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Original Article

Smallholder Farmers' Coping Strategies to Perceived Climate Change and Variability in Isingiro District, South Western Uganda

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ABSTRACT

Climate change and variability pose a major challenge facing the agricultural sector around the world and trends are feared to intensify by 2050. This is likely to complicate agricultural decisions affecting local communities who depend on the sector for their livelihood. Seasonal changes in weather patterns are projected to reduce food production due to the reduction in average yields of common food crops. With the majority of smallholder farmers in Uganda depending on agriculture for survival, building their adaptive capacity to climate change is vital to ensure household food and income security. This study aimed at establishing the smallholder farmers' perceptions of climate change and their initiatives to cope with and manage the associated risks. A sample of 126 farming households were randomly selected from three Sub counties in Isingiro District and studied using field observations and questionnaires. Key informant interviews were also conducted with three extension workers. The collected data was analysed using Stata 14 and Excel. The findings revealed that there was increasing awareness of the climate change and variability challenge among smallholder farmers with the increasing need to take on adaptation strategies. The results showed that the major perceived changes were, increased intensity and frequency of droughts (98%), increase in daytime temperatures (92.7%), decrease in rainfall intensity (92.1%) and changes in rainfall distribution patterns (90%). It also showed that different initiatives had been taken by farmers to cope with the changes like changing planting dates (92.1%), growing crop variety mixtures (73.8%) and practising soil and water conservation (62.7%). Based on the findings of this study, smallholder farmers greatly perceived climate change and variability with negative impacts imposed on their farming operations. Although farmers have tried to adapt, there is still a need to support their coping strategies through appropriate policies. This will facilitate increased adoption of adaptation measures, thereby reducing the negative consequences of climate change in future.

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INTRODUCTION

Climate change and variability have exhibited impacts on many systems and sectors that are important for human livelihoods (Abeka et al., 2012). Today, it is one of the major challenges facing the agricultural sector around the world and has the potential to affect Sustainable Development Goals (IPCC, 2022). According to the Ministry of Agriculture Animal Industry and Fisheries (2020), rural farming households in Uganda are faced with serious climate-related risks which greatly affect their livelihoods. The current changes and variability in climatic conditions in many parts of the world have brought the need to transform the agricultural sector to fit in the changing climate (Lipper & Zilberman, 2018).

Farming communities have adopted different adaptive practices to cope with climate shocks and stresses as presented in different seasons (Rubongoya, 2019; Tumwesigye et al., 2019; Twongyirwe et al., 2019). Some of these strategies are influenced and supported by external partners. However, for improved sustainability and success of adaptation strategies, it is important to involve the affected communities in their initiation and implementation (Derr, 2018). Previous knowledge and observations suggest that farmers in Uganda have been reluctant to change their agricultural practices in response to the changing climate (Derr, 2018; Twongyirwe et al., 2019).

Climate change and variability present opportunities in farming which lie in the use of technology and innovations such as irrigation, greenhouse farming, crop and livestock diversification, planting drought-tolerant and quick maturing crops, among others (Zizinga et al., 2017). Rural farming households use different coping strategies and local innovations, though these are normally disregarded by the scientific community. However, these local innovations can give a better understanding of the specific challenges in the community in order to develop better-coping strategies (Mubiru et al., 2015).

Local farmers in South Western Uganda are highly vulnerable to external shocks such as droughts that can damage or destroy crops, livestock, and homes (Nagasha et al., 2019). Climate change in the region will exacerbate many current environmental risks and may give rise to other risks. The vulnerability of rural farmers to the effects of climate change depends not only on the magnitude of climatic stress but also on the low capacity of affected populations to cope with such stress (Climate Change Profile Uganda, 2018; Uganda Bureau of Statistics, 2017).

Despite efforts by the Government, the effects of climate change are becoming more pronounced

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and increasingly reducing agricultural production in the region (Isingiro District Local Government, 2015). Therefore, understanding the various local coping strategies is crucial in developing a wider community adaptation approach in support of sustainable agricultural production and livelihoods. There is a need to strengthen the capacity of smallholder farmers to engage in adaptation action. The objective of this study was to investigate the ability of smallholder farmers in South Western Uganda to notice climate change and their current coping strategies employed to safeguard their farming systems.

