 percent other methods, and 04 percent macro- catchments. These results revealed that mulching is the most dominant technology adopted by the small-scale farmers in Malongo and Kyazanga sub-counties. This could be explained by the fact that materials needed for mulching are widely available from crop residue. Besides this, less labour is required to apply the technology. Underground and surface water tanks, spring wells and macro catchments, on the other hand, were not found to be dominant which could be because most farmers are less educated, and yet these technologies are more technical.

### ***The dominant WCTs***

In order to determine and characterise the dominant WCTs adopted by the farmers, a scree plot was used to compare the strength of each of the dependent variable before grouping them together. This involved derivation of percentage variability in the levels of adoption and the results are shown by the scree plot in Figure 2.



**Figure 2: Dominant WCTs**

From Figure 2, the percentages of variance for mulching, valley dams, terracing, tied ridges, deep tillage and infiltration pits were 27.5 percent, 19 percent, 15.8 percent, 13.8 percent, 12.8 percent and 11 percent respectively. The results affirmed that mulching was the most dominant technology used by small-scale farmers in Malongo and Kyazanga sub-counties and others followed in that order; i.e. reservoirs/valley dams, terracing, tied ridges, deep tillage and infiltration pits.

### ***Mulching***

Mulching is the most dominant water conservation technology employed (Figure 1) and is used mainly in Kyazanga sub-county where banana plantations dominate, and the relief is relatively gentle compared to Malongo. An interrogation of farmers as to why they use mulching revealed that of the 75 farmers, 47 were using it because it maintains moisture in the soil. 11 farmers were using it because of the availability of grass, 8 were using it because it was cheap, while 7 because they control weeds in the garden, and 2 because mulches fertilise the soil. From the study the materials which farmers use to mulch their gardens were also established. 43 farmers were found covering their gardens with crop residuals such as leftovers of old harvested maize stalks and this was mainly used in banana plantations. 30 farmers were using

cut grass, and this was mainly used by vegetable growers, while only 2 were found covering their gardens with dug grass as shown in Plate 1c.

Maintaining moisture in the soil is the major reason why farmers are using mulches and this is in line with Jamieson and Stevens (2006) argument that mulches support infiltration of runoff and irrigation water because they protect the soil from the impact of raindrops, hence maintaining moisture in the soil for a long period. In the study area, farmers who were found using it revealed that in mulched gardens seeds germinate quickly.

### ***Reservoir/Valley dam***

Reservoirs/valley dams were found to be the second dominant WCT employed by adopters in the study area. Like any other cattle corridor, they were mostly being used by cattle keepers in the area (Uganda Water and Environment Sector Performance Report 2017). Some dams are dug on top of hills with no aquifers and with limited run off, which makes them dry up during prolonged dry seasons (Plate 1a). This agrees with what happens elsewhere in cattle corridors of Uganda, for example the district chairperson of Nakasongolo reported that a persistent dry spell led to drying out of the valley dams in the area. In such places, farmers resort to hiring mobile tanks to refill some of the valley dams to save their animals. Though this was reported to be the only solution, it was discovered that most farmers could not afford it and even those who could afford it, could not sustain it.

### ***Terracing***

Terracing was found to be the third dominant WCT employed by small scale farmers in the study area and it is used mostly by farmers with farm plots on the upper slope segment. However, some farmers whose plots were on steep slopes reported that it was hard for them to dig terraces on their farms because of the soils being shallow and rocky. This agrees with Bagoora (1997) in his analysis of the efficacy of terraces in Rukiga highland. He observed that terraces decline in height with increase in slope. Meaning that farmers with plots on upper slopes find it hard to construct terraces. There is therefore a need to help these farmers because they do not only suffer from little run-off, but also from soil erosion and these factors render their land unproductive. Although terraces mainly serve the purpose of soil conservation in most areas where they are used (Zuazo *et al.* 2005), in the study area the technique is mostly employed as a water conservation measure.

