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FACTORS INFLUENCING THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES AMONG SUBSISTENCE FARMERS IN NAKAPIRIPIRIT DISTRICT, UGANDA

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ABSTRACT

Land degradation and climate change effects hamper agricultural production and productivity amongst subsistence farming households. As a result, in north-eastern Uganda, subsistence farmers in Nakapiripirit district grapple with declining yields and incomes. This has contributed to the prevailing poverty and food insecurity in the district. Sustainable land management is crucial in mitigating these effects for sustainable development. Despite the efforts of governmental and non-governmental organizations to promote sustainable land management technologies, adoption remains low amongst subsistence farmers. Therefore, this study is aimed at assessing the underlying factors that influence the adoption of these technologies amongst subsistence farmers in Nakapiripirit district. Purposive random sampling was used in selecting a total of 20 interviewees. Semi-structured individual interviews were conducted with 15 farmers from the three broad livelihood zones in the district and five key informants at both district and sub-county levels. Content and thematic analyses were used in analysing the data. The findings reveal that crop rotation, intercropping, farmyard manuring, and crop residue composting are the most practiced sustainable land management technologies amongst subsistence farmers. However, labour, access and cost of farm inputs and equipment, knowledge and skills capacity, traditional practices and thinking, climate change effects, gender and financial support to stakeholders influence the adoption of these technologies. Apart from increasing financial support and strengthening the technical capacity of extension workers, government and non-governmental organizations need to use stakeholder inclusive approaches in promoting climate resilient, less labour intensive and financially demanding sustainable land management technologies. The promotion initiatives must always consider the differences in the level of adoption by the various categories of subsistence farmers in the different livelihood zones of the district.

Key words: Land degradation, climate change, food insecurity, poverty, stakeholders

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ABBREVIATIONS

ACTED	Agency for Technical Cooperation and Development
DCA	DanChurchAid
FAO	Food and Agriculture Organization of the United Nations
GOU	Government of Uganda
GRÓ LRT	GRÓ Land Restoration Training Programme
IBFAN	International Baby Food Action Network
IPC	Integrated Food Security Phase Classification
MAAIF	Ministry of Agriculture Animal industry and Fisheries
MWE	Ministry of Water and Environment
NabuZARDI	Nabuin Zonal Agricultural Research and Development Institute
NDLG	Nakapiripirit District Local Government
NGOs	Non-Governmental Organizations
OPM	Office of the Prime Minister
SCSI	Soil Conservation Service of Iceland
SLM	Sustainable Land Management
UBOS	Uganda Bureau of Statistics
UNDP	United Nations Development Programme
UNICEF	United Nations International Emergency Children’s Fund
WFP	World Food Programme

1. INTRODUCTION

Land degradation and climate change effects are the most severe environmental problems that Uganda currently faces (NEMA [National Environment Management Authority] 2019). Most developing countries, as is the case for Uganda, experience soil erosion as the most severe form of land degradation (Jiang et al. 2014). These effects are more noticeable in Uganda's least socio-economically developed sub-region of Karamoja where Nakapiripirit district is located (GOU [Government of Uganda] 2009; Mubiru 2010). This sub-region is part of the cattle corridor region of Uganda which is highly degraded and drought prone, with the predicted rate of soil erosion of over 10 tons per hectare per year (Karamaje et al. 2017).

Land degradation refers to "a group of natural or human-induced processes that impair or destroy the potential of land to sustain properly an economic function or the original natural ecological function" (FAO 2007, p. 63). In the Nakapiripirit district, the significant forms of land degradation are soil erosion, nutrient depletion, and habitat loss. Land degradation in the district has widely been attributed to both natural causes such as climate change effects and human-induced causes such as indiscriminate bush burning, tree cutting, and overgrazing (Kagan et al. 2009; NDLG [Nakapiripirit District Local Government] 2015; Karamage et al. 2017; NEMA 2019). Together, these have greatly affected the environmental and socio-economic well-being of the people by advancing the rate of land degradation in the district (Kagan et al. 2009; UNDP 2014; NDLG 2015; UBOS [Uganda Bureau of Statistics] 2017; NEMA 2019).

Most of the people in the district solely depend on rain-fed agriculture as 94% of 25,401 households entirely derive their livelihoods from either rearing livestock, cultivating crops, or both (UBOS 2017). The other available alternative livelihood options such as trading, gold mining, and stone quarrying employ not more than 6% of the households in the district (UBOS 2017). This, therefore, has left much of the population entirely dependent on the land resources for their present and future survival.

The district is occupied mainly by pastoralist and agro-pastoralist groups uniquely divided into the Karimojong, Pokot, and Kadama but generally called the Karimojong, who make up the majority. The area has high levels of illiteracy, infant mortality, malnutrition among children under five years of age, and a high prevalence of abject poverty and is one of the poorest in the country (UNDP 2014; UBOS et al. 2020). In the past, delivery of public services to the communities and other development initiatives have been derailed by the occasional occurrence of insecurity resulting from cattle raids. However, with relatively prevailing peace in the district and in the region these days, more households have settled in communal villages known as "manyatta". For the last decade, this has stimulated an increased involvement of the households in crop cultivation alongside transhumance livestock keeping (Cullis 2018).

In agricultural production, the participation of women and children is more pronounced than men. They are involved in the planting, weeding, and harvesting more than men who mostly carry out land clearing. Traditionally, women are also the caretakers of children and all domestic affairs in the home including brewing, collecting firewood, and building houses, yet they are excluded from control of production assets such as land. The lack of control on the use of and access to the land has hampered the implementation of sustainable land management technologies that require physical construction because men maintain the ultimate control over what is put on their land.

The high annual human population growth rate of 4.6% compared to the national average of 3% amidst the limited available livelihoods options has further increased the pressure on the various land resources leading to land degradation (UBOS 2016). This includes poor land management practices such as overgrazing of rangelands because of the high livestock populations and seasonal grazing regimes. These regimes concentrate many animals in fewer places with good pastures and water, loosening the soils and exposing the land to erosion by water or wind. Other practices, such as communal land tenure systems, indiscriminate cutting of trees for wood fuel, fencing of villages, conversion of rangelands and wetlands for crop cultivation (Nakalembe 2018), mining, and mono-cropping have also intensified soil erosion. These have contributed to the continuous decline in farmers' agricultural yields and incomes in the district (Kagan et al. 2009; Karamage et al. 2017).

To reverse or minimize land degradation in the Nakapiripirit district, sustainable land management which entails the utilization of soil, water, and vegetative cover management measures is key. Schwilch et al. (2014) noted that the concept of sustainable land management is anchored on the fundamental principles of enhancing production, productivity, and the protection of natural resources. Liniger et al. (2011) defines sustainable land management (SLM) as "the adoption of land use systems that, through appropriate management practices, enables land users to maximise the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources" (p.19). SLM includes various technologies categorised under soil fertility and crop management, soil and water control and conservation measures and grazing and forest management (Cordingley et al. 2015). SLM technologies have been promoted amongst subsistence farmers by both governmental and non-governmental institutions. These include the district local government, NGOs, and central government institutions like the Office of the Prime Minister (OPM), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), and Ministry of Water and Environment (MWE). Despite the numerous efforts of these actors, the adoption of SLM amongst subsistence farmers remains generally low (DCA [DanchurchAid] 2010; GOU 2010; Cordingley et al. 2015; Kagoya et al. 2018). This study, therefore, contributes to existing literature as it will shed light on the factors influencing and hindering the adoption of SLM technologies in Nakapiripirit district. The study will conclude with recommendations for further advancement.

