Factors Influencing Uptake of Bench Terraces in Kabale District

Vivian Gordon Safari

Bishop Stuart University, P.O Box 9, Mbarara, Uganda.

E-mail: safariviviangordon@gmail.com

Abstract

The study was conducted to identify the factors influencing the uptake of bench terraces in Kabale district specifically, Rubaya Sub County. The study estimated the yields of Irish potatoes and beans among farmers with and without bench terraces, compared the net returns from Irish potatoes and beans among the farmers with and without bench terraces, identified the perception of the farmers on the uptake of bench terraces, and explored the strategies for increasing the uptake of bench terracing in Kabale district.

The study adopted a descriptive research design to collect and analyse both quantitative and qualitative data. A sample size of 134 study units was selected from a target population of 200 study units using purposive and simple random sampling. Data was collected through questionnaires and interviews while data analysis was descriptive, inferential and thematic for qualitative data.

The findings reveal that farms with bench terraces had better crop yields than the farms without bench terraces (for both beans and Irish potatoes). Farmers' net returns from bench terraces outstrip farmers' net returns from farms that are not bench terraced (for both beans and Irish potatoes). Lack of money, awareness, and attitude are the most limiting factors to the uptake of bench terracing and the strategies for uptake were based on government support holistically for development to be realised.

The researcher concludes that bench terraces should be embraced and promoted for better crop yields since it was evidenced by the research findings. The practical implication on this indicated that bench terraces should be promoted by development practitioners as a means of having degraded land rejuvenated into productive and arable land for agriculture.

In recommendation, government should ensure that bench terracing is promoted by putting in place the budgetary allocations in the sector of Agriculture in order to promote growing of common crops like potatoes and beans, it should highly be recommended to spearhead bench terracing in order to increase on production and productivity which in the long run will as well increase on farmers income, the farmers perception on the bench terracing indicated that they were mainly affected by high investments' and thus government should embrace supporting farmers to venture into terracing, it is highly recommended for the government to foster the policy of bench terracing in the aspect of ensuring sustainable land management technologies are taken on by the farmers.

***Key words*:** Bench terraces; uptake of technology; sustainable land management; crop yields and net returns

1. Introduction

Terracing steep lands in Africa is an indigenous technology. The same is true of earth bunds, stone lines and vegetative strips. New methods have evolved over the years in response to increasing population and land pressure. Under colonial regimes, large areas of communal lands were compulsorily terraced in the1950s for example in Kenya, Malawi and Zambia through the construction of ridges or bunds. Often rejected immediately after independence such techniques made a come-back in the 1970s having been improved and promoted through projects and or programs [1].

Land degradation resulting from unsustainable land management practices is a threat to the environment in Sub Saharan Africa and Uganda is not an exceptional. The threat is as well to the livelihoods where the majority of people directly depend on Agricultural production. There is potentially devastating down ward spiral of over exploitation and degradation enhanced by the negative effects of climate change leading in turn to reduce availability of natural resources and declining crop productivity. Because of its adverse agronomic, environmental, social and economic effects, it has attracted considerable attention from scientists and development agencies around the world, [2].Land degradation is most problematic in highlands and it impairs the capacity of soils to support proper plant growth [3]. It is estimated that 95 million hectares of land in eastern and central Africa have reached a state of degradation where only huge investments can make them productive again, [4].

In Uganda, technologies have been specifically promoted to help farmers control soil erosion because it is the major form of land degradation in highland areas [5]. They include: terraces, contours, trenches agro-forestry, and planting of Napier grass along contours and terraces. [6] provided evidence that farmers can increase their farm productivity by up to 5 times upon adoption of soil conservation technologies. Therefore, increasing the adoption of soil conservation technologies by farmers is a positive step towards increasing economic growth, especially in agrarian economies like Uganda.

Sustainable land management is the antidote, helping to increase average productivity, reducing seasonal fluctuations in yields and underpinning diversified production and improved incomes and food security. For most Sub-Saharan African (SSA) countries, agriculture is crucial to achieving broad based pro-poor economic growth and attaining the Millennium Development Goal of halving poverty and hunger by 2015, and continuing to reduce them thereafter,[7].