### ***Tied ridges***

Tied ridges were found to be the fourth dominant WCT employed and were most used in Malongo sub-county. In fact, tied ridges were found to be the second dominant technology employed on the upper slope segments. All the farmers who were found using them were using them because they allow water infiltration in the lower parts of the garden. This agrees with Temesgen (2012), who discovered that in the Rift Valley dry lands of Ethiopia tied ridges are more effective at improving water conservation than enhancing the fertility of the soil. Although in the study area, tied ridges are being used without farmyard manure, Temesgen (2012) discovered that when tied ridges are used together with farmyard manure, they enhance crop yields compared to when they are used alone. Therefore, much effort is needed to train farmers in the use of the technology combined with farmyard manure if they are to realise greater yields. It is also important to note that whereas Temesgen (2012) in his studies in Ethiopia discovered that tied ridges are most commonly used in maize plantations, in this study only 3 farmers were found using them in maize plantation, and they never tie them after digging them as it is done in Zimbabwe.

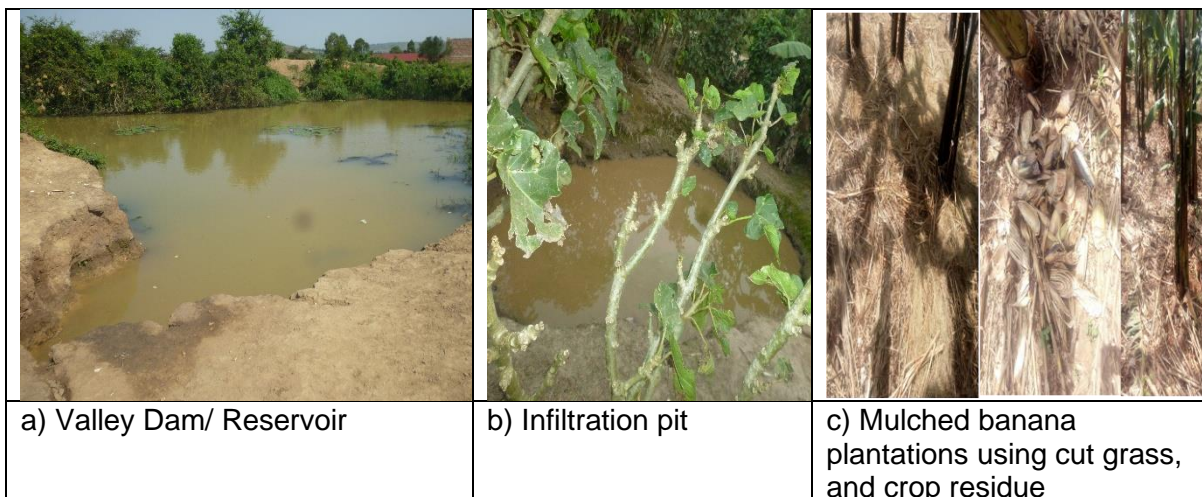
### ***Deep tillage***

Deep tillage was found to be the fifth dominant WCT employed and was being used on all three slope segments; i.e. upper slope, middle slope and lower slope. It was discovered that most farmers were using this WCT because it checks runoff, consequently controlling soil erosion but all the same time aiding water infiltration in the soil. This is in line with Hudson's

(2004) findings. He discovered that deep tillage helps to enhance soil moisture holding capacity through increased porosity, increasing the infiltration rate and reducing surface runoff by making the surface rough which helps in temporary storage of rainwater, consequently providing more time for infiltration. He continues by saying that deep tillage not only increases porosity, but also reduces surface sealing of the soil, thereby permitting root development which then utilises soil moisture and nutrients at deep horizons. Hatibu and Mahoo (1999) also emphasise that deep tillage significantly reduces surface runoff and increase crop yields when applied appropriately.