1.1 Purpose of the study

The overall aim of this study was to assess the factors influencing the adoption of SLM technologies among subsistence farmers in Nakapiripirit district in North-eastern Uganda. The specific objectives of the study were:

i). To identify SLM technologies that subsistence farmers are utilizing in Nakapiripirit district.

ii). To identify challenges to the adoption of SLM technologies among subsistence farmers in Nakapiripirit district despite the input of the district local government, Non-Governmental Organisations (NGOs) and other governmental institutions.

iii). To provide recommendations to the district local government, farmers, NGOs, and other governmental institutions for scaling up the adoption of SLM technologies in Nakapiripirit district.

1.2 Factors affecting the adoption of SLM technologies

Evidence from several studies suggests that the adoption of SLM technologies among subsistence farmers is generally affected by several factors (Banadda 2010; Cordingley et al. 2015). These either positively or negatively influence the adoption of these technologies. Banadda (2010) categorised these factors as economic and financial barriers, social and behavioural barriers, technological and knowledge management barriers, and institutional and policy barriers. However, Cordingley et al. (2015) argues that these factors are also ecological in nature and area specific amongst subsistence farmers.

Shiferaw et al. (1998); Holden and Shiferaw (2002); Banadda (2010) and Birungi and Hassan (2010) all noted that poverty is one of the major factors that affect the adoption of SLM technologies amongst subsistence farmers. This limits the capacity of the farmers to invest in various SLM technologies especially for those that need specialised farm inputs. Studies in western Kenya and Malawi showed that different wealth groups of farmers adopted various land management technologies based on their income levels with the very poor adopting the least (Cavanagh et al. 2017; Kansanga et al. 2021*b*). Limited livelihood alternatives, access to credit and financial resources, and poor condition of roads all contribute to poverty which affects technology adoption (Atube et al. 2021). In Ethiopia, Legesse et al. (2021) and Adimassu et al. (2016) found out that better income positively and significantly influenced the decision of small holder farmers to adopt SLM technologies. In addition to the farmer's individual economic capacity, the adoption of SLM technologies is constrained by many other economic and financial factors. Inadequate funding of public institutions dealing in SLM cripples the proper delivery of extension services to the farmers by extension workers (Bannada 2010; Atube et al. 2021). This is critical as extension workers need to continuously build the capacity of farmers for better adoption of SLM technologies. Farming experience (Atube et al. 2021), farmers' awareness (Bannada 2010; Barungi et al. 2013) and the knowledge and skills (Bannada 2010) among small-holder farmers affect the adoption of SLM technologies. Those with adequate experience, awareness of the benefits and costs, and better knowledge and skills adopt more SLM technologies. Moreover, Kansanga et al. (2021*a*) found that participatory farmer-to-farmer training improved the uptake of SLM technologies in Malawi. Most institutions promote SLM technologies without assessing the capacity of the farmers to adopt them. Apart from being labour demanding, Giger at al. (2018) noted that the high initial cost of some SLM technologies such as most soil and water conservation technologies is a barrier to adoption. Further, if the returns of a particular technology are long-term, its adoption is considerably affected especially where farmers have limited alternative livelihood opportunities (Atube et al. 2021).

Although Banadda (2010) noted that the low technical capacity of the extension workers affects the adoption of SLM technologies by farmers, he also argues that this may be due to the low investment in capacity building. Coupled with limited access to extension services, low awareness of SLM among various land users is the result that is observed in most developing countries. This affects the ability of farmers to make informed decisions on technology adoption and have a better understanding of how to integrate various SLM technologies for better yields and lower costs. Similarly, in Iran, Rezvanfar et al. (2009) concluded that adequate extension services are vital in increasing awareness and knowledge about the effects and consequences of various technologies among farmers for increased adoption.

Socio-cultural factors such as land tenure, gender, and participation in community organizations (social capital) among others determine the behaviour and attitudes of farmers in adopting various technologies. Birungi and Hassan (2010) found that land tenure and social capital increased the adoption of land management practices in Uganda. Farmers with better land tenure security invest more in SLM technologies than those with unstable land tenure and so is social capital. In addition, the adoption of SLM technologies is affected by gender in any community (Sanginga et al. 2007; Atube et al. 2021). Studies show that in north-western Ethiopia, northern and central Uganda, small scale farmers tended to adopt only certain types of SLM technologies based on the gender of the household head (Nigussie et al. 2017; Kagoya et al. 2018; Atube et al. 2021). Men tended to undertake more physical-labour demanding SLM technologies than women. Therefore, the decision on which technologies to adopt is anchored on the gender dynamics of the household (Mugonola et al. 2013; Esabu and Ngwenya (2019). Also, Banadda (2010) noted that the behaviour of pastoralists to resist livestock destocking and maintain larger family sizes increases pressure on various land resources. Similarly in Ethiopia, Legesse et al. (2021) found that livestock holding size and household size significantly influenced the adoption of sustainable management options amongst small-holder farmers. In addition, Alemu et al. (2020) revealed that household perception of land degradation (Saguye 2017)), farmland size, age group and gender controlled the willingness of small holder farmers to invest labour in sustainable land management. Although Gayfer et al. (2012) reported that the dependence on incentives negatively affects the adoption of SLM technologies in Karamoja sub-region, Tukahirwa (2002); Banadda (2010); Chemutai (2013), Adimassu et al. (2016); Kagoya et al (2018); Alemu et al. (2021) all found that better incentives are important drivers that positively influence adoption. Legesse et al. (2021) concluded that environmental factors such as the status of soil erosion hazard affect the choices of small-holders in adopting various sustainable management practices in Ethiopia. The higher the degree of land degradation, the more farmers adopt various SLM technologies. In Kenya, Mganga et al. (2015) found that farmers adopted simple SLM technologies in combination to mitigate recurrent drought. Much as SLM provides opportunities for combating land degradation and climate change effects, farmers are key stakeholders that are often inadequately consulted in technology promotion by various institutions. Hurni (1997) noted that the use of the multi-level stakeholder SLM approach fosters the adoption of technologies. It allows for the participation and inclusion of all stakeholders' needs in technology adoption with the proper understanding of the specific context of the farmers.

2. METHODS

2.1 Study area

This study was carried out in Nakapiripirit district in the southern part of Karamoja sub-region in the North-eastern part of Uganda. The total land area of the district is 2640.7 km^2 with a population density of 43 persons per square kilometre and average household size of 5.18 (UBOS 2020). Administratively, it is comprised of two counties, Chewkii and Chekwii east with nine sub-counties that include Nakapiripirit town council, Moruita, Kakomongole, Loregae, Namalu, Loreng, Kawach, Lemusui, and Tokora. The district has a unimodal rainfall pattern which averages 500-1200 mm per annum. The rainy period extends from late March to November with rainfall peaking in April and May with a short break in June (Uganda IPC [Integrated Food Security Phase Classification] technical working group 2015).