1.1 The guiding theory

This research was guided by the Innovation-diffusion theory as stated by [8], who elaborated that the innovation-diffusion theory as "the process by which an innovation is communicated through certain channels over time among members of a social system'. The innovation-diffusion model states that a technology is passed on from its source to end users through a medium of agents and its diffusion in potential users for the most part dependent on the personal attributes of the individual user. The model assumes that the technology in question is appropriate for use unless hindered by lack of effective communication. [8], a number of factors act together to influence the diffusion of a certain innovation. The four major factors that influence the diffusion process is the innovation itself, how information about the innovation is communicated, time and the nature of the social system into which the innovation is being introduced

1.2 Problem statement

Despite the continuous efforts to promote bench terraces for sustainable land management and increasing on crop production and productivity, the uptake of the technology is still low [9] This was based on the statistical figures from the report where out of 5 parishes that Kigezi Diocese Water Sanitation Programme reached out, with 1349 farmers only 108 farmers had taken on the venture of terracing their land. The land users and owners are willing to uptake a technology if it provides higher net returns, lower risk or a combination of both, [10]. It is not clear however, whether these aspects of higher net returns or lower risks are among the factors leading to low adoption rates of the bench terraces technology.There are evident impacts of land degradation and despite the efforts by Government and non-government organizations to promote technologies that improve on land productivity and increase crop production, the uptake of these technologies by farmers has not reached the recommended standards [11]. This was thus, the basis for the research to explore the factors influencing the uptake of bench terraces, in Kabale district specifically Rubaya Sub County.

1.3 Research objectives

This paper was guided by the following specific objectives

- To estimate the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Kabale district
- To compare the net returns of the common food crops; Irish Potatoes and beans among the farmers with and without bench terraces in Kabale district
- To identify the perceptions of the farmers on the uptake of bench terraces technology in Kabale district.
- To explore the strategies for increasing the uptake of bench terraces technology in Kabale district.

1.4 Hypotheses

The following hypotheses guided the research objectives

H_0: There is no significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H_1: There is a significant difference in crop yields between farmers using bench terraces and those without bench terraces.

H_0: There is no significant difference in net returns between farmers using the bench terraces and those without bench terraces.

H_1: There is a significant difference in net returns between farmers using the bench terraces and those without bench terraces.

1.5 Significance of the study

- To the University; the study created a benchmark for further research to the users of Bishop Stuart University Library and other institutions of higher learning as it avails information on bench terrace technology as an innovation for sustainable land management in Kabale District, Uganda Sub-Saharan Africa and World at large.
- To the policy makers; the study findings would be beneficial to policy makers especially the Government of Uganda to put forward policies that will greatly enhance sustainable land management with emphasis on bench terracing in hilly areas after obtaining better results from this study. Therefore the research finding was to act as a reference tool for policy makers, other researchers and the target community for further developmental undertakings. To explore which factors explain the current and future adoption of terraces with close attention to the potential effects of local institutions and farmers capacity to invest in bench terraces in Rubaya Sub-County in Kabale district.
- To the researcher; this study enabled the researcher to obtain first-hand information concerning bench terrace technology an innovation for sustainable land management. It was further a benefit to the researcher to obtain a Master's Degree in Agriculture and Rural Innovations of Bishop Stuart University

2. Literature Review.

This paper looked at most of the available literature mainly focusing on bench terraces technology and its uptake in line with crop production and productivity, the net returns from crops on both terraced and non terraced fields as well as the perceptions from farmers on the uptake.

2.1 The estimated crop yields of Irish Potatoes and beans among farmers with and without the bench terraces.

[12] pointed out that Soil is a vital resource for crop production and so its productive capacity should be maintained through use of appropriate technologies. Through research several land management technologies have been developed to combat effects of land degradation. These technologies include: use of legumes in crop rotation, mulching, terracing, biomass transfer, contour bunds, and agro-forestry. The crop yields will increase in fields which have good biomass, terraced to avoid acceralated soil erosion and retain nutrients added in the soils.

A study by [13] on land use change in Kabale district revealed that the total size of farmland (fallow and cultivated) only increased significantly in one area, while the expansion of farmland in the upland areas had already stopped by the 1950s, due to the lack of available land. The yields on the farm are as a result of several factors like fallowing which paves way for the soil to rejuvenate. In the areas where grassland, bush land and woodlands were covering important areas in the 1950s, these land use classes were converted into small-scale farmland and planted woodlots. Their findings suggested that farmers tend to expand production first into upland areas and thereafter into the wetlands, possibly because of the significant work involved in draining swamps.

[11] in a study on idle land in the densely populated Kigezi highlands of South-western Uganda found that plot abandonment and long fallow was a common problem in the area. This contributes to the specific crop production trends since some of the plots which may be put under fallow will rejuvenate the soil fertility parameters and in the due course improve on the crop productivity. [14] Investigated socioeconomic factors influencing seasonal fallowing in Kigezi highlands and revealed that only 26% of farmers reported cropland under fallow.

While average Irish potato yields in North America and Western Europe often reach 40 tons per hectare, yields in developing countries are usually below 20 tons per hectare. The national average yields for Kenya has been reported at 7.7 tons per hectare, but this figure has fluctuated consistently over recent years from over 9.5 tons per hectare to around 7.5 tons per hectare [15] The low yields have been attributed to poor agronomic practices, low use of inputs especially fertilizers, low soil fertility, limited access to good quality seeds , diseases especially bacterial wilt late blight and viruses and insect pests.