***Infiltration pits***

Infiltration pits (Plate 1) were found to be the sixth dominant WCT. It was established that those who were using infiltration pits dig several pits/ponds in the garden/farm where they collect and store rainwater on farm for a long period of time (Plate 1b). Contrary to these findings, in Zimbabwe, farmers fill the pits with grass and other organic material to form organic manure. The reason for preference of this method was also established. It was discovered that farmers prefer it because they collect and store water for a long period of time which can later be used for irrigation in the dry season. Whereas in other areas these pits are dug along contour drainage channels, farmers in Kyazanga and Malongo sub-counties dig them anywhere in the garden. It was discovered that farmers do it this way because infiltration pits enhance water infiltration to the nearby plants. So, the more they dig pits in the garden, the more the plants benefit directly from them rather than irrigating the crops with one pit near the drainage channel which is tiresome and more costly.

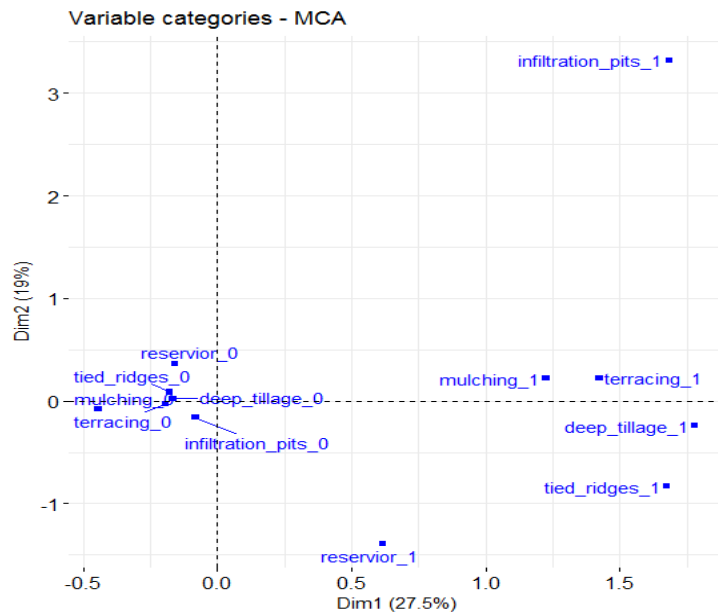


**Plate 1: a) Valley dam/Reservoir, b) Infiltration pits and c) Mulched gardens**

Source: Field data

***Categorisation of WCT used by small scale farmers in the study area***

In order to understand which combination of technologies farmers were most likely to adopt, a biplot was used for visualisation as shown in Figure 3.



1 Adoption  
0 Non adoption

**Figure 3: Categories of WCTs**

From Figure 3, it can be noted that farmers who are using infiltration pits are more likely to use mulching and terracing as well (these are found in the same quadrant). Whereas those who use deep tillage and tied ridges are less likely to use reservoirs (reservoirs are tending towards the negative side of the biplot). From the geographical point of view, the reason for this is that reservoirs are mostly employed by farmers on the lower slope segment while tied ridges and deep tillage are mostly common in the upper and middle slope positions.

**Factors influencing adoption of WCTs by small scale farmers in Lwendo District**

In order to establish the most important factors which influence adoption of WCT in the study area, a logistic regression model was used. Seven independent variables, namely: farm slope location (X1), farmer’s level of income (X2), accessibility to credit (X3), off-farm employment opportunities (X4), accessibility to markets (X5), farm size (X6), and accessibility to agricultural inputs and investment subsidies (X7) were regressed with the dependent variable which was farmers’ response to water conservation. The different coefficient values for each independent variable and the odds ratio indicating the probability of adoption of water conservation occurring were computed. The results are presented in Table 2.