The district is divided into four livelihood zones that include the mountain slopes maize and cattle zone, mixed crop farming zone, central sorghum and livestock zone and the south-eastern maize and cattle zone (Uganda IPC technical working group 2015). For this study, three broad livelihood zones are considered (see Fig. 1). The central sorghum and livestock zone (Kakomongole and Loregae sub-counties), mixed crop farming zone ((Namalu, Kawach and Loreng sub-counties) and the south-eastern maize and cattle zone (Nakapiripirit town council, Tokora, Moruita and Lemusui sub-counties). The major crops grown in the district are sorghum and maize along with legumes like beans and vegetables. The important livestock kept are cattle, goats, and sheep.

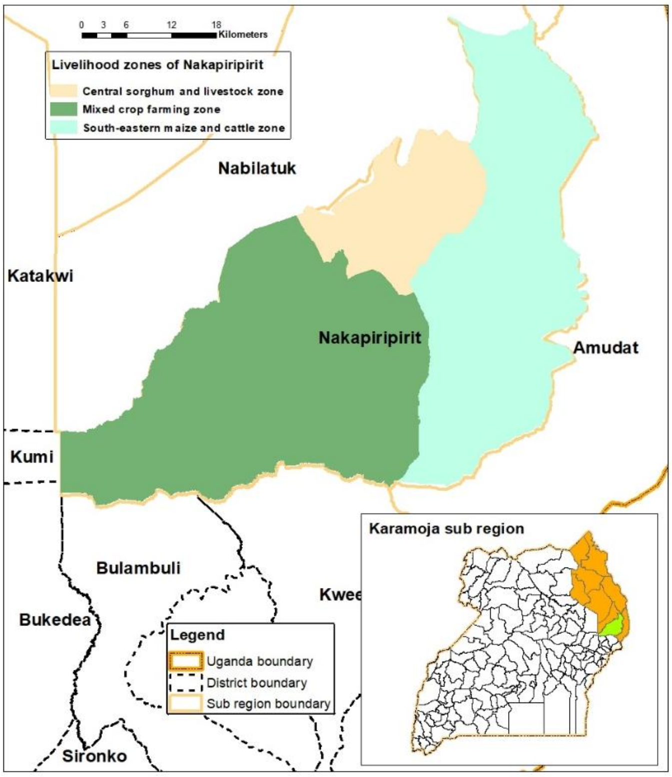

Figure 1. Map of the study area.

2.2 Study design

This study followed a qualitative approach to research where the focus was on interviewing individual participants using semi-structured interview guides (Merriam & Tisdell 2016). Taylor et al. (2016) noted that this approach entails getting written or spoken words and observable behaviour from the interviewees or participants themselves. Besides, the free expression and the desire to know and understand each interviewees' opinions, made this approach the preferred one as it facilitates the development of rich insights and drawing of meanings and conclusions from the data in the context of the study (Braun and Clarke 2013; Merriam & Tisdell 2016; Taylor et al. 2016).

The researcher instructed the supervisor of the interviews to prioritize getting informed consent from the interviewees in advance. In addition, the use of follow-up questions, proper English to local language translation of the interview questions and proper time management by the interviewers during the interviews were explained and emphasised. Three local language (Ngakarimojong) speaking research assistants (one woman and two men) with the ability to translate were hired. These were taken through the interview frames for data collection by the supervisor.

A total of twenty participants were purposively and conveniently sampled to participate in the study. The researcher engaged a supervisor, the head of Natural Resources Department at Nakapiripirit district local government to oversee the selection of interviewees, hiring and supervision of the research assistants during the data collection process. The head of Natural Resources Department was chosen because of his institutional job responsibilities, superiority, vast experience, knowledge, and skills in natural resources management. To ensure a proper understanding of the interview frames, the researcher guided the supervisor through the semi-structured individual farmer and key informant interview frames first. Official records from the Department of Production and Natural Resources in the district were used in selecting 15 subsistence farmers from different households. The selection of the interviewees was based on their location, gender, and knowledge and experience in SLM. They consisted of five subsistence farmers; 3 males and 2 females, selected from each of the three livelihood zones and within a radius of 40 km from Nakapiripirit town.

Marshall (1996) defines a key informant as "an expert source of information" (p. 92). Drawing from this understanding, five key informants were selected based on their expertise in SLM, job responsibilities, and area of work. This included two district-level heads of departments (Head of Natural Resources Department and Head of Production Department) and three agricultural officers selected from each livelihood zone. The agricultural officer of Loregae subcounty for the central sorghum and livestock zone, the agricultural officer of Namalu subcounty for the mixed crop farming zone and the agricultural officer of Moruita subcounty for the south-eastern maize and cattle zone.

Data collection was undertaken in the third week of July 2021. The interviewees were requested two days earlier by the supervisor for their consent to voluntarily spare time for the interviews with the research assistants on the adoption SLM technologies. In the field, the research assistants explained to the interviewees beforehand the purpose of the study and the need for the researcher to be able to verify their responses by having both written and audio recordings of the interviews. The aim of this was to put them at ease in responding to the interview questions (see Appendix I and II) and confirming their consent to participate in the study. All the interviewees confirmed their consent, and the key informants verbally agreed to have only their job titles appear in the study report. The questions in the individual farmer interview frame were translated back and forth from English into the local language, 'Ngakarimojong' for proper understanding. This was done for almost all the interviewees except in cases where the interviewee understood English. The key informant interview frame was used in interviewing the two selected heads of department and the agricultural officers. This was conducted in English. All the interviews during the data collection process were audio-recorded and all responses were written down by the research assistants in English.

2.3 Data analysis

After the interviews were conducted, the supervisor got both the written English interview notes and the audio recordings from the research assistants. The written interview notes were scanned and sent along with the interview audio recordings to the researcher. The audio recordings of the key informant interviews were all in English while all the audio recording recordings from the other interviewees (subsistence farmers) were in the local language. Thematic analysis (Braun and Clarke 2006) and content analysis (Schreier 2012) were used to analyse the data as per the set-out research study objectives. First, the audio recordings in the local language were listened to repeatedly and transcribed into English text. These were compared with the written English notes from the research assistants to ensure proper capture of all the individual interviewee responses. Initial ideas were identified, noted down and coded using Microsoft Excel. The various codes were then organized into themes based on the study objectives. The themes were then reviewed to check if they fall under the various set out study objectives before they were defined and named. The data was then examined for significant issues and to develop patterned meanings and conclusions as referred to in Braun and Clarke (2006).

3. FINDINGS

The themes presented here are SLM technologies practised by subsistence farmers, their promotion, adoption, and challenges experienced in Nakapiripirit district.

3.1 SLM technologies practiced by subsistence farmers in Nakapiripirit district

All the fifteen interviewed subsistence farmers in Nakapiripirit district mentioned that they mostly practice either one, two or all the three SLM technologies of crop rotation, intercropping, and farmyard manuring. They explain that these technologies give them higher yields and are much easier to implement than others (see Table 1).