Statement of the Problem

A changing climate associated with more occurrences of extreme weather events like drought, floods and intense rainfall has had a negative impact on agricultural production in Uganda (MAAIF, 2020). Bagamba et al. (2012) estimated between 70 to 97% of households in Uganda be affected by advanced climate change with the South Western region being more affected. This is because the region has limited alternatives for diversification. Farmers have adopted different strategies like shifting planting dates, adopting new crop varieties, changing land preparation methods and crop mixtures grown on the farm due to climate variability (USAID, 2013). However, their capacity to adapt to climate change risks and shocks is still low (Climate Change Profile Uganda, 2018). Getting a better understanding of how smallholder farmers cope with and adapt to climate change is essential for designing incentives to enhance their adaptive capacity. This will also help the government to design appropriate programs for specific areas to help farmers adapt.

Self-initiated efforts by farmers to adapt to climate variability are not usually successful due to challenges surrounding the timing and nature of climate shocks (Mubiru et al., 2015). In addition, some coping strategies by farmers accentuate climate change impacts such as cutting down trees for firewood and charcoal as alternative sources of livelihood. Therefore, there is a need to identify and scale-up strategies with positive environmental impacts. Adoption of coping strategies is more successful when appropriate practices such as improved crop varieties, soil and water conservation strategies and other technologies are implemented (Zizinga et al., 2017). Supporting the coping strategies of local smallholder farmers through appropriate policies will facilitate increased adoption of adaptation measures thereby reducing the negative consequences of climate change in future. Therefore, this study was carried out to ascertain the farmers' perceptions of climate change and establish the various local coping innovations in order to develop a wider community adaptation approach in support of sustainable agricultural production and livelihoods.

METHODOLOGY

Study Area

The study was carried out in Isingiro District located in South Western Uganda. The District falls within the dry cattle corridor with two rainy seasons, *i.e*. March to April and September to November. More than 80% of the District's population of 517,800 are engaged in rain-fed subsistence agriculture as the main source of livelihood (UBOS, 2016). The nature of the soils, together with frequent droughts, tends to adversely affect crop production with severe implications on household food and income security.

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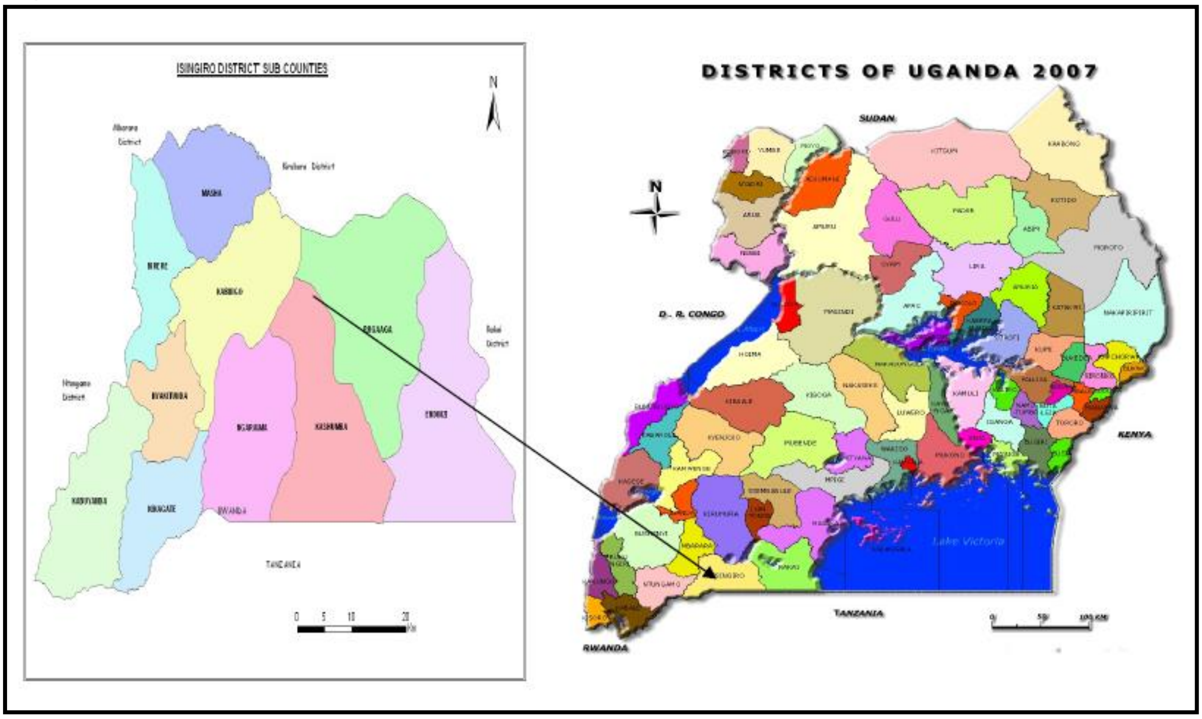
Figure 1: Location of the study area