**Table 2: Logit regression model estimates**

**Parameter estimates**

Adoption	Coef.	Odds ratios	Std. Err.	P> z	[95% Conf. Interval]	
Accessibility to credit (X3)	1.2197	3.3862	.4547	0.007**	.3284	2.1109
Accessibility to market (X5)	.2243	1.2514	.3148	0.476	-.3926	.8413
Level of income (X2)	0.2468	1.2799	.1274	0.053*	-.0028	.4965
Farm slope location (X1)	0.7434	2.1031	.1319	0.000**	.4848	1.0020
Land size (X6)	0.4068	1.5020	.1866	0.029**	.04104	.7726
Engagement in other activities (X4)	-.8196	0.4406	.3077	0.008**	-1.4227	-.2164
Agric inputs and subsidies (X7)	0.4066	1.5017	.3663	0.030**	-0.3113	1.1244

**Wald Chi-square = 73.85**

**Probability chi2=0.0000**

**Number of observations=282**

**\*\* Significant at 5%; \* significant at 10%.**

As shown in table 2, the Wald Chi2 and probability Chi2 were used to determine whether this model was the most appropriate; as observed, the Wald Chi2 shows that 73.4 percent of the variance in the dependent variable can be explained by the independent variables used in this study. This is an indication that the independent variables (X1-X7) have a significance combined effect on farmers' adoption of water conservation. The other 26.6 percent variance in the dependent variable can be explained by other factors not considered in this study.

In the interpretation of the Logit results, the coefficient values which measured the change in the estimated Logit for a unit change in the values of a given regressor holding other factors constant (Gujaranti 2003) were used. These were also used to show the significance of the factor towards predicting the output and the direction of the relationship. The exponential values (odds ratios) were used to show the odds of adopting water conservation by a farmer and were obtained by taking the anti-log of the various slope coefficient values. Since the strength of the relationship between the two variables is reflected in the magnitude of the coefficients and exponential values, variables with larger coefficient and exponential values were said to be of higher significance than those with smaller coefficient values. A positive coefficient value indicated that the factor was greater than one hence the odds were increased, while a negative coefficient value meant that the factor was less than one and the odds were decreased. When the coefficient value was zero, the factor was equal to one and this meant that the odds were left unchanged.

#### ***Credit accessibility***

The results revealed that accessibility to credit (X3) had the greatest influence of any other factor and was positively and significantly influential in determining farmers' adoption of water conservation with a positive coefficient value of 1.3 and odds ratio of 3.4, implying that a unit increase in credit accessibility increases the odds of adopting water conservation by a factor of 3.4, keeping other factors constant. This implies that farmers who access credit are more likely to adopt water conservation as compared to the farmers who do not access credit, holding other factors constant. Access to credit enables farmers to construct the different WCTs, as well as maintaining them, plus buying other agricultural inputs which increase their ability to practice water conservation on their farms. Nabalegwa and Asaba (2015) also find a positive and significant relationship between access to credit and adoption of soil conservation in Bugoye County on the Rwenzori mountain slopes.

In fact, they find it to be the third most significant factor influencing farmers' decisions to adopt soil conservation in the area. Mlenga and Maseko's (2015) study on factors influencing adoption of conservation agriculture in Swaziland shows that 92.3 percent of non-adopters did not have access to credit for agricultural production. They further agree with the above results when they assert that lack of access to cash or credit may constrain farmers from using technologies which require initial investments. The lack of access to cash or credit is often seen as an indication of market failures that government or NGOs should help to resolve (Doss 2006). Whereas access to credit was found to be the most significant factor influencing water conservation, it should be noted that only 15.2 percent of the 282 respondents reported having access to credit, and this calls for improvements in credit infrastructures so as to enhance water conservation in the area.