> *I get higher yields now than before I started practicing crop rotation, intercropping and farmyard manuring. I used to get 2 sacks and 5 sacks of maize from 1 acre but nowadays, I get on average 4-5 sacks of beans and 11 sacks of maize. When I sell, I get enough money to do other things like paying for school fees and buying more livestock. Also, it is just easy to mobilize farmyard manure as it is readily available and that is why we need livestock too. I involve my children and sometimes I even get it from other peoples' livestock sheds without paying any money and take it to spread in my garden.*

However, the decision on what type(s) of SLM technology/ies to use depends on the type of livelihood zone. From Table 1, crop residue composting was most often used by interviewees from the central sorghum and livestock zone, followed by intercropping and crop rotation. This is also the area with the least variation. In the mixed crop farming zone, intercropping and crop rotation were the most used by the interviewees followed by farmyard manuring. Finally, in the south-eastern maize and cattle zone, crop rotation and farmyard manuring were the most used by the interviewees followed by intercropping. This zone also appears to have the highest number (11) of SLM technologies that are commonly practised in Nakapiripirit district. Also, farmyard manuring was used more by the interviewees from the mixed crop farming and south-eastern maize and cattle zones than in the central sorghum and livestock zone. In addition, terracing is only used in these two zones of the district. The District Production Officer of Nakapiripirit district local government explained that these two zones have special characteristics that may be contributing to the observed trends. First, all these two zones have mountainous slopes, and the subsistence farmers find it effective to use terraces for slowing down the speed of water and controlling the loss of fertile soils. This is not the case in the central sorghum and livestock zone with low altitude and flat terrain. These two zones have better climatic conditions and many NGOs that are promoting sustainable land management besides the district local government efforts.

Based on the use of SLM technologies by the interviewees, it is noted that intercropping, crop rotation and crop reside composting were the most practised (most 4s in Table 1) while vegetative strips, agroforestry, permanent planting basins and ripper tillage were the least used (most 0s in Table 1). However, agroforestry is only practised in the central sorghum and livestock zone while vegetative strips, permanent planting basins and ripper tillage are only practised in the south-eastern maize and cattle zone shown in Table 1 (note that the interviewees could state more than one technology).

Table 1. Practiced SLM technologies in Nakapiripirit district based on the interviews.

SLM technology	Responses		
	Central sorghum and livestock zone	**Mixed crop farming zone**	**South-eastern maize and cattle zone**
Crop residue composting	4	1	1
Intercropping	3	4	2
Crop rotation	3	4	3
Farmyard manuring	2	3	3
Fallowing	2	1	1
Assisted natural tree regeneration	1	1	0
Mulching	1	0	2
Terracing *(fanya juu and fanya chini)*	0	3	3
Zero tillage	0	2	1
Vegetative strips	0	0	2
Agroforestry	1	0	0
Permanent planting basins	0	0	1
Ripper tillage	0	0	1

3.2 Promotion of SLM in Nakapiripirit District

3.2.1 Institutions promoting SLM

Several institutions are involved in the promotion of SLM in Nakapiripirit district and carry out various roles. The Natural Resources Officer of Nakapiripirit district local government explained that the departments of production and natural resources under the Local Government Act are mandated to carry out the decentralised sustainable natural resources use and management roles of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and Ministry of Water and Environment (MWE) respectively. Therefore, sustainable land management directly falls under sustainable natural resources utilization and management. These two departments, through the extension officers at the subcounty level, are responsible for carrying out awareness-raising among natural resource users, regulating, coordinating, lobbying, and advocating for sustainable utilization of natural resources. They conduct planning, monitoring and evaluation of natural resource-based projects and continuously build the technical capacity of natural resource users, among others.

The District Production Officer of Nakapiripirit district local government explained that the NGOs complement the efforts of the government in extending agricultural extension services to subsistence farmers. In doing this, they collaborate with the two departments mentioned earlier on issues of sustainable land management. This collaboration entails facilitating and building the technical capacity of subsistence farmers in sustainable land management through awareness creation and training. These are either jointly organized and conducted at village, parish, subcounty and district levels with the district local government staff or directly carried out.

Most of the interviewees practicing SLM were trained by NGOs in the last five years. The trainings offered to them by NGOs covered all the stages of crop or livestock husbandry. This crop or livestock production chain training approach enables subsistence farmers to understand, participate and apply the knowledge and skills gained. This approach is further strengthened by the routine follow-up of the trained subsistence farmers to check progress, identify, and provide solutions to the challenges faced. One female interviewee stated that:

> *So many organizations have trained us on land management issues…. but I remember four years ago we were trained by ACTED (Agency for Technical Cooperation and Development) on crop rotation, harvesting produce and post-harvest handling of produce. We were trained as a group of farmers, and we keenly followed the advice from our trainers. This resulted in us getting bumper harvests in 2018 and that is when we realised that we did not have enough individual granaries to store our produce in our homes. So, we raised the need to our trainers for the NGO to find a solution for us. Oh God, fortunately, they constructed a permanent grain store that we are happily using up to now.*

However, the use of the single crop or livestock production stage focused training approach by the district local government can hinder the adoption of SLM. Linking and integrating SLM into the other stages of the production chain is a challenge to some subsistence farmers. This is because the trainings, demonstrations, and visits by extension workers are scarcely organized on various topics and irregularly conducted based on the quarterly receipt of resources. Few technical extension staff are available to provide agricultural extension services at both district and subcounty levels compared to the population of subsistence farmers. In addition, the meagre financing limits the adequate follow-up of the trained subsistence farmers by the extension officers.

> *I want to admit that our training approach is highly dependent on the availability of funds that are released by the government after every three months. The funds are meagre, and most times are released late. This makes us the extension workers to focus and prioritize on training subsistence farmers on specific stages of the production chain of various crop or livestock enterprises within a short time. This affects the smooth connection of knowledge and skills from one stage to the next one by farmers.*

3.2.2 SLM technologies promoted

Agroforestry is the most promoted SLM technology by both the NGOs and the district local government. In the area there is a high rate of vegetative tree cover loss because of the indiscriminate cutting of trees for commercial charcoal production and other uses.

> *We promote agroforestry so much in the district, not only us but also NGOs help in the promotion of Agroforestry. We do this specially to discourage people from cutting down trees mostly in times of crop failure due to prolonged drought. Some do not have any livelihood options and so run to charcoal production for daily survival.*

Yet from Table 1, it was observed earlier that this is not one of the technologies most of the farmers use. The promotion of agroforestry is seen as the best way to mitigate climate change effects while simultaneously addressing the short-term household needs through integrating tree planting alongside crop cultivation. This approach is also intended to provide alternative sources of both food and income to the households through the planting of fruit trees. The fruits can either be eaten or sold for income by the household hence decrease the pressure on vegetative tree cover. The interviewees appreciate the practise of agroforestry but majorly blame its low adoption on the late delivery of tree seedlings by the various institutions. Due to this, there is delayed establishment of the tree seedlings which predisposes them to harsh climatic conditions of prolonged drought or floods**.** The traditional grazing system in the area where all land belongs to everyone after the crop cultivation season allows livestock to trample and destroy planted trees. In the dry season, this is worsened by the uncontrolled, extensive, and indiscriminate burning of grass lands. In addition, the benefits from agroforestry take a long period to be reaped by subsistence farmers, and yet many want quick returns from any crop or livestock venture. All these factors demoralise the interviewees as most of the planted trees do not establish.