[16], pointed out that on sloping lands, terracing is necessary for reducing overland flow rates thereby contributing to water and nutrient conservation. When the soil nutrients improve, then the crop yields are most likely related to increase since the crops will have benefited from the nutrients. Some of the common terracing technologies used by farmers in Uganda are *fanya juu* and bench terraces. Bench terraces are commonly made on steep slopes and they are labor intensive. For this reason, bench terraces are rarely excavated directly but instead they are developed over time from *fanya juu* terraces.

2.2 Establishing the net returns from Irish potatoes and beans among farmers with and without bench terraces.

Potatoes and beans have the potential to relieve the pressure of increasing demands on the poorest people and contribute significantly to food security and income generation, [17]. Potatoes are an important source of food and income in the developing countries. At higher altitudes farmers have a complete three planting season for both beans and Irish potatoes and the net revenue from these crops outweighs the revenue collected from cereal crops like maize. The average yields form a basis for potato farmers to continue growing the crop and the net returns provides the potential contribution raised from these crops, [18].

Potato (*Solanum tuberosum* L.) is a crop of major economic importance worldwide [15]. In terms of global production, it is the third most important food crop after rice and wheat for human consumption and over a billion of people on earth feed on potatoes [19]. Global potato production is estimated at 20.8 t ha-1, and potato

yield vary considerably across regions. Generally, Asia and Europe are the world's major potato producing regions, accounting for more than 80%; while Africa is the least, accounting for about 5%. Nationally, potato yields in Uganda have remained low at 7.5t ha-1 compared to other countries in which case, 40-60 t ha-1 are achievable and the low yields are attributed to poor quality seed among other factors [20].

2.3 The perceptions of the farmers on the uptake of bench terraces.

Despite the scientific advances in understanding the causes and outcome of land degradation, uptake of bench terraces is mostly limited to a minority of innovative land users and practioners. Although principles and practices of sustainable land management are well known, and increasingly promoted at the policy and development cooperation, land degradation is still increasing and becoming a major global threat. This demonstrates a wide gap existing between acknowledgement of the need for sustainable land management and the implementation of the successful bench terraces practices,[21].

[6],noted that poor implementation of bench terrace technology for Sustainable Land Management (SLM) are related to technological, ecological, institutional, economic and socio-cultural aspects. Lack of access to appropriate technologies, practices or equipment is a major barrier in many countries. This may either be due to a lack of access to knowledge and information on sustainable land management options and their proper implementation, or because of insufficient resources in land, labor, inputs, biomass, energy, water or plants.

Bench terrace practices that are technically effective or suitable for one specific site location are not necessarily the best option for other site locations with different biophysical constraints and socio-economic contexts. It is therefore important to have area- and case-specific technological packages accompanied by the necessary capacity-building measures and resources for appropriate implementation. Often, knowledge gaps of the ecological implications at different spatial and time scales make it difficult to select the most suitable sustainable land management options, [22].

The adoption of bench terrace technologies in agriculture has attracted the attention of development economists and sociologists because the vast majority of the population in developing countries derives its livelihood from agricultural production and because there are opportunities for increased output and higher income levels which technological change can offer [23]. Adoption studies relate to use or non-use of a particular technology by individual farmers at a point in time, or during an extended period of time. Adoption therefore presumes that the technology exists, and studies of the adoption process analyze the determinants of whether and when adoption takes place [24].

The decision to uptake a new or improved technology/practice can be regarded as an investment decision [25]. This decision may involve sizeable fixed costs, while the benefits realized over time. The choice of whether or not to adopt a new technology will, therefore, be based on a careful assessment of a large number of technical, economic and social factors. The technical feature of a new technology may have a direct consequence on the decision making process. It appears that the more technically complicated the innovation, the less attractive it may be to many farmers.

Limited finance and access to capital for implementation and maintenance of Sustainable Land Management. Economic considerations and incentives schemes are two of the land users 'primary motivations for selecting SLM technologies and practices, including a strong dependence on external subsidies for implementation and maintenance, [26].

2.4 Strategies for increasing the uptake of bench terraces

For successful up scaling and foster large scale implementation of sustainable land management practices like bench terracing, more attention must be paid to the social system from the first involvement stage, up to long term maintenance. ensuring stakeholder participation throughout decision making processes, from the design of projects all through the implementation and monitoring, will increase the likelihood of acceptance and implementation, [14].