Household Survey

An exploratory survey was conducted in the District using a structured questionnaire to collect data from 126 households. This sample size was determined from the total population of households in the study area using the formula proposed by Yamane (1967) below.

$$n = \frac{N}{1+N(e^2)}$$

Where n = Sample size, N = Total population of households in the sub-county, and e = error tolerance (was set at 10%).

Considering a population of 26,789 households (UBOS, 2017), a sample of 99 households was generated. However, a sample of 126 households was used for the study to increase the representativeness of the sample and generalise the results.

Surveyed households were randomly selected from Masha, Birere and Nyamuyanja Sub-counties which constitute Isingiro North Constituency. This area is dominated by smallholder crop farmers. Surveys were conducted between September and October 2022 which falls within the sowing period for most annual crops following the traditional cropping calendar of the area. This period is very busy for farmers with many agricultural tasks being performed and therefore this enabled physical observation of the applied practices. The Sub-counties were purposively selected based on knowledge of the area and agricultural practices, but the selection of farmers within Sub-counties was random. More information was generated through direct field observations and key informant interviews with three extension workers.

Data Analysis

Data collected from observations regarding different applied coping strategies in farmers' fields and observable effects of climate change on agriculture, plus information collected from the household survey were analysed using descriptive statistics. Stata 14 and Excel were used to generate frequency tables, percentages, charts and graphs to summarise, present and interpret survey results. A chi-square test was run to test the relationship between farmers and household characteristics with their perceptions of climate change.

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RESULTS

Perceptions of Climate Change and Variability

All respondents (100%, n = 126) strongly agreed to have experienced climate change in reality and its effects on agricultural production in the area. This showed clearly the growing knowledge of climate change problems among smallholder farmers in the study area.

Perceived Indicators of Climate Change

The ability of farmers to perceive climate change is important for them to make informed decisions for adaptation choices. Great awareness of climate change is vital if farmers are to take appropriate adaptation strategies. The results in *Table 1* show the responses of farmers in relation to the perceived changes and variability in climate over the past five years. The results show that the major apparent changes and variability in climate noticed by smallholder farmers in Isingiro District were, increased intensity and frequency of droughts (98%), increase in daytime temperatures (92.7%), decrease in rainfall intensity (92.1%) and changing rainfall distribution patterns (90%). Strong destructive winds (14.1%) and hailstorms (4%) were rare occurrences in the area over the past five years.

Table 1: Perceived climate change and variability indicators among smallholder farmers in Isingiro District

Perceived condition/change	Percent (n=126)
Increase in daytime temperatures	92.86
Increase in seasonal rainfall intensity	41.27
Decrease in seasonal rainfall intensity	92.06
Changes in rainfall distribution patterns	90.48
Increased frequency & intensity of drought	98.41
Increased frequency & intensity of floods	33.33
Strong winds	14.29
Hail storms	3.97

Analysis of household characteristics in relation to farmers' perceptions of climate change was done using the Chi-square test of independence. This was intended to establish the possible influence of household characteristics on the sensitivities to climate change among smallholder farmers. The results are shown in *Table 2*.

The results showed a significant association between different household characteristics and the farmers' perceptions of climate change. The age of the household head showed low significance (significant at 10%) on farmers' sensitivities to hailstorms. This parameter did not seem to significantly influence farmers' perceptions of other climate change events. On the other hand, the gender of the farmer showed a highly significant influence on farmers' perceptions of the occurrence of floods and increased rainfall intensity at a 1% significance level, while changes in rainfall distribution patterns showed significance at 5%.

The results also showed that the income level of the household showed a significant influence on farmers' perceptions of increased rainfall intensity at a 1% significance level. Farm size also showed low significance with farmers' sensitivities to increased temperatures at a 10% significance level but high sensitivity to increased rainfall intensity and floods at 1% and 5% significance levels, respectively. However, the education level of the farmers showed no significant influence on farmers' perceptions of climate change.