#### ***Farm slope location***

Farm slope profile is one of the important factors which is said to affect soil and water conservation in a way where the rate of erosion normally increases with the slope (Morgan 1986). In this study, farm slope location (X1) was found to be the second most significant variable in determining farmers' adoption of water conservation with a positive coefficient value of 0.7 and odds ratio of 2.1, implying that a unit increase in farm slope location increases the likelihood of adopting water conservation by a factor of 2.1, keeping other factors constant. Farm slope characteristics influence farmers' decision to adopt water conservation (Lee 2005; Kassie *et al.* 2009). These results agree with what Nabalegwa and Asaba (2015) found when



they assessed the location of farm plots on the slopes of Bugoye on Mountain Rwenzori. They discovered that most adopters (55.6 percent) had plots on the upper slopes. Kassie *et al.* (2009) also found that farmers in Ethiopia who had plots on steep slopes adopted conservation technologies because they realised that their plots were prone to soil erosion. They concluded that adoption practices in Ethiopia declined with decrease in slopes of the farms. Contrary to Kassie *et al.*'s (2009) findings in Malong and Kyazanga sub-counties, adoption decreases with increase in slope and this is attributed to difficulties posed by steep slopes when it comes to constructing WCTs. Unless government facilitates these farmers, water conservation will remain low, therefore worsening the problem.

### **Farm size**

Farm size (X6) was found to be the third most significant factor influencing adoption of water conservation with a positive coefficient value of 0.4 and odds ratio of 1.5, meaning that a unit increase in farm size increases the probability of a farmer adopting water conservation by a factor of 1.5, leaving other factors constant. This implies that farmers with bigger farms had a higher possibility of adopting water conservation technologies compared to their counterparts with small farms. Knox and Meinzen-Dick (1999) report land size to significantly affect people's options of adopting a technology. This is indeed true, because farmers with bigger sizes of land are always found to be endowed with other assets; hence being able to afford investing in water conservation. Perret and Stevens (2003) also agree with the results when they affirm that farmers who possess a higher quantity and quality of endowments will place a higher future value on medium- and long-term benefits produced by investing in WCTs while households who lack capital, labour, essential skills and the ability to manage risks will face constraints.

The results were also consistent with the findings of Kassie *et al.* (2009); they noted that ownership of farmland increases the assurance of future access to returns on investment, thus increasing the probability of adopting organic fertilisers. Okoye (1998), in his comparative analysis of the factors influencing adoption of traditional and recommended conservation practices in Nigeria, also confirms that adoption of soil erosion control practices responded to farm size positively and significantly. In another way, farmers who own their land invest in new technologies with long-term benefits without any fear of their land being taken away like their counterparts who use leased or rented land (Perret and Stevens 2003).

### **Accessibility to agricultural inputs and investment subsidies**

As observed in Table 2, access to agricultural inputs and investment subsidies (X7) was found to be the fourth most significant factor influencing adoption of water conservation with a positive coefficient value of 0.4 and odds ratio of 1.5 meaning that a unit increase in access to agricultural inputs and investment subsidies increases the chances of adopting water conservation by a factor of 1.5, keeping other factors constant. This indicated that farmers who have access to these services have a chance of adopting WCTs compared to those who do not access them. Access to information on new technologies is central in creating awareness and attitudes towards their adoption (Place and Dewees 1999).

In line with this, it was discovered that access to agricultural extension services, indicated by whether the farmer had contact with an extension agent, positively impacted on water conservation. Contact with extension services gives farmers access to information on innovations, advice on inputs and their use, and management of technologies. In most cases, extension workers establish demonstration plots where farmers obtain hands-on learning and can experiment with new farm technologies (Kassie *et al.* 2009). Consequently, access to extension is often used as an indicator of access to information (Adesina *et al.* 2000). Given that access to these services enhances farmers' ability to adopt water conservation, inaccessibility to these services in the study area pose a great challenge to water conservation efforts in Malongo and Kyazanga sub-counties in particular, and rural Uganda generally.