A framework that assesses cost-benefits and trade-offs also promotes the uptake of more coherent Sustainable Land Management choices at different scales (in time and space)of implementation. Such frameworks will

facilitate moving towards developing strategies and processes that involve stakeholders at all levels, link bottom-up experience with science-based data and knowledge, and make the best Sustainable Land Management choices to simultaneously address climate change adaptation and mitigation and land degradation. Simultaneously addressing these multiple objectives and goals could be facilitated by a pragmatic and integrated framework to track the best technical choices and to promote the necessary enabling environments and co-benefits, as well as by addressing trade-offs at the appropriated scales and taking specific circumstances into account, [27].

Scientific evidence shows that Bench terrace practices like bench terraces, if widely adopted, as a means to prevent, reduce or revert land degradation and in achieving the LDN (SDG 15.3), also contribute to adapting to, and mitigating, climate change. Furthermore, they help to maintain biodiversity, and they contribute to other SDGs in a number of ways, by alleviating poverty, and foster economic prosperity for land-dependent communities. However, one size does not fit all; specific circumstances need to be carefully taken into account, and there are no silver-bullet SLM solutions. Each environmental and socio-cultural context requires assessment of the most appropriated ways to achieve multiple benefits and to reduce trade-offs through sustainable land management, [23].

Databases such as the World Overview of Conservation Approaches and Technologies (WOCAT), TERRAFRICA, the World Bank sourcebook, and the Voluntary Guidelines for Sustainable Soil Management (VGSSM) provide comprehensive recommendations and examples of Bench terrace practices. The combined implementation of practices that address both soil and water conservation, the diversification of cropping systems, the integration of crop and livestock systems, and agro-forestry are most effective and should be prioritized, [25].

Increasing Soil Organic Carbon (SOC) stocks is key to most bench terrace practices, and provides synergies for addressing degradation of land decimals and disaster risk reduction, climate change adaptation and mitigation. Besides contributing to climate change mitigation by removing Carbon dioxide from the atmosphere, enhancing organic carbon in soils improves soil health and fertility, water and nutrient retention capacity, food production potential and resilience to drought. The potential and magnitude of each of these benefits will depend on the baseline conditions, and local environmental, socio-economic and cultural conditions, [28].

3. Research Methodology

Methodology is the theory on the research undertaken and various steps taken to ensure dependability of the data. The methodology involved the research design, study population, sample size, data sources, data collection methods, data processing and analysis criteria.

3.1 Research design.

A descriptive research design was used for this study because it helps to generalise the findings to other similar situations [29]. The descriptive research design aimed at obtaining information to systematically describe the population and the phenomenon where the research was conducted in Rubaya Sub County. Both quantitative and qualitative approaches were used in order to establish the extent and rate of the problem. Hence, under these approaches, semi- structured questionnaires and interview guides were used to obtain information from the specific respondents in the study area.

3.2 Study population

The target population for the study was derived from the households (farmers) as land users and owners in Rubaya Sub County. The study was conducted in Rubaya Sub County with a population of 4018 people. However, research was conducted within 5 parishes that have a total population of 2991 people and considering a population of 1,349 farmers who are actively engaged in farming.(Sub county annual report, 2019). The technical team including the Agricultural officer, Community Development officer, Sub county chief and the secretary for production at the sub county level were approached to get in depth understanding about the perceptions of up taking the bench terraces technology. The study population constituted farmers in Rubaya Sub County, who were either having bench terraces or not. The study chose the respondents from a target population

of 100 farmers who had bench terraces and 100 farmers who did not have bench terraces from where the sample was derived. This constituted a target population of 200 study units.

3.3 Sample size and sample selection

The sample size was based on the formula by Slovene which is the formula used to determine the ideal sample size for the population. The formula states that n=N/1+ (N*e^2) where n= number of samples, N= Total population, e = Margin of error (which will be 5% or 0.05). Therefore considering the total population of 100 farmers (land users) who are both females and males the sample for farmers with bench terraces was derived from the population. Using Slovene formulae a sample of 80 respondents was reached at out of 100 targeted farmers in the population. Considering the population of 200 farmers (land users) who are both females and males the sample for farmers without bench terraces was derived from the population. Using Slovene formulae a sample of 160 respondents was obtained out of 200 targeted farmers in the population.

$$Sample\ size = \frac{N}{1 + Ne^2}$$

Where N is the Target Population (200), n is the sample size and e is the level of significance at 0.05

$$Sample\ size = \frac{200}{1 + 200(0.05)^2} \approx 134$$

Therefore, the sample size for the study was 134 respondents.

3.4 Sampling procedure/techniques

The study employed both purposive sampling technique which was used to select the farmers with bench terraces and simple random sampling which was used to select farmers without bench terraces. The technique involved getting an interval considering the nth value, for purposes of getting a uniform representation of the respondents.

3.5 Sources of data

Two sources of data were used for purposes of this research. These were primary data and secondary data.