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Table 2: Chi-square test of independence between household characteristics and farmers' perceptions of climate change and variability in Isingiro District

Perceived change	Household parameters									
	Age of HH		Gender of HH		Education level		Income level		Farm size	
	Chi-square	P	Chi-square	P	Chi-square	P	Chi-square	P	Chi-square	P
Increased temperatures	2.2354	0.525	3.5343	0.060*	2.805	0.423	2.7115	0.258	8.758	0.067*
Increased r/f intensity	5.4541	0.141	8.9091	0.003**	5.7561	0.124	13.9772	0.001*	24.9324	0.000*
Decreased r/f intensity	0.7872	0.853	4.5660	0.033**	1.0167	0.797	2.5291	0.282	4.4913	0.344
Changing r/f patterns	2.4051	0.493	0.0301	0.862	3.3146	0.346	0.8225	0.663	3.1731	0.529
Drought	2.2355	0.135	1.3874	0.708	0.4846	0.922	1.5743	0.455	3.4159	0.491
Floods	5.1445	0.162	17.325	0.000*	2.3123	0.510	3.6765	0.159	11.0555	0.026**
Strong winds	2.0251	0.567	0.0477	0.827	5.0073	0.171	4.0953	0.129	1.2119	0.876
Hailstorms	7.1122	0.068*	1.5923	0.207	2.1203	0.548	4.0333	0.133	3.2043	0.524

** p<10%, **significant at p<5%, *** significant at p<1%*

Effects of Climate Change and Variability on Crop Production

Climate change and variability have both direct and indirect effects on crop production. Farmers were asked about the effects they have experienced in their farming which they attributed to climate change and variability over the last five (05) years. The findings are represented in *Figure 2*.

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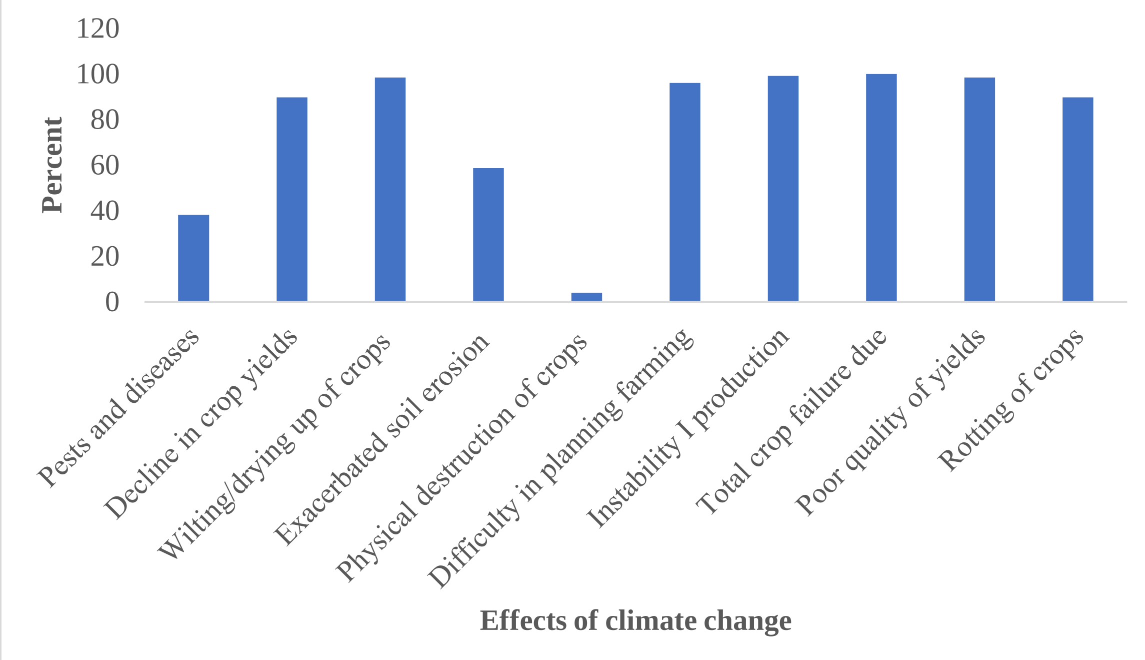
Figure 2: Effects of climate change and variability on agriculture production