### **Level of income**

Level of income (X2) was found to be the fifth most significant factor influencing farmers' adoption of WCTs with a positive coefficient value of 0.2 and odds ratio of 1.3, meaning that a unit increase in income increases the odds of adopting water conservation by a factor of 1.3, keeping other factors constant. This implies that farmers who earn larger incomes are more likely to adopt water conservation compared to their counterparts who earn less. These results are similar to what Nabalegwa and Asaba (2015) found in their study on Bugoye County on Rwenzori Mountain; they noticed that household income significantly affected farmers' response to soil conservation, implying that farmers with higher incomes adopted soil conservation more than their counterparts with lower incomes. The results also agree with Dudal (1980), who notes that income from farm and non-farm activities influences how much is invested in soil conservation. This implies that if the total income is adequate, a larger portion will be spent on conservation efforts, but if income is low less will be put into conservation with new technologies.

In Malawi, Nyabose and Jumber (2013) also found that higher incomes play a greater role in the acquisition of funds for conservation agriculture. Contrary to this study's finding, Gelgo *et al.* (2016) found household income to have a negative effect on use intensity of organic fertilisers among the small-scale farmers of Shashemene district in Ethiopia. They found that farmers with high incomes were more attracted to invest in high interest-earning investments other than agriculture. As such, it is difficult for the low-income peasants of Malongo and Kyazanga to practice water conservation. Unless urgent attention is given to this area, agricultural productivity may continue to decrease.

### **Off-farm employment opportunities**

Off-farm employment opportunities (X4), as observed in Table 2, negatively influenced the adoption of WCTs with a coefficient value of -8.2 and odds ratio of 0.4, meaning that a unit increase in engagement in off-farm employment opportunities decreases the odds of adopting water conservation by 0.4, keeping other factors constant. This implies that farmers who engage in other economic activities are less likely to adopt water conservation compared to those who only engage in agriculture. Ng'ombe (2014) finds that off-farm incomes reduce the odds of adopting conservation agriculture amongst small scale farmers, holding other factors constant. This happens when households' major sources of income are off-farm activities and these households would less likely invest in agricultural technologies.

The findings support Ng'ombe (2014) as the majority of the adopters' incomes are from farming activities. The major reason for this negative influence is that in most cases where family labour is allocated to off-farm activities, it tends to fetch higher returns than on-farm water conservation which is relatively expensive. Therefore, when opportunities for off-farm employment exist, they not only affect the decision to adopt conservation technologies but also the degree of adoption as well as the maintenance of conservation structures once they are in place (Pender *et al.* 2004). As such, unless agriculture is made attractive to small scale farmers in this area, efforts for improving water conservation may not succeed.

### **Accessibility to market**

As observed in Table 2, it can be noted that access to market (X5) was found to be insignificant in influencing farmers' decisions to adopt water conservation, meaning whether a farmer has access to a market or not has nothing to do with adoption. In fact, most respondents were found to have access to a market for their products. These results disagree with those of Tiffen *et al.* (1994) who find a positive role of market access in promoting water conservation in Machakos district in Kenya due to its proximity to Nairobi. Access to a market increases the profitability of investments in new technologies and hence boosts adoption (Pender and Kerr 1988). This is attributed to the fact that the number of adopters who have access to a market (75.9 percent) is almost equal to that of the non-adopters who have access to market (63.1

percent). This means that access to a market is not a major driving factor inspiring small scale farmers of Malongo and Kyazanga sub-counties to invest in water conservation.

## Conclusions

This study was carried out in order to establish the dominant WCTs employed by small scale farmers in Lwengo district in the sub-counties of Malongo and Kyazanga and establish the most significant factors influencing adoption of these WCTs. Based on the study findings, the following conclusions were made: mulching, valley dams, terracing, tied ridges, deep tillage and infiltration pits are the dominant water conservation technologies employed by small scale farmers in Malongo and Kyazanga sub-counties. It discovered that there is no water conservation technology that can single-handedly effectively conserve water because of the physical characteristics of the area in terms of relief. Consequently, farmers need to be effectively trained in how to use the different WCTs and the importance of investing in more than one technology, especially if one technology cannot effectively work on their farms.