> *I have been planting mango and orange trees supplied by the government in my gardens but only a handful have established. In fact, I have only 17 now in my gardens. The problem is that these seedlings are delivered late in the season around June or July. This makes it difficult for them to establish well before the dry season. In 2017, I received about 60 seedlings and planted them. Unfortunately, only two survived. Most of them dried up due to prolonged drought that year.*

The NGOs and the district local government are aware of the short-term needs of the households and therefore also assist by integrating and training subsistence farmers in crop rotation, intercropping, crop residue composting, mulching, zero tillage, and terracing, among other interventions. Crop rotation, intercropping and crop residue composting technologies require less labour and money to carry out and the materials for composting are readily and locally available with the subsistence farmers. Zero tillage and mulching enable subsistence farmers to avoid weeding costs. Although very laborious, terracing is effective in slowing down the speed of water and the loss of fertile soils on cultivated mountainous slopes. Other SLM technologies like permanent planting basins, rangelands reseeding, assisted natural tree regeneration, afforestation and rainwater harvesting are also promoted. This was highlighted by the District Production Officer of Nakapiripirit district local government:

> *We also train and sensitize farmers on the use of terraces and other soil and water conservation structures like contour basins. There is also mulching, zero tillage in some other areas, and cover cropping. In hilly areas, we have also been advising farmers to at least have contour terraces to reduce run off which eventually deteriorates their land.*

More SLM technologies are promoted in the mixed crop farming and the south-eastern maize and cattle zones of the district than in the central sorghum and livestock zone. The Agricultural officer of Loregae Subcounty noted that:

> *In the central sorghum and livestock zone, SLM is a generally new concept that needs a lot of input from both the promoters and the farmers. A lot of trainings and demonstrations need to be conducted to show farmers the benefits otherwise the*

> *adoption will remain low. As of now meagre funds are channelled to facilitate trainings of SLM and farmers look at it as not being useful to them. We depend almost entirely on the seasonal releases of government funds for promoting SLM. And we have very few NGOs operating and promoting SLM in this area.*

From this quote, it appears that this zone lags the most in sustainable land management, and that ground-breaking efforts from all stakeholders are needed for increased adoption of SLM technologies. There is potential for increased adoption though it appears to be time consuming and in need of a lot of manpower.

3.3 Adoption of SLM technologies in Nakapiripirit District

3.3.1 Subsistence farmers who have adopted one SLM technology

Intercropping is the most adopted SLM technology amongst subsistence farmers who have adopted one SLM technology as it appears to be a hunger coping strategy. They explained that intercropping requires less labour and money and creates better yields. The shorter maturing crop that is used in the intercrop rescues the household from hunger before the main crop is harvested.

> *I always practice intercropping in my garden because for me it gives me better yields. I do not have to hire many people in my garden as I can do the work both in the morning and evening with my wife and children. We harvest beans in early July before maize in August and this helps us to survive in the family.*

In addition, intercropping is influenced by the land size holding of an individual subsistence farmer. Subsistence farmers with more land may practise intercropping in smaller portions of land or not at all compared to those with only 0-5 acres of land. The subsistence farmers interviewed described this as a trend. Those with smaller pieces of land tend to practice intercropping because they do not have enough land. Intercropping allows them to cultivate most of their crops in the smaller pieces of land owned. Besides this, they have experienced several setbacks. Climate change effects, inadequate knowledge and skills and traditional gender roles are the key challenges faced by this category of subsistence farmers.

> *In some years, our produce is greatly spoilt by too much rainfall and flooding. Most often we have a prolonged dry spell mid-season and prolonged drought at the end of the season, so this affects us a lot. Sometimes, you may have to replant the whole garden two or three times because of prolonged drought.*

Inadequate knowledge and skills in SLM are aggravated by the limited provision of agricultural advisory services to subsistence farmers. Few subsistence farmers can easily access organized trainings on sustainable land management. Women farmers specifically have limited access to trainings organized especially in the central sorghum and livestock zone as was noted by one female interviewee:

> *We find difficulty in accessing trainings on SLM. Most times when trainings are called for, the number of men triples that of women. Yet the men do not pass on the learned knowledge and skills to their wives because they keep on moving from one wife's home to another with excuses. At least if a few of us could be trained alone such that we can also spread out the knowledge to our fellow women.*

Most of the subsistence farmers that have adopted only one SLM technology are stuck in the traditionally determined gender roles that stipulate what men and women can do. Traditionally, most operations in crop cultivation and any associated activities are basically a woman's domain. This may be the reason why most of the subsistence farmers are inactive in implementing SLM technologies as underscored by one elderly farmer:

> *Some lazy individuals that have the perception of, 'let others plant, we shall share'. This is greatly affecting farmers because lazy individuals do not want to work. They can even kill you, the owner of the garden, when you try to arrest them in your garden, whether at night or daytime. This mentality will surely bury us the Karimojong. We need to copy from other tribes that have come here … they work hard and are getting money from agriculture as we are looking on.*

3.3.2 Subsistence farmers who have adopted more than one SLM technology

When looking at subsistence farmers that have adopted multiple SLM technologies, there is an improvement in subsistence farmers' attitude, integrated knowledge, skills, and growing confidence in implementing various SLM technologies compared to those who have adopted only one SLM technology. Improved yields realised and the knowledge of integrating the various technologies are appreciated by this category of subsistence farmers. They explained that costs are considerably reduced in the long term and patience is a very important aspect anyone should have in implementing SLM.

> *In my land, I practice crop rotation, intercropping, farmyard manuring and a bit of Agroforestry. I get the manure from the kraal here at home. The children help me with that and take it to spread in the gardens. But I have realised over time that these technologies have improved my yields so much. The cow dung that people see as rubbish, I see it as food for the soil that feeds my crops and I eat the crops.*

Further, the high cost of implementing SLM technologies, limited access to oxen/tractors for timely land opening and the traditional livestock husbandry practices are the most important challenges affecting these subsistence farmers. Most of them expressed the belief that SLM is highly costly in terms of purchasing the required inputs needed such as tools and the amount of time spent in implementing the various SLM technologies. As noted by one farmer:

> *Enough money is needed buy inputs like seeds, fertilizers, specialised tools and for paying labourers to be able to adequately carry out these technologies especially if you want on large scale, otherwise, you cannot. Locally, we call it financial muscle.*

The agricultural officer of Loregae subcounty also noted that "*farmers fear the initial costs involved in SLM and most times neglect practicing the technology after initiating it, that is why they say it expensive"*. From these quotes, it is clear that Subsistence farmers fear to invest in SLM as they are not guaranteed of its benefits in the short run compared to the costs incurred.

Most of the interviewed subsistence farmers have more than 5 acres of land. This means timely cultivation is of great value for them to not only fit within the shorter rainfall period in the area but also have adequate time for other farm operations. They explained that oxen and tractor services in the area are limited when compared to the demand from farmers. This makes them take much time in land opening which affects the succeeding operations as the rains become heavier making the soils almost non-workable as they stick so much on any garden tools used.

> *Most times we wait too long before we can hire oxen or tractors to plough our gardens. Though some farmers have oxen, they are not enough to help them open land as first as possible. As others plough in early much, we plant at the end of April or early May when the first rains are at the peak. So, any farmer who would not think of first digging trenches in the garden or applying farmyard manure because if he does not plant by the end of May, he may almost look forward to famine.*

Indiscriminate burning of bushes and overstocking are traditional practices that hinder subsistence farmers in practicing sustainable land management. At the end of the cultivation season, all land belongs to the community and can freely be used for grazing by livestock. Apart from trampling and destroying planting trees, the herders also indiscriminately set bush fires that destroy vegetative strips and other vegetation exposing it to soil erosion agents. It is noted that these practices suppress the morale of subsistence farmers in practising especially agroforestry as they see it as a waste of effort.