Farmers reported that the increased intensity and duration of drought had the most devastating effects on crop production in the area. From the current study, all respondents (100%) affirmed to have ever experienced total crop failure as a result of drought over the past five years. In addition, 98.4% of the farmers also reported that intense and prolonged drought had resulted in wilting and drying-up of crops especially during the March to April growing season. This consequently resulted in declining quality (98.4%) and quantity (89.7%) of crop yields over the past five years, as reported by farmers. The results also indicate that farmers had perceived great fluctuations in crop production (99.2%) with high unpredictability of output as a result of climate change and variability. Other reported effects of climate change and variability were increased diseases and rotting of crops due to heavy rainfall especially during critical stages of crop growth (89.7%) and difficulty in planning farming operations (96%).

Coping with Climate Changes and Variability

Smallholder farmers are at the frontline of fighting the challenges of climate change and variability. Rural farming households whose livelihoods mainly depend on agriculture must adjust their farming practices and their way of life in the face of climate change. From the current study, apparent changes in climate and the associated negative effects have pushed farmers to adopt different coping strategies, as shown in *Figure 3*.

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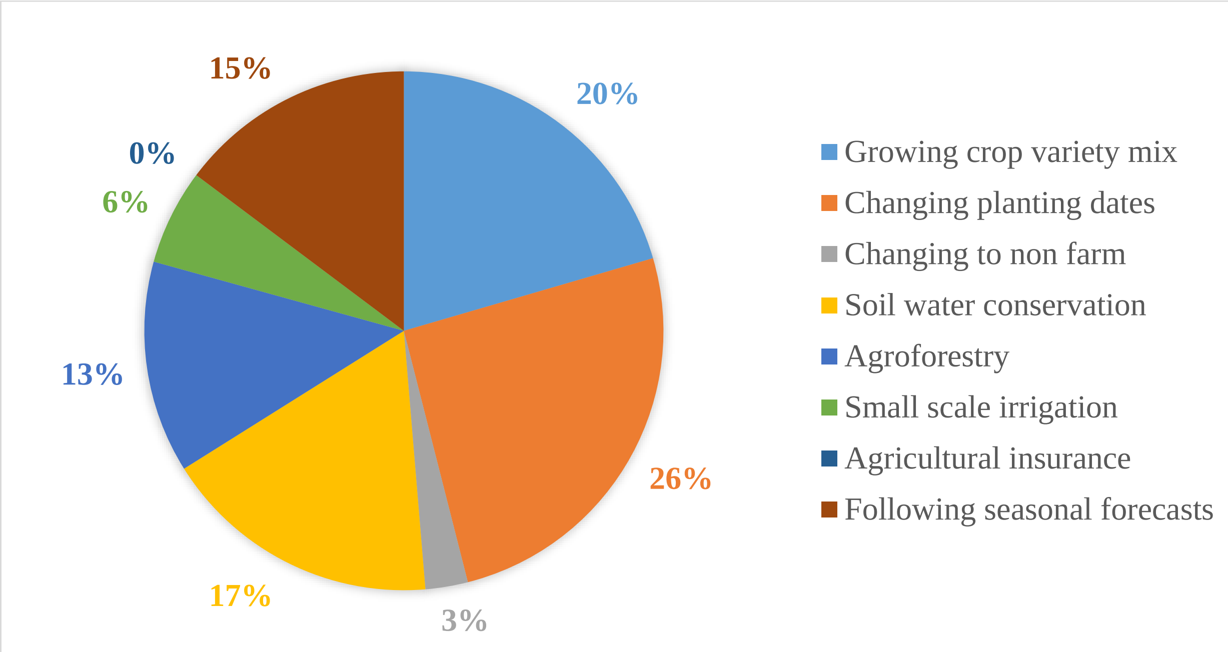
Figure 3: Farmers' coping strategies to climate change and variability in Isingiro District



Adaptation strategies are vital to safeguard the livelihoods of rural farming communities in the face of climate change. The results in *Figure 4* indicate that farmers responded to climate change and variability in different ways. The major coping strategies taken were, changing planting dates (92.1%), growing crop variety mixtures (73.8%) and practising soil and water conservation measures (62.7%). To some extent, farmers had adopted agroforestry (47.6%), following seasonal weather forecasts (53.2%) and the use of small-scale hand irrigation (21.4%) as alternative coping strategies.