3.6 Methods and Instruments of data collection

The research used semi- structured questionnaires and Interview guides. The semi-structured questionnaires were used to obtain the information from farmers with and without bench terraces. The interview guide was used to interview Agriculture Officers and the sub-county administrators to get in depth understanding of factors influencing the uptake of the bench terraces. The interview guide was also used to derive information from farmer groups by conducting interviews face to face with farmers.

4. Data analysis and presentation.

The detailed analysis and presentation of the findings was based on objectives of the study. The study investigated different background characteristics, the findings of which were summarized in the table below.

Table 1: Background data

Variable list	Categories	Frequency	Percent	Valid Percent
Gender	Male	64	64	64
	Female	36	36	36
	Total	100	100	100
Marital status	Married	72	72	72
	Single	8	8	8
	Widowed	20	20	20
	Total	100	100	100
Education	Primary	56	56	56
	Secondary	24	24	24
	Tertiary	20	20	20
	Total	100	100	100
Do you have bench terraces on your land	Yes	44	44	44
	No	56	56	56
	Total	100	100	100
Age groups	Below 35	16	16	16
	35 – 49	36	36	36
	50 and above	48	48	48
	Total	100	100	100

Source: (Field data 2021)

The statistics indicated that 64% of the farmers were male while 36% were female. This was noted possibly because in the study area male counter parts own land and have full control of the resource. While still on marital status, the statistics showed that 72% of the farmers who participated were mainly the married, and this could suggests that the married are independent and have a big control of the land resource. The statistics indicated that 56% of the respondents had attained primary education, with the implication that agriculture was left with those who had not attained higher levels of education. In regard to the age differences, it was found that 48% of the farmers were old (over 50 years), 36% were adults (35 – 49 years) while only 16% were youths (below 35 years) meaning the youth show less concentration in agriculture.

4.1 Analysis of the research problem

The problem was analysed basing on the research objectives. Consequently, the techniques of data analysis depended on the research objectives.

Objective one: To estimate the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Rubaya Sub county Kabale district.

Table 2.Total Quantity(s) harvested (Kgs) in the season of 2019/2020

Do you have bench terraces on your land	Type of crop grown	Count	Percent	Mean crop yield (kg)
Yes	Beans	28	29.2	444
	Irish	12	12.5	4720
	Total	40	41.7	1727
No	Beans	36	37.5	495
	Irish	20	20.8	506
	Total	56	58.3	499
Total	Beans	64	66.7	473
	Irish	32	33.3	2086
	Total	**96**	**100**	**1011**

Source: Field data, 2021

The analysis on differences on crop yields was based on 96 farmers. This suggested that of the 100 farmers who took part in the study, the information provided by 4 of the farmers constituted invalid cases and were eliminated from this analysis. Of the 96 farmers whose crop yields were analyzed and compared, 40 farmers (41.7%) were using bench terraces technology on their land while 56 farmers (58.3%) were not using bench terraces on their land. This was possibly because the construction of bench terraces is quite expensive and few farmers afford the expenses incurred in the process of terracing. In terms of the crops grown, 64 farmers (66.7%) grew bean in 2020 while 32 farmers (33.3%) grew Irish potatoes. Therefore, most of the farmers in 2020 grew more beans than Irish potatoes possibly because much of the Irish potatoes were grown in the lower valleys commonly referred to as wetlands/Swamps.

The distribution on the annual crop yield in 2020 indicated some differences in harvests. The study shows 495 kg as the mean annual beans yield among farmers who had bench terraces and 444 kg among farmers who did not have bench terraces. There was thus a slight margin and difference in yields of 51 kgs. Therefore, beans yields were better among farmers who had bench terraces than those who did not have bench terraces. The study also shows 4720 kgs as the mean annual yield of Irish potatoes among farmers who used bench terraces and 506 kg among farmers who did not use bench terraces. Therefore, Irish potato yields were better among farmers with bench terraces than those who did not use bench terraces. This was possibly because the farm inputs like manures and fertilizers applied in the bench terraces would fully be used by the crops and thus planted Irish potato and beans benefited from the nutrients since they would not be eroded by any run off or there would be no soil erosion from terraced fields.

Objective two: To compare the net returns of the common food crops; Irish Potatoes and Beans among the farmers with and without bench terraces in Rubaya Sub county Kabale district

This objective called for a comparison of the net returns in both crops (beans and Irish potatoes), and application of bench terraces (farms with and without terraces). The net return, which is the difference between total sales and costs of production, was computed as a variable in SPSS. The tables below show the outcome on net returns in the season.