3.3.3 District local government and Non-Governmental Organizations (NGOs)

In the promotion of SLM in the district, it is observed that a mix of the project and cost-sharing extension approaches used by the NGOs appears to work better than those used by other entities. Subsistence farmers are motivated to adopt the various SLM technologies promoted because NGOs provide better incentives, unlike the local government or other entities. This is coupled with intensive training, routine monitoring, and follow-up of the selected subsistence farmers from the initial planning stage up to the marketing of the produce. The subsistence farmers interviewed explained that although the NGO-funded projects exist for only a short period and serve in most cases a few selected beneficiaries, they benefit a lot more than from the district local government extension system that offers a few or no incentives at all. The agricultural officer of Moruita subcounty stated that subsistence farmers are generally more willing to adopt a technology if there are incentives attached to it.

> *It is difficult for us to call farmers for training without training allowance for them. We try to provide refreshments during the training sessions but some farmers lament that this is not enough and at the end of the training leave with negative feelings of having wasted time. This affects the tendency of the farmers to carry out what they have been trained on.*

From this quote by the Agricultural officer of Loregae subcounty, it appears that the promotion of SLM and its adoption are affected by incentives. Therefore, without incentives, the adoption of SLM amongst subsistence farmers is hindered.

Most key informants recognize that there is generally a low degree of adoption of SLM technologies amongst subsistence farmers in the district. However, a few also noted that there are differences in the adoption of SLM technologies across the various livelihood zones due to several factors. For instance, the agricultural officer of Namalu subcounty suggested that subsistence farmers in the mixed crop farming zone are adopting SLM technologies at a faster pace than in other zones.

> *There is an increase in the adoption of SLM technologies by many farmers in my area of work. I think that the number of farmers that are practising various SLM technologies here is more than in other areas.*

This may be because some of the subsistence farmers that have adopted the SLM technologies in the mixed crop farming zone realised better yields from their land. Much in accordance with the farmer at the beginning of the findings section explaining that there was now even money left for education. Moreover, the optimistic farmers also talked of the improving attitude in the communities in embracing agriculture, favourably higher annual rainfall amount, fertile soils, high literacy rates, better accessibility to agro-inputs, land tillage services and better markets for their produce. It is important to note that this zone is observed to have the highest number of NGOs promoting SLM in the district and with the efforts of other stakeholders like the district local government, this may have contributed to the respective difference in the adoption.

Nevertheless, not all farmers are optimistic. Besides the high dependency on incentives described earlier, the traditional way of thinking and doing things instils the belief that SLM technologies are tedious and expensive in nature as they assume that they all require farm inputs. Inadequate funds for wide-scale and continuous implementation along with inadequate technical staff capacity are indispensable factors that hinder the promotion of sustainable land management by various institutions and the adoption of these technologies by subsistence farmers. The district production officer of Nakapiripirit local government stressed that:

> *One of the challenges is the poor mindset of the communities, they believe it is labour intensive and they still have that traditional way of farming that does not march with the current situation. Laziness and alcoholism have become the order of the day for some households as the men do not have much to do in the gardens. Women are left to perform most of the field operations as men take local brew. We also have the low technical capacity in SLM, we do not have highly trained staff on SLM, sometimes we rely on other experts coming from outside the district and of course I cannot forget the meagre funding channelled specifically to handle SLM issues.*

3.4 Proposed measures to address the challenges in the adoption of SLM technologies

A multitude of measures were suggested by the interviewees to address the challenges for improved adoption of sustainable land management technologies in Nakapiripirit district. Most importantly, the interviewees recommend increased efforts on strengthening the capacity of subsistence farmers in SLM. They believe that having frequent and regular intense trainings will not only strengthen the capacity of subsistence farmers but also facilitate the extension workers to save and have adequate time in delivering the knowledge and skills to them in a step-by-step process. Subsistence farmers can easily connect and integrate the various SLM technologies learned into the various crop or livestock production stages. Additionally, creating awareness on SLM and tailoring trainings to change the traditional behaviour and thinking of the subsistence farmers is vital. Many of the key informants interviewed agree with this suggestion, strengthening the technical capacity of the extension workers in SLM and recruiting more is also vital for scaling up its adoption.

> *According to my thinking, I feel that many farmers need to be continuously trained on issues of land management. Anyone forgets if trained only once in a year. This is exactly what is happening in the government system. Personally, I have been*

> *trained only 2 times this year and on different things. With regular trainings people will be able to adopt easily.*

One experienced subsistence farmer emphasised the need for fellow farmers to be trained on changing their behaviour and thinking. He believes this would create a positive shift in their tradition behaviour and practice of thinking and doing things. According to him, some of the subsistence farmers are excessively involved in charcoal burning, and some also abuse alcohol. This is derailing many efforts aimed at improving their livelihoods:

> *Besides the intensive training of farmers in SLM, local brew is one thing that is destroying farmers. It delays people and makes them lazy. Imagine someone goes to the garden and even first leaves his garden hoe there to go and look out for local brew first. Remains there and even forgets that he was working. There is frankly a great need for farmers to be trained on changing their behaviours and thinking or on how to stop or minimize alcoholism, if possible, otherwise, agriculture is doomed.*

There is also a need to improve access and timely delivery of agricultural farm inputs such as seeds, tree seedlings and equipment to subsistence farmers. The interviewees explained that much time is lost in looking and waiting for supply of farm inputs and therefore want farm inputs to be delivered early in the season. This can further be enhanced by the engagement of business operators to avail the farm inputs and equipment like tractors for timely land opening.

Furthermore, the establishment of coordination and dialoguing platforms where subsistence farmers and the various institutions can learn, and exchange ideas can foster the increased adoption of SLM technologies. One of the interviewees voiced the need for farmers to work in groups for easy delivery and access to agricultural advisory services that would lead to better adoption of SLM technologies:

> *As farmers, I am sure that we need to establish a district farmers association that is formally recognised by the district. Such that when any partner like NGOs come, it is easy for them to access farmers and deliver the needed services. We will also be able to give them our challenges as a group not as scattered individuals. Farmers will gain knowledge as they will be motivated by each other, and adoption of better land management practises will improve in the long run.*

Additionally, increasing the allocation and timely release of funds for promoting SLM at subcounty and district levels is vital. The key informants believe that this can foster the increased adoption of SLM amongst subsistence farmers. They explain that SLM is not prioritized in terms of funding amidst the many other competing needs. Meagre funds are allocated for promoting SLM and most times are released late than planned causing delays. Changing this trend would foster an improvement in the delivery of extension services and adoption of sustainable land management by subsistence farmers.

Finally, the interviewees pointed out that there is a need to encourage subsistence farmers to embrace co-financing arrangements on farm inputs supply. This kind of arrangement may involve the engagement of the private sector business operators in supplying the farm inputs to subsistence farmers on a co-shared basis. Some of the interviewees explained that they prefer this kind of approach compared to the one used by the district local government. This is because they receive farm inputs in time and there is ownership and responsibility from the farmers to ensure they get good returns. Other measures proposed were livestock population regulation and movement control, fencing of gardens in the dry season, and income diversification.

4. DISCUSSION

The study objective was to assess the factors influencing the adoption of SLM technologies among subsistence farmers in Nakapiripirit district in North-eastern Uganda, based on interviews with fifteen subsistence farmers and five key informants who agreed to participate in the study.

There are differences in the adoption of SLM technologies in the three livelihood zones. More SLM technologies are adopted in the mixed crop farming and the southern-eastern maize and cattle zones than in the central sorghum and livestock zone. This is because subsistence farmers in these zones have more income, better access to agricultural advisory services from both NGOs and government institutions, and access to farm inputs and equipment. They have a more positive attitude towards SLM coupled with more favourable climatic conditions.