DISCUSSIONS

Indicators of Climate Change among Smallholder Farmers

The result of the current study shows that farmers in Isingiro District have really encountered the climate change and variability problem. All respondents strongly agreed that they had witnessed changes and variability in climate over the past five years. Changes in daytime temperatures with increased hotness and decreased night temperatures (coldness) were reported as one of the most perceived changes by farmers. However, farmers had no idea about the extent of change in the average temperatures. According to IPCC (2018), the number of hot days are increasing while cold days are decreasing due to climate change. The change in the number of hot and cold days affects crop growth differently depending on the sensitivity and plant response mechanisms (Gray and Brady, 2016).

Changes in precipitation in regard to the timing, intensity of different rainfall events and the frequency and length of drought were perceived by farmers in the current study as another major change in climate over the past five years. These factors are all important for crop growth and the general productivity of agricultural systems. It was noted that farmers have experienced the late onset of rains and sometimes early cessation, which affects the general production cycle of crops reducing the yields. On the other hand, farmers mentioned that they have experienced intense rainfall events that cause severe soil erosion and flooding of crop fields in lowlands. Farmers also reported high agricultural risks mainly attributed to drought and high variability of seasonal rainfall patterns which has reduced investment in agriculture due to fear of

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losses in case of unfavourable weather conditions. This is in agreement with findings by NEMA (2016), Mubiru et al. (2015) and Nagasha et al. (2019) regarding rainfall variability in other parts of Uganda. Rainfall variability and change with extended drought periods was also reported in southern Ethiopia by Belay et al. (2021) which is in agreement with the farmers' observations from this study. Discussions with key informants also were in agreement with the farmers' perceptions.

Actual and Perceived Effects of Climate Change and Variability among smallholder farmers in Isingiro District

Decline in Quantity of crop Yields and quality attributes

Severe effects from prolonged and intense drought associated with high daytime temperatures were reported by farmers during the current study. Increased temperatures that are associated with dry spells accelerate the evapotranspiration rate resulting in water stress in crops (Hasanuzzaman et al., 2013; Lisar et al., 2012). Farmers reported a reduction in yield or total crop failure in the absence of irrigation. Farmers also associated high daytime temperatures with reduced quality of yields, especially in fruits and grains with characteristic small sizes and shrivelled grains and fruits. The decline in the quality of yields is as a result of the increased rate of respiration during high temperatures, which leads to the breakdown of stored sugars leaving less in the harvestable product (Ryan, 1991). Similarly, high temperatures during the drought have been associated with a decline in agricultural production in different parts of the world (Zwane, 2004; Rhaguraman, 2017; Twongyirwe et al., 2019).

Difficulty in Planning Agricultural Operations

The changing rainfall patterns reported by farmers have made it difficult to plan and follow seasonal calendars as they used to in the past years. Farmers reported that it had become increasingly difficult to plan and make accurate agricultural decisions about different farming operations. With the high variability of rainfall, there is difficulty in planning and managing production on the side of the farmer (Wakjira et al., 2021). This may lead to frequent crop failures due to poor timing of operations, posing significant threats to household food security and livelihoods.

> *"We are often misled by early rains to plant crops which dry up due to cessation of rains",* explained one of the farmers in the Masha sub-county.

> *"It's difficult to tell when the rainy season starts and when the rains will stop",* he further explained.

Similar results of uncertain rainfall patterns have been reported by Jost et al. (2016), Derr (2018) and Muyiramye (2020). Late onset of rains or subsequent early cessation lead to a shortened growth lifecycle for crops which may affect the general yields (Raza et al., 2019). On the other hand, the intensity and distribution of rainfall in a growing season determine whether farmers can grow crops with or without irrigation supplementation (Bedane et al., 2022). Therefore, a reduction in seasonal mean rainfall is likely to reduce crop productivity, especially in soils of low organic matter with low moisture retention capacity (Ogenga et al., 2018).

Physical Damage to Crops

Heavy rainfall sometimes associated with hailstorms and strong winds was reported to have caused physical damage to crops. It was mentioned by farmers that heavy rains during the final stages of crop growth also delayed harvesting, which affected the quality of yields, especially beans and tomatoes.