Table 3. Net returns (Ug shillings) in the season of 2019/2020

Do you have bench terraces on your land	Type of crop grown	Count	Percent	Mean returns
Yes	Beans	28	29.0	1,121,365
	Irish	12	12.6	1,995,144
	Total	40	41.6	2,116,303
No	Beans	36	36.7	474877
	Irish	20	22.6	799,321
	Total	56	59.3	561207
Total	Beans	64	65.7	965056
	Irish	32	35.2	2,661577
	Total	96	100	1,973,722

Source: Field data, 2021

The analysis on the net returns on the crop yields in the season of 2019/2020 was based on 96 farmers. This suggests that of the target 100 farmers who took part in the study, the information provided by 04 of the farmers constituted the invalid cases and were eliminated from this analysis.

This analysis was also based on the 40 farmers (41.6%), who used the bench terraces and 56 farmers (59.3%) who were not using the bench terraces in the season of 2019/2020. The analysis also considered the total number of 64 farmers (65.7%) who grew beans and a total number of 32 farmers (35.2%) who grew Irish potatoes in the season of 2019/2020.

For the farmers who used bench terraces, 28 farmers (29%) grew beans and 12 farmers (12.6%) grew Irish potatoes. The annual net returns for farmers with bench terraces on their crop yields were UGX. 1,121,365 from the Beans and UGX.1,995,144 from Irish potatoes respectively. The statistics suggests that farmers with bench terraces fetched more from Irish potatoes than from beans. This was possibly because the prices of Irish potatoes were always higher during the harvesting seasons. Among farmers who were not using bench terraces, 36 farmers (36.7%) grew beans and 20 farmers (22.6%) grew Irish potatoes. The annual net return on their crops was UGX. 474,877 from beans and UGX.799,321 from Irish potatoes respectively. There was still a slight higher return from the sale of Beans and Irish potatoes because prices of Irish potatoes were always higher during the harvests seasons compared to the prices of beans. It was thus observed that the net returns of the farmers using the bench terraces was higher than the net returns of the farmers without bench terraces for both crops respectively. This was attributed to the fact that crop yields from the bench terraces were always higher compared to the yields from non terraced fields.

Objective three: To identify the perception of the farmers on the uptake of bench terraces in Rubaya Sub County Kabale district.

To understand and identify the perceptions of the farmers on the uptake of bench terraces, the open-ended questions were administered to farmers. The question sought for farmers' opinions on the perceptions about the uptake of bench terraces. Three factors strongly emerged out of their response that is lack of money, awareness, and attitude.

Farmers looked at the initial construction of the bench terraces to be an investment that required huge start-up capital. In their response, it was noted that such capital requirements were lacking to most of the farmers. For example, one farmer commented on the idea of lack of money and said: " *Iam engaged in farming on a small scale not because I want it that way, but because of limited capital to invest in farming as a business,"*

The average acreage of land among the farmers in the study area was about 0.45 acres. Most of the farmers, including those whose land is up for bench terracing have small pieces of land. Therefore, there is some degree of unawareness that bench terracing is to help small land acreage owners to obtain the most out of their small

land. On this account, one of the farmers said: "…*my pieces of land are very fragmented. I fear that they might be made smaller if I gave them for bench terraces*…" perhaps the idea here was hinged on the fact that land was fragmentation and farmers feel that if the land was consolidated then a lot would be realised from venturing into bench terracing.

The research findings captured attitudinal changes amongst the farmers where their attitude on terracing the land with the external support was looked at as an avenue for grabbing land from them. Actually some of the farmers knew that after the terraces have been introduced on their land, the land would be taken from them. One of the farmers reiterated that: "…*bench terracing is good but very expensive for an ordinary farmer. People fear that their land may be taken if terraced by use of the external support either from the government or Non government organisations*…" This view is just a macrocosm of the many divergent view held amongst farmers on the uptake of bench terraces.

Objective four: To explore the strategies for increasing the uptake of bench terraces in Rubaya Sub county Kabale district

To understand the strategies for increasing the uptake of bench terraces, the researcher used open-ended questions. The questions sought for farmers' opinions on the strategies that could be taken to increase the uptake of this technology. While most of the farmers identified a number of strategies: sensitizing farmers, government policies, constant monitoring of terraces, support from NGOs, farmers' exposure, government funding of terraces, give incentives to farmers, change farmer attitude, extension services, the study identified one factor, which was themed as 'government support' ranging from government financial support, government policy support, government partnership, and government extension service support.