Of the factors affecting farmers' decisions to adopt water conservation, access to credit (X3) was found to be the most significant factor influencing farmers to conservation efforts, followed by farm slope location (X1), farm size (X6), access to agricultural inputs and investment subsidies (X7) and level of income (X2). On the other hand, off-farm employment opportunities had a negative and significant influence on adoption of water conservation and access to a market was found to be insignificant in influencing farmers' behaviour towards water conservation. As such, it is important for those charged with implementation of water conservation to pay more attention to the most significant factors while planning and designing WCTs in these sub-counties.

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## References

- Adesina, A. A., Mbila, D., Nkamleu, G. B. and Endamana, D. 2000. Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of Southwest Cameroon. *Agriculture, Ecosystems and Environment*, 80: 255-65.
- Akudugu, M. A., Guo, E. and Dadzie, S. K. 2012. Adoption of modern agricultural Production. Technologies by farm households in Ghana. *Journal of Biology, Agriculture and Healthcare*, 2(3): 2-9.
- Bagoora F. D. K. 1998. Soil erosion, mass wasting risk in the highland areas of Uganda. *Mountain Research and Development*, 8(2/3): 173-182.
- Baizin, B. and Stroosnijder, L. 2012. To tie or not to tie ridges for water conservation in the rift valley drylands of Ethiopia. *Soil and Tillage Research*, 124: 83–94.
- Doss, C. R. 2006. Analyzing technology adoption using microstudies: Limitations, challenges and opportunities for improvement. *The Journal of the International Association of Agricultural Economics*, 34: 207-219.
- Dudal, R. 1980. An evaluation of soil seeds. In: Morgan, R. P. C. ed. *Soil Conservation Problems and Prospects*. Chichester: John Wiley and sons, 3-12.
- Gelgo, B., Mshenga, P. and Zemedu, L. 2016. Analysis of the determinants of adoption of organic fertilizers by smallholder farmers in Shashemene District, Ethiopia. *International Journal of Agricultural Economics*, 1(4): 117–124.

Government of Uganda 2017. Uganda Water and Environment Sector Performance Report 2017. Uganda: Ministry of Water and Environment Government of Uganda.

Gujaranti, N. D. 2003. *Basic Econometrics*. New Delhi: McGraw-Hill.

Hatibu, N. and Mahoo, H. 1999. Rainwater harvesting technologies in the forest-savannah zone of Cameroon: Implications for poverty reduction. *World Applied Sciences Journal*, 11(2): 196-209.

Hudson N. 2004. *Soil and water conservation in semi-arid areas*. Rome: Food and Agriculture Organization of the United Nations.

Jamieson, L. E. and Stevens, P. S. 2006. The effect of mulching on adult emergence of Kelly's citrus thrips (pezothrips kellyanus). *New Zealand Plant Protection*, 59: 42-46.

Johnson, R. A. and Wichern, D. W. 2006. *Applied Multivariate Statistical Analysis*. 6th Ed. Eaglewood Cliffs: Prentice-Hall.

Kassie, M., Zikhali, P., Manjur, L. and Edwards, S. 2009. Adoption of organic farming techniques: Evidence from a semi-arid region of Ethiopia. Washington: Environment for Development.

Kibona, D., Kidulile, G. and Rwabukambara, F. 2009. Environment-climate warning and water management. *Transition Studies Review*, 16(2): 484-500.

Knox, A. and Meinzen-Dick 1999. Collective action, property rights and devolution of natural resources management: A conceptual framework. Washington: International Food Policy Research Institute.

Lee, D. R. 2005. Agricultural sustainability and technology adoption: Issues and policies for developing countries. *American Journal of Agricultural Economies*, 87(5): 1325-34.

Mlenga, D. M. and Maseko, S. 2015. Factors influencing adoption of conservation agriculture: A case for increasing resilience to climate change and variability in Swaziland. *Journal of Environment and Earth Science*, 5(22): 16-25.