> *"Rainfall experienced when beans are ready for dry harvesting causes losses",* reported one of the farmers in Rukuuba Parish.

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> *"Such rains interfere with harvesting; beans germinate in husks; sometimes beans rot in fields due to dampness; the quality of beans is really poor when harvested in the rainy season",* she further explained.

Increased Outbreak of Pests and Diseases in Crops

In the current study, the major pest outbreak reported by farmers was the American armyworm in maise which was associated with increased temperatures or drought. Farmers narrated that this pest mainly attacked maise plants during the dry spell. Farmers also reported the infestation of bean Aphids and cutworms during dry spells. Such outbreaks could be attributed to the migratory nature of pests in response to changing environmental conditions. Changes in diversity, insect populations and distributions are also influenced by the temperatures of the surrounding environments (Shrestha, 2019). Increasing pests as a result of climate change in Uganda were also reported by Mubiru et al. (2018).

Similarly, farmers in this study attributed increased disease outbreaks to intense rainfall and it negatively affected crop productivity. This was mainly reported by farmers growing beans, tomatoes, Irish potatoes and cabbages, who reported that heavy rains led to the rotting of crops and high incidences of blight. This could be attributed to the fact that during periods of too much rainfall, the plant foliage is exposed to prolonged wetness which gives a chance for fungal spores to sprout and cause infections (Ahanger et al., 2013). The common diseases reported by farmers were early blight in tomatoes and Irish potatoes (*Alternaria linariae*), Bean Anthracnose mainly affecting stems and pods, dumping off in cabbages and Watery soft rot (*Sclerotinia sclerotiorum*). Similarly, Muyiramye (2020) reported the rapid evolution and spread of Potato bacteria disease with increased rainfall intensity in Rwanda.

Soil Erosion

Farmers reported that during periods of intense rainfall, there was a lot of surface runoff which washed away farmers' fields, sometimes with crops that did not have well-established root systems. Deposits of silt result in the covering of crops in the low lands resulting in losses for the farmers (Thakur & Kapoor, 2022). Soil erosion has prolonged effects on crop productivity due to the loss of soil organic matter and subsequent decline in fertility (Răileanu & Bucur, 2019; Balasubramanian, 2017). This makes it difficult for farmers to realise higher yields. Incidences of increased soil erosion as a result of increased precipitation have also been reported by Wang et al. (2018) and Chapman et al. (2021).

Coping Strategies to Perceived Changes and Variability in Climate among smallholder farmers in Isingiro District

The current study results showed that farmers had adopted different coping strategies in response to changes and variability in climate. Soil and water conservation strategies were among the major strategies adopted by farmers to cope with the changes. These aim at reducing the amount of soil erosion and increasing the amount of water infiltrating into the soil (Sharma, 2020). Mulching of banana plantations using dried banana leaves and grasses was a common practice observed among farmers. The use of mulch helps to reduce soil moisture loss through evaporation which reduces the need for watering crops (Iqbal et al., 2020). This helps the plants to withstand periods of dry spells when there is little or no moisture supply from rainfall. Mulching can therefore, effectively help crops adapt to climate change, mainly drought.

Also, growing mixed crop varieties has been adopted by the majority of farmers to cope with climate change. This practice had helped farmers to reduce the risks of loss in crop yields as a result of bad weather. In addition, it enhances crop yields and promotes nutrient use efficiency since different crop

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varieties have different nutrient requirements (Gururani, 2022). Farmers in the study area testified that growing different varieties of beans helped them stabilise yields. For example, farmers testified that it was rare to suffer a total loss when they grew mixed varieties of beans compared to when they grew only one variety. Crop diversification as a coping strategy was also reported by Assan et al. (2018).

Farmers also cited postponement of planting or sowing in case of delays in rainfall. Farmers testified that sometimes sowing of seeds was delayed up to September and October from the usual planting time of August. They attributed this to the late onset of rains to facilitate the sowing of seeds. This result supports findings by Jost et al. (2016), Findlay (2017) and Muyiramye (2020) that farmers have been pushed to change their farming practices as a result of climate change. Studies in the Mountainous areas of South Western Uganda also showed increased maise yields with changing planting dates (Zizinga et al. 2015).