The farmers opinion was that government should come up with policies that govern the use and extension of bench terraces in rural and hilly areas. These policies would not only provide governance mechanisms but also provide a means of making the project compulsory in devastated hilly areas. In view of the above, one farmer said: "…*government should make it mandatory for the farmers in Kabale to terrace their land*…" This farmer had used his own money to terrace the land that was about 2.5 acres. At the time of the investigation, the farmer was boosting of controlled run-off of water, improved productivity, increased soil fertility, and increased crop yield. Farmers used the concept 'policy' many times as a viable option to improving the uptake of bench terraces technology. For instance one farmer said: "…*enforce the terracing of landscapes in Kabale…government should take an upper hand in land use management*…"

The findings captured the opinions of farmers on partnership, where the government should embrace partnerships 'networks and liaises with other NGOs in promoting sustainable land use management. One farmer observed: "…*government should work with NGOs like Kigezi Diocese water and sanitation programme to embrace terracing of land…"* This particular farmer obtained external financial support from the same Nongovernmental organisation in the initial construction of terraces on his land. The farmer was proud of the benefits of bench terraces such as "…*increased land productivity, reduced soil erosion, planted grass for animals, used less seeds to plant, and learnt good farming practices*…" This farmer reported a gross sale of approximately UGX 3,800,000 in the 2020/2021 season. The implication here is that government can collaborate with other development partners to promote the uptake of bench terraces in Kabale district. Regardless of farmer's use of the concept, it might be a viable option to increase the uptake of bench terraces in the sub county. For example, one farmer commented: "… the *need for extension services to create awareness about the terraces technology should be empasised*…" In another excerpt, a farmer observed: "…*extension service delivery should include terracing of landscapes*…" and thus extension workers should ensure that messages related to bench terracing are embraced.

5. Discussion of findings

The first objective estimated the crop yields of the common food crops; Irish potatoes and beans among farmers with and without bench terraces in Rubaya Sub county Kabale district. The study found that farms with bench terraces had better crop yields than the farmers without bench terraces (for both beans and Irish potatoes)

This was reflected on the factor where 495 kg was registered as the mean annual yield among beans farmers who had bench terraces and 444 kg among farmers who did not have bench terraces. There was thus a slight margin and difference in yields of 51 kgs. Therefore, beans yields were better among farmers who had bench terraces than those who did not have bench terraces. The results also showed that 4720 kg was the mean annual yield of Irish potatoes among farmers who used bench terraces and 506 kg among farmers who did not use bench terraces. Therefore, Irish potato yields were better among farmers with bench terraces than those who did not use bench terraces. It was thus observed that the crop yields from farms of the farmers using the bench terraces was higher than the crop yields from farms of the farmers without bench terraces for both crops respectively. This was attributed to the fact that the bench terraces hold better the soil nutrients and water for crop growth and development. The research findings were thus in line with the former researchers [16] who noted that when the soil nutrients improve, then the crop yields are most likely related to increase since the crop will have benefited from the nutrients. This was more evidenced where practices like terracing was done, in Uganda. [12], as well pointed that terracing land brings about the factor of combating land degradation where bench terracing controls soil erosion and this in the process gives way for crops grown in such terraced fields to gain from the soil nutrients which supports them for proper growth and producing better yields.

The second objective compared the net returns of the common food crops; Irish Potatoes and Beans among the farmers with and without bench terraces in Rubaya Sub county Kabale district. The study found that farmers' net returns from bench terraces outstrips farmers' net returns from farms that are not bench terraced (for both beans and Irish potatoes). The research findings indicated that**,** the minimum mean net returns from the Beans was 316,585 UGX registered among farmers without bench terraces in season 2020/2021 and the maximum mean net returns was 1,121,365 UGX registered among farmers with bench terraces in the season of 2019/2020 respectively. Following the farmers who grew Irish potatoes, the minimum mean net returns from the sales among farmers with bench terraces was 1,995,144 UGX and the maximum was 2,660,203 UGX. The minimum mean net returns among the Irish potatoes farmers without bench terraces was 799,321 UGX and the maximum mean net returns was 893,600 UGX respectively. Thus, the minimum mean net returns from Irish potatoes was 799,321 UGX registered among farmers without bench terraces in season 20219/2020, and the maximum mean net returns was 2,660,203 UGX registered among farmers with bench terraces in season 2020/2021 respectively. Following figures of Shillings got, the researcher concludes that farmers with bench terraces fetched more on their crop yields than those who were not using bench terraces. The researcher also observed that regardless of whether the farms were bench terraced or not, the net returns from Irish potatoes were significantly higher than the annual net returns from beans. On the whole, this research therefore, found out that farmers' net returns from bench terraces outstrip farmers' net returns from farms that are not bench terraced.

The research findings were thus in agreement with the previous research with reference made to [15], where Irish potatoes are seen as the most important source of food, employment and income for the developing countries fetching more than other crops. And FAO report 2008 which spelt out that potatoes and beans had the potential to revive the incomes of the farmers with many getting more that 1 million shillings from the sales of the harvest season.