Differences exist in the adoption of SLM technologies amongst subsistence farmers. Therefore, subsistence farmers were categorised into those who have adopted one SLM technology and those with more than one. It is observed that differences exist in the challenges faced by these two categories. Climate change effects (prolonged drought and floods), inadequate knowledge and skills, and traditional genders roles are the major challenges faced by those who have adopted only one SLM technology. Conversely, the high cost of implementing SLM technologies, limited access to extension services, agro-farm inputs, and equipment such as oxen/tractors for land opening, and traditional practices and thinking are the most important challenges to those who have adopted more than one SLM technology. In addition, the differences in the challenges may stem from the approach used in promoting SLM technologies. NGOs majorly focus on progressing farmers who in most cases are those who have adopted more than one SLM technology. This is because of the need to show results within the lifespan of any project which in most cases is short. At institutional level, the high dependency on incentives by subsistence farmers, inadequate funding and inadequate technical staff capacity are the key challenges faced by the various governmental and non-governmental institutions in promoting SLM in the district.

In response to the challenges experienced, subsistence farmers who have adopted one SLM technology prioritized the strengthening of their knowledge and skills capacity to implement various SLM technologies. The inadequate knowledge and skills on SLM by subsistence farmers and the agricultural extension staff as revealed by various studies (Resvanfar et al. 2009; Banadda 2010; Atube et al. 2021) affects the adoption of SLM technologies, which was also visible in this study. Besides having few and irregular trainings, there is low technical capacity amongst the few extension staff in the district to properly execute these trainings. Meagre funds are channelled by the government to facilitate the extension staff in implementing SLM technologies. Hence, few subsistence farmers are reached and there is low awareness and bias towards SLM technologies. Due to low awareness, many subsistence farmers still depend on unsustainable land management practices like indiscriminate cutting of trees for commercial charcoal production for survival, especially in times of crop failure. Therefore, to scale up the adoption of these technologies, the first concern must be to strengthen the technical capacity of the extension staff and recruit more for better delivery and accessibility of agricultural advisory services by subsistence farmers. This is consistent with various studies (Resvanfar et al. 2009; Banadda 2010; Atube et al. 2021).

Following that, capacity strengthening is needed for subsistence farmers through conducting regular trainings on SLM and other social issues like unsustainable traditional practices and behaviour. The trainings should be systematically structured and delivered to suit the socio-economic context of the various categories of subsistence farmers and the production cycles of the various enterprises that they are engaged in. This would allow farmers enough time to fully understand how to carry out the various technologies at different production stages of their various enterprises. Also, it would enable them to understand how to integrate the various technologies to minimize labour or financial costs. As reported by Banadda (2010), better knowledge and skills on SLM technologies increases adoption. Moreover, the participatory farmer-to-farmer training approach was noted by Kansanga et al. (2021) to improve the adoption of SLM technologies.

As part of capacity strengthening, increasing efforts to raise awareness among subsistence farmers on SLM is key to breaking unsustainable traditional practices, norms, and way of thinking. Various fora can be used to create awareness like radio talk shows, traditional community gatherings and celebrations. Access to the right information on SLM will empower the subsistence farmers to make the right investment decisions on their land. This is in agreement with Banadda (2010) and Barungi et al (2013) who all noted that awareness of farmers increases the adoption of SLM technologies. This will also enable them to actively participate in individual or community initiated SLM initiatives hence increased adoption of SLM technologies. Similarly, Birungi and Hassan (2010) in their study noted that social capital increased the adoption of SLM technologies.

In addition, trainings must be tailored in such a way that they promote the active participation of women in SLM despite the existing biased traditional gender roles. The active involvement of women is important as they are the ones that most undertake most of the farm operations. Their involvement can be enhanced by targeted mobilisation, selection, and setting training times that favour their active involvement such that at least 40% of the participants are women.

Most importantly, increased, and timely financing of the agricultural extension services delivery system is key. Inadequate funds affect the wide-scale and continuous promotion of SLM technologies by government and non-governmental institutions. Therefore, increasing funds allocation for SLM will facilitate the extension officers at parish, subcounty and district levels to adequately provide extensive capacity strengthening trainings, follow-up of trained subsistence farmers, and feedback generation. More trainings, awareness creation campaigns, and SLM-based demonstrations can be set up. These will facilitate the increased adoption of SLM technologies by subsistence farmers. This agrees with similar studies that noted that increasing financial support to both state and non-state actors for the promotion of SLM is vital in advancing its adoption (Banadda 2010; Atube et al. 2021).

Encouraging subsistence farmers who have adopted one SLM technology to adopt a combination of simple SLM technologies through increased efforts on training, sensitizing, and creating awareness is another strategy for SLM promotion. The cumulative effect of many combined SLM technologies can minimize the disastrous effects of climate change that are evidenced by erratic rainfall, prolonged dry spells, and flush floods. This is in line with Mango et al. (2015) who noted that the use of a combination of various SLM technologies mitigated the devastative effects of repetitive drought amongst small holder farmers in Kenya.

Timely provision and access of incentives by subsistence farmers in the form of farm inputs and equipment boosts the adoption of SLM technologies. According to the findings, subsistence farmers with more than one technology need majorly tractors or at least oxen-ploughs for timely opening of large acreages of land, timely supply, and improved access to other farm inputs like seeds. Procuring more tractors or oxen for farmer groups will facilitate early land opening in the season for timely planting. Therefore, the timely access and delivery of farm inputs to subsistence farmers by various organisations is vital. These will motivate farmers and allow ample time to implement the various SLM technologies. This opinion is supported by similar studies that revealed that better incentives are important in influencing the adoption of SLM technologies amongst farmers (Tukahirwa 2002; Banadda 2010; Chemutai 2013; Adimassu et al. 2016; Kagoya et al. 2018; Alemu et al. 2021).

Finally, it is crucial to establish or strengthen the existing multi-stakeholder platforms at sub-county and district levels. These bring together various stakeholders to harmonize interests and to facilitate learning through knowledge and experience sharing. For instance, establishing a district farmers association or other multi-stakeholder platforms can foster the adoption of SLM technologies through farmer to farmer-based sharing and learning. This conforms with Atube et al. (2021) who reported that farmers with more farming experience, in turn, adopted more SLM technologies. In addition, these platforms facilitate easy mobilization of stakeholders, timely access to information on SLM and foster active individual and community participation in SLM. These lead to increased awareness creation and therefore improved adoption in SLM technologies as reported in various studies (Bannada 2010; Barungi et al. 2013). Further, the inclusion of all stakeholders especially women in these platforms as was noted by Hurni (1997) fosters participation and improved adoption of SLM technologies.

As with all studies, this one is not without its limitations. It is essential to note that the major limitation of this kind of research approach is that the results can only be applied in the context of Nakapiripirit district while at the same time it provides the opportunity to provide tailor-made recommendations for this specific area only. Additionally, the data used in the study was collected from Uganda, yet the researcher was in Iceland. This may in some cases have affected the depth of the data collected as recognized from the interview audio recordings. There were limited follow-up questions on certain aspects mentioned by the interviewees. Some interviewees may have had more information about the subject but were either interrupted or immediately asked the next question during the data collection process. The translation of the interview frame questions back and forth from English to the local language slowed down the interviews and could have contributed to distortion in the flow of responses from the interviewees. Therefore, the study results must be taken and applied with caution.