Agricultural insurance policies can protect farmers against agricultural risks and natural disasters over which they have limited or no control (Reusche et al., 2015). In the face of climate change and variability, agricultural insurance would be an option for farmers to consider. However, the results of the current study indicated zero use of insurance among farmers. This result supports the findings by Yousof et al. (2019) who also reported low use of agricultural insurance by farmers. The non-adoption of this policy could be attributed to a lack of awareness among farmers as most of the interviewed farmers reported that they had no knowledge of crop insurance policies. It is also probably due to the fact that the studied farmers practised farming on a small scale mainly for subsistence which makes it uneconomical to spend on insurance.

Other adaptation responses used by farmers were agroforestry, following seasonal weather forecasts and the use of small-scale hand irrigation. Generally, it was noted that farmers had adopted multiple coping strategies in response to different climate change events. Nevertheless, the adopted strategies were mainly skewed towards adaptation than mitigation benefits. It was also noted that farmers had mainly adopted traditional low-cost strategies with the aim of stabilising agricultural production. This is probably due to the limited capacity to afford capital-intensive strategies that have higher upfront costs.

Farmer Characteristics in Relation to their Perceptions of Climate Change

Sex, age, income level and farm size were found to have a significant influence on farmers' sensitivities towards climate change and variability. Climate change tends to exacerbate existing gender inequalities; women, in particular, may thus perceive climate change more than men (UN Women Watch, 2009). The fact that women are more involved in agriculture and the production of food to feed the family, they are more likely to perceive the changes and variability in a climate than men (Senja, 2021; Onwutuebe, 2019). The findings of the study are also in agreement with the findings by Murage et al. (2015) that climate change affects men, women, boys and girls differently because of the inequalities between them caused by gender-based roles in society and the resulting levels of vulnerability men.

On the other hand, household income level showed a significant influence on farmers' perceptions towards climate change and variability. This is probably because poor and marginalised segments of society are especially vulnerable to the adverse effects of climate change since they have limited resources. This gives them a limited capacity to adapt, and their livelihoods tend to be highly dependent on natural resources that are highly sensitive to climatic variability. Therefore, farmers with lower household income levels may perceive climate change more than their counterparts who have more financial resources.

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The study results showed that farmers with small size land greatly perceived climate change and its effects more than those with large farm holdings. This result is in line with findings by Morton (2007) that farmers with larger pieces of land are endowed with more resources and may have a greater capacity to prepare or respond to climate change-related hazards. On the other hand, a study in the Hamadan province of Iran showed increased sensitivity to climate change with reduced farmland size among farmers (Jamshidi et al., 2018). Correspondingly, farmers accessing more land area for agricultural production were reported to suffer less from climate-related disasters in the Kyoga Plains of Uganda as reported by Chombo et al. (2018). Therefore, even though smallholder farmers may be exposed to the same climate change-related hazard, their sensitivity and adaptive capacity may greatly differ which is likely to influence their perception of such scenarios.

In the current study, both educated and illiterate farmers had perceived climate change and variability. This implies that climate change has no boundaries and affects all farmers. However, it is important to note that the degree of vulnerability varies within the same society among educated and illiterate farmers.

CONCLUSION

This study was carried out to establish the smallholder farmers' perceptions of climate change and what initiatives they had taken up to cope with the risks associated with it. Based on the findings of this study, the following conclusions were made. There was increasing awareness of climate change and variability challenges among smallholder farmers and the emerging need to take on adaptation strategies. All the studied farmers were in agreement with the reality of climate change. The changes perceived by the farmers in Isingiro District were an increase in daily temperature, a change in rainfall patterns (intensity, timing and length), increase in the intensity and frequency of drought.

The current study also established that climate change and variability posed direct and indirect effects on crop production. The major effects reported by farmers in the area were, wilting and drying up of crops, declining crop yields both in quality and quantity, difficulty in planning farm operations, exacerbated soil erosion, increased diseases and rotting of crops, among others. These effects had made farmers take up different adaptation responses such as changing planting dates, growing crop variety mixtures, agroforestry, soil and water conservation measures, small-scale hand irrigation and following seasonal weather forecasts. Though, this had been done to a small extent.

Recommendations

The local government and development partners need to enhance the sensitisation of farmers and other policymakers at national and local levels regarding climate change, preparedness for climate-related disasters and devising sustainable adaptation responses. There is a need to identify and scale up the local farmers' coping strategies that have greater adaptation and mitigation benefits in order to reduce future climate risks.

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