The third objective identified the perception of farmers on the uptake of bench terraces technology in Rubaya Sub County Kabale district. The study found out that lack of money, awareness, and attitude were the factors that majorly influence the uptake of bench terraces technology. The research findings indicated that farmers were not aware that bench terraces technology is to benefit smallholder farmers, particularly those with small pieces of land. They could not uptake bench terraces because they thought it requires large pieces of land. Farmers reported that their land was small and could not be taken up for bench terraces. The average acreage of land among the farmers investigated was about 0.45 acres. Most of the farmers, including those whose land is up for bench terracing have small land pieces of land. Therefore, there is some degree of unawareness that the said technology is to help small land acreage owners to obtain the most out of their small land. The findings further indicated that farmer's perceptions were that bench terraces technology was very expensive. They were making conclusions perhaps without any assessment of what it required to uptake such a technology.

This finding was in line with (Thuo et al, 2014), who noted that limited finance and access to capital for implementation and maintenance of sustainable land management technologies like bench terracing should be well considered. On the other hand, the decision to uptake a new or improved technology/practice could be regarded as an investment decision as pointed out by [25] and therefore the attitude of the farmers was seen as a strong basis on whether the farmer uptake the bench terracing in the study area.

The fourth objective explored the strategies for increasing the uptake of bench terraces technology in Rubaya Sub county Kabale district. The research findings indicated that government support should be the major strategy towards increasing the uptake of bench terraces technology. The researcher found that most of the farmers who were using bench terraces had either used their own money or obtained external support from Kigezi Diocese water program. None of the farmers who were using bench terraces ever obtained funding from government. The government support was thus, four fold in sense that support would be in material or financial obligations, policy, partnership and extension services. This was on the basis that some other research reports had as well highlighted on the government as an organ that would spearhead the technologies.

The findings were thus in-line with what some of the previous researchers found out. This was pointed out by [30], where it was stated that a major portion of the land used for agriculture, particularly in ecologically fragile areas, is cultivated by small holder farmers who perform significant ecological services in the process. But for economic reasons these farmers need a multidimensional support ranging from policy, financial, and social-economic obligations.

5.1 Conclusion.

Following research objectives, findings indicated that better crop yields were realized on farms which were bench terraced compared to the farms not terraced. While still the net returns from the crops on the terraced land were higher compared to the crops harvested from none terraced land in line with yields realized. The perceptions were however, hinged on the basis that bench terracing is an expensive venture and even though farmers have limited awareness and show a weak attitude on uptake, the government should holistically support the mechanisms ranging from policy, financial, and strengthen extension services. The researcher concludes that bench terraces should be embraced and promoted for better crop yields since it was evidenced by the research findings. The practical implication on this indicated that bench terraces should be promoted by development practitioners as a means of having degraded land rejuvenated into productive and arable land for agriculture.

5.2 Recommendations

There is need to include sustainable land management as a special package in the extension system for purposes of spearheading the technologies and practices in land improvement and management. And the government should ensure that bench terracing is promoted by considering putting in place the budgetary allocations in the sector of Agriculture in order to promote growing of common crops like potatoes and beans and realize better crop yields.

The recommendation of terracing land in line to producing high crop yields that would in the long run bring about high net returns from the sales of crops grown like Irish potatoes and beans should highly be recommended. This was observed because bench terracing leads to increased crop production and productivity which in the long run will as well increase on farmers' income.

The recommendation on objective of farmers perception should be that government should embrace supporting farmers to venture into terracing, because the farmers perception on the bench terracing mainly indicated limitations with the high investments attached to the bench terracing. The government should thus consider special packages in the extension system and look at putting in place demonstration sites where degraded landscapes would be terraced to convince farmers who would in the long run easily uptake the technologies.

The recommendation on policy formulation should be emphasized. The government and development agencies should have great concern of having special and guiding policies that govern the management of land in line to bench terracing and such policies should be well aligned with land and environment management act for purpose of ensuring that the farming communities are protected while harnessing and gaining from the agricultural domain.

5.3 The constraints/limitations of the study.

Language: Majority of the respondents (farmers) were used to the local dialect/language and this required translating the questions first to the local dialect/language. It was found to be time consuming, and spending more time with the respondent/interviewee and more still some of the respondents would not be fully comfortable to sit for long hours and respond to the administered questionnaires.

Nature of the terrain: The terrain of the study was hilly and in order to administer the questionnaires, it required movements from homesteads to homesteads crossing valleys and climbing hills, moving from farmer gardens to gardens for observations. In addition by nature of the terrain, majority of the farmer fields are fragmented and for purposes of getting the good information it would require reaching on all the sampled fields together with the respondents selected who would feel comfortable when their gardens are visited during the research study.

The funding of this study was self-centred. As a matter of fact, I have sponsored myself for the entire period while doing this Masters degree. It has become one of the challenging times and the greatest challenge encountered in the field while collecting data from the respondents where they would expect some facilitation and which was inevitable because at the end of the day humanly speaking it would be hard to leave the respondent who would have given you her/his time responding to the questionnaire administered empty handed.

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