5. CONCLUSIONS AND RECOMMENDATIONS

The benefits of SLM such as improved agricultural harvests, incomes, and attitudes of subsistence farmers as revealed by the study are vital in minimizing the effects of land degradation and climate change. Broadly, the adoption of SLM technologies amongst subsistence farmers in Nakapiripirit district is low. However, there is potential for the enhanced adoption of these technologies amidst the existing identified challenges. The challenges are varied depending on the livelihood zone and the number of technologies adopted by subsistence farmers**.** Most notably, the labour demand of the technology, access and cost of farm inputs and equipment, knowledge and skills capacity of the farmers, traditional practice and thinking and the adaptability of a technology to the local climate influence the adoption of SLM technologies**.** In addition, institutional factors such as inadequate technical staff capacity and funding limit the promotion of these technologies. Therefore, governmental, and non-governmental institutions need to promote climate resilient, less labour and financially demanding SLM technologies. To do this, all stakeholder-inclusive and farmer-centred training approaches with complete understanding of the local socio-economic factors should always be considered and employed by the various institutions for increased adoption.

Based on the study, the following are recommended for the increased adoption of SLM technologies amongst subsistence farmers in Nakapiripirit district. These recommendations take in account the differences in the challenges faced by the various categories of subsistence farmers and the different levels of adoption in the various livelihood zones.

a) The district local government, NGOs and other government institutions are encouraged to increase their efforts on strengthening the knowledge and skills capacity of subsistence farmers and extension staff on SLM. Organized trainings, sensitization, and awareness creation campaigns should prioritize on changing the passive traditional practices and way of thinking by subsistence farmers.
b) Mainstream SLM and gender by prioritizing and integrating SLM and gender priorities into parish or subcounty and district development plans by the district local government, farmers, and NGOs.
c) The district local government, farmers, NGOs, and other government institutions are encouraged to establish or further strengthen the existing multi-stakeholder platforms at district and sub-county levels for better learning and exchange of knowledge, skills, and experiences on SLM by the various stakeholders.
d) Encourage farmers with the technical guidance of the district local government staff to establish a district farmers association for improved coordination, farmer needs identification, collective marketing, accessibility and systematic transfer of knowledge and skills.
e) If the government manages to increase the allocation of funds for undertaking SLM initiatives and recruitment of more extension staff, this will most likely lead to the improved delivery of agricultural advisory services to farmers in the district.

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APPENDICES

APPENDIX I: FARMER INTERVIEW FRAME

Dear Interviewee, I am **Andrew Evans Opiolo**, a 2021 fellow of the Land Restoration Training Programme (GRÓ LRT) based in Iceland. As part of the programme, I am carrying out a research study entitled "**Factors influencing the adoption of Sustainable Land Management (SLM) technologies among subsistence farmers in Nakapiripirit district, Uganda**". This is purposely aimed at identifying and understanding the challenges faced by subsistence farmers and suggesting feasible recommendations to the district local government, farmers, NGOs, and other governmental organizations for increased adoption of SLM technologies in Nakapiripirit district.

You have been identified as an important stakeholder in Sustainable Land Management in the district. Therefore, I humbly request you to cooperate and provide your beneficial contribution to this research study. If it is ok with you, I will be asking you some questions. I want to emphasise that there are no right or wrong answers to this because it is all about your experiences. I will need to record the interview so that Andrew back in Iceland can analyse the data and listen to what you have to say. I hope that you will be okay with that.

Section A: Introduction

i). Briefly tell me about your understanding and experience in Sustainable Land Management (SLM)

Section B: Land management practices

i). What kind of land management practices (crop rotation, mulching, manuring, fallowing, tree planting, minimum tillage, terracing, gully control, vegetative strips, sustainable grazing management, etc) do you use in your household?

ii). Do you remember when Land management technologies were introduced to you or in this area?

iii). Of the ones that you have mentioned in (i) above (interviewer should state out the ones mentioned earlier by the interviewee), which ones have you always been carrying out and why?

iv). How do you decide which Land management technologies to use?

v). What skills do farmers need to be able to adequately implement SLM technologies?

Section C: Challenges to the adoption of Sustainable Land Management (SLM) technologies

i). What kind of challenges or barriers do you face in adopting Sustainable Land Management (SLM) technologies?

ii). In which ways have you personally tried to solve some of the challenges that you have mentioned?

iii). Whom do you approach in case you have a challenge in adopting a specific Sustainable Land Management (SLM) technology?

iv). Which other challenges do you think other farmers facing that you have not mentioned?

Section D: Possible measures to address the challenges in the adoption of Sustainable Land Management (SLM) technologies

i). In what ways do you think that the challenges can be addressed?
ii). Do you think that adopting SLM technologies can change the farm/household? And if so, how?
iii). If you were to make a wish for something that could improve your work/farm/production/life, what would that wish be?

Thank you so much for your precious time.

APPENDIX II: KEY INFORMANT INTERVIEW FRAME

Dear Interviewee, I am **Andrew Evans Opiolo**, a 2021 fellow of the Land Restoration Training Programme (GRÓ LRT) in Iceland. As part of the programme, I am carrying out a research study entitled "**Factors influencing the adoption of Sustainable Land Management (SLM) technologies among subsistence farmers in Nakapiripirit district, Uganda**". This is purposely aimed at identifying and understanding the challenges faced by subsistence farmers and suggesting feasible recommendations to the district local government, farmers, NGOs, and other governmental organizations for increased adoption of SLM technologies in Nakapiripirit district.

You have been identified as a key informant in SLM in the district. Therefore, I humbly request you to cooperate and provide your beneficial contribution to this study. If it is ok with you, I will be asking you some questions. I want to emphasise that there are no right or wrong answers to this because it is all about your experiences. I will need to record the interview so that Andrew back in Iceland can analyse the data and listen to what you have to say. I hope that you will be okay with that.

Section A: Introduction

i). Briefly tell me about your understanding and technical experience in Sustainable Land Management

Section B: Promotion of Sustainable Land Management (SLM) technologies

i). How does your sector/department promote sustainable land management amongst subsistence farmers in your area of operation?
ii). Which sustainable land management technologies have been promoted in your area of work by either the district local government or any other non-governmental organization?
iii). What role do you exactly play in sustainable land management in the area/Subcounty/district?

Section C: Challenges to the adoption of Sustainable Land Management (SLM) technologies

i). In terms of SLM, what do you think has been going on well?
ii). What kind of challenges or barriers do subsistence farmers face in adopting Sustainable Land Management (SLM) technologies in your area/Subcounty/ district?
iii). What kind of challenges or barriers does your sector/department face in promoting the adoption of Sustainable Land Management (SLM) technologies in the area/Subcounty/district?
iv). Which other challenges than the ones mentioned above, do you think Non-Governmental Organizations (NGOs) in your area encounter as they promote the adoption of Sustainable Land Management (SLM) technologies?

Section D: Possible measures to address the challenges in the adoption of Sustainable Land Management (SLM) technologies

i). In what ways do you think that the challenges can be addressed by your sector/ department in the area to ensure increased adoption of SLM technologies amongst subsistence farmers?

ii). As an institution/individual, what are your plans (in 5 years period) for increasing the adoption of SLM in the area/Subcounty/district?

iii). If everything were possible and you could make one change, what would it be and why?

Thank you so much for your precious time.