Mustafa, M. 2017. Assessment of water quality and sustainability of Euphrates river in Iraq for drinking purpose by applying water quality indices (WCIS) and geographical information systems (GIS) techniques. *International Journal of Science and Nature*, 8(4): 241-756.

Mvungi, A., Mashauri, D. and Madulu, N. F. 2005. Management of water for irrigation agriculture in semi-arid areas: problems and prospects. *Physics and Chemistry of the Earth*, 30(11-16): 809-817.

Nabalegwa W. and Asaba, J. 2015. Assessment of socio-economic factors affecting the adoption of soil conservation technologies on Rwenzori Mountain. *The Indonesian Journal of Geography*, 47(1): 26-29.

Ng'ombe, J., Kalinda, T., Tembo, G. and Kuntashula, E. 2014. Factors that affect adoption of conservation farming practices. *Journal of Sustainable Development*, 7(4): 124-138.

Nsubuga, F. N. W., Namutebi, E. N. and Nsubuga-Ssenfuma, M. 2014. Water resources of Uganda: An assessment and review. *Journal of Water Resource and Protection*, 6: 1297-1315.

- Nyabose N. W. and Jumbe, C. B. L. 2013. Does conservation agriculture enhance household food security? Evidence from smallholder farmers in Nkhotakota in Malawi. Paper presented at the 4th International Conference of the African Association of Agricultural Economists, Tunisia, 22-25 September 2013.
- Okoye, C. 1998. Comparative analysis of factors in the adoption of traditional and recommended soil erosion control in practices Nigeria. *Soil and Tillage Research*, 45(3-4): 251-263.
- Pender, J. L. and Kerr, J. M. 1998. Determinants of farmers' indigenous soil and water conservation investments in semi-arid India. *Agricultural Economics*, 19: 113–125.
- Pender, J. L., Jagger, P., Nkonya, E. and Sserunkuuma, D. 2004. Development pathways and land management in Uganda. *World Development*, 32: 767-792.
- Perret, S. R. and Stevens, J. B. 2003. Analysing the low adoption of water conservation technologies by smallholder farmers in Southern Africa. *University of Pretoria Working Paper: 2003-01*, 1–16.
- Pesaresi, M., Melchiorri, M., Siragusa, A. and Kemper, T. 2016. Mapping human presence on earth with the global human settlement layer. Luxembourg: European Commission.
- Place, F. and Dewees, P. 1999 Policies and incentives for the adoption of improved fallows. *Agroforestry Systems*, 47: 323-343.
- Rogers, E. M. and Shoemaker, F. F. 1971. *Diffusion of innovations*. New York Free Press.
- Rugadya, M. A. 2006. Pastoralism and conservation studies: Uganda Country Report. Nairobi: IUCN.
- Sharma, R., and Bhardwaj, S. 2017. Effect of mulching on soil and water conservation – a review. *Agricultural Reviews*, 38(4): 311-315.
- Temesgen, B. B. 2012. Rainwater harvesting for dryland agriculture in the Rift Valley of Ethiopia. Doctoral Thesis, Wageningen University.
- Tiffen, M., Mortimore, M. and Gichuki, F. 1994. More people-less erosion: Environmental recovery in Kenya. Nairobi: Overseas Development Institute.
- Uganda Bureau of Statistics. 2016. Statistical Abstract.
- Vörösmarty, C. J., Green, P., Salisbury, J. and Lammers, R. B. 2000. Global water resources: vulnerability from climate change and population growth. *Science AAS*, 289: 284-288.
- Wandera, D. 2018. Farmers resort to mobile water tanks as valley dams dry up. *Daily Monitor*, 22 January.
- Zuazo, V. H. D. and Carmen, R. P. 2005. Soil erosion and runoff prevention by plant cover: A review. *Agronomy for Sustainable Development*, 28(1): 65-86.