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Research Paper

Assessing the smallholder farmers' coping strategies to the effects of climate change: evidence in rural districts of northern uganda

Opiyo Baranabas[1*], Osiru David[2], Ssemakula Edward[3], Kalibwani Rabecca[4], Malinga. M.Geoffrey[5]
[1*,2,3,4]Faculty of Applied Sciences, Department of Agriculture, Bishop Stuart University, P. O Box 09, Mbarara (U) Uganda.
[5]Faculty of Sciences, Department of Biology, Gulu University, P.O Box 166, Gulu (U) Uganda.

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ABSTRACT

Background: The effects of climate change such as droughts, floods and land degradations normally result into crop failures among smallholder farmers. The effect is more adverse on smallholder farmers of Sub Sharan region owing to its low coping strategies and poverty prevalence. Assessing the smallholder farmers coping strategies to the effects of climate is an evitable thought if we want to develop sustainable coping options and policies to climate change. The main objectives of this study were to investigate the effects of climate change, and assess on how the smallholder farmers coped up with them. A cross-sectional survey research design was employed to generate data from the 360 randomly selected household heads across the nine parishes in the Sub County via a semi-structured questionnaire, interviews schedules to key informants and focus group discussion to smallholder farmer groups. The SPSS tool was used to analyze the effects of climate change and their coping strategies and presented in frequency distribution tables and correlation matrices. Results: The two most widely practiced coping strategies were sales of productive assets and reduction in food consumptions rates among the smallholder farmers. The results from the correlation analysis revealed that there were significant positive correlations between floods, droughts, famines, and sales of productive assets and reduction in consumption rates of food.
Conclusion: The findings from the study note that there are several factors that work in synergy to influence the specific coping strategies by smallholder farmers to climate change. This therefore calls for more efforts from government and development partners to strengthen the agricultural extension services by customizing climate information delivery system, allocating more fundings to researchers to engineer climate-tolerant crop and animal resources, investing on water for production projects, renting out idle pieces land to investors by smallholder farmers in order to provide the additional source of earnings.

Corresponding Author:
Opiyo Baranabas
Faculty of Applied Sciences, Department of Agriculture, Bishop Stuart University, P. O Box

09, Mbarara (U) Uganda.
Email: lalogi03@gmail.com

1. INTRODUCTION

The general agreement among the different stakeholders such as policymakers, development partners and researchers currently is that coping with change effect is not taking a desired speed [1]. Recurrent droughts, floods, loss of land value leading to crop failures are some of the signs of climate change [2].

In comparison to other regions, Sub–Saharan Africa has been labeled to have the greatest negative effect of climate change owing to its low level of copings and poverty [3], [4]. Developing countries require a sound coping strategies to climate since the means of survival of their citizens is dependent on agriculture whose successes largely depend on climatic some climatic events [5], [6].

The East African region has witnessed a warming trend of about 0.5 degrees centigrade. Uganda is one of the countries in East Africa that is heftily burdened by the effects of climate change, and the most vulnerable are the smallholder farmers who form up the majority [7]. It has been an increase in the temperature of up to 1.5 degrees centigrade during the last twenty years by up to 4.3 degrees centigrade [8].

More than 50% of the rural households are dependent on farming for their means of survival, and nearly 50% of those rural households that depend on agriculture usually experience one or more of the several categories of food crises resulting from decline in household food production and diversity due to climate [9].

The Uganda Bureau of Statistics (UBOS) defines smallholder farmers are those who usually cultivate less than one hectare of land in a cropping season, use rudimentary technology, own few heads of cattle and produce mainly for consumption, with limited surplus for market. Family labor is main source labor provided by the women and children [10].

According to [11], Uganda is likely to experience higher temperature increases, changing rainfall patterns and increased climate change due to its position to the equator. [12] Reported of seven droughts occurrence in the space of ten years in Uganda. The occurrences of drought and torrential rains in early 2017 in northern Uganda resulted into food and water crises; flood and malaria infection respectively [13].

About 600,000 smallholder farmers in Northern Uganda are prone to the effect of drought due to climate change. This climatic event has put the farmers to the risk of food insecurity [14]. The combination of drought, hailstorms and floods phenomena have led to crop failures in the region, which leads to about 83% -90% declines in crop yield. The combinations of these phenomena have led to food insecurity in this region. Currently, in Karamoja, Acholi and Teso Sub regions, about 12% of smallholder farmers are food insecure, which is the result of poor rainfall that has led to drought phenomenon in the area [15], [16].

[17] The phenomena of drought and Lanina rain as a result of climate change in Northern Uganda, can be traced way back in December 2017 which have led to food insecurity, water shortage and disease infection to smallholder farmers [18].

The government of Uganda, development partners and other international community bodies have already made some efforts such as tree planting and other climate smart agriculture interventions targeting farmers in the region in order to avert the effects CC [19], however the previous studies have shown that there are inexhaustive investigations about the coping strategies to the effects of CC by small holder farmers. This study is to investigate how the smallholder farmers cope with the effects of CC [20].

This paper, therefore, intended to add to the body of knowledge the practical and theoretical interventions to famine, drought and famine to smallholder farmers [21]. This can be achieved through cascading of practical interventions in mitigating climatic events right down to the disadvantaged stakeholders (smallholder farmers).

2. METHODOLOGY

2.1 Study Area

This study was conducted in nine parishes of Akara, Pachua, Pudo, Pajong, Pakuba, OkolKal, Yepa, Bura and Ogwapokewhich are all in Mucwini Sub County Kitgum district Figure 1. We selected the area because it has scanty information about the effects of climate change and how they coped up with them. Mucwini Sub County headquarters is situated 12Km away from Kitgum District headquarter and it is situated North-East of Kitgum District. It also lies between latitude 3oC N and longitude 33 oC E, within an average altitude of 993M above sea level and it is generally aflat land [22].

The vegetation in Mucwini Sub County is mainly of woody Savannah, characterized by wood cover and grassland. The dominant grasses are Hyperemia, Penicum, Bracharia and Seteria Spp and Acaciac ambrelium constitutes the most dominant tree. The vegetation in the Sub County also includes shrubs. The soil types in Mucwini vary with localities but are generally well-drained sandy and sand clay [23].

They are strongly weathered and generally with low fertility. The Sub County receives average annual rainfall of 1300mm. Rain starts in late March or early April and ends in November. Rainfall is bimodal with peaks in April and August. It is dry-hot and windy from December to mid-March. The average monthly maximum temperature is 27oC and average monthly minimum temperature is 17oC. Like many Sub Counties in the district, Mucwini Sub County is predominantly engaged in smallholder farming [24]. The people grow a variety of food and cash crops. Over 80% of the farmers are engaged in crop production as their major activity and a small percentage in livestock rearing, Bee keeping and fishing farming on small family holdings using family labor and rudimentary hand tools such as hoes as common input [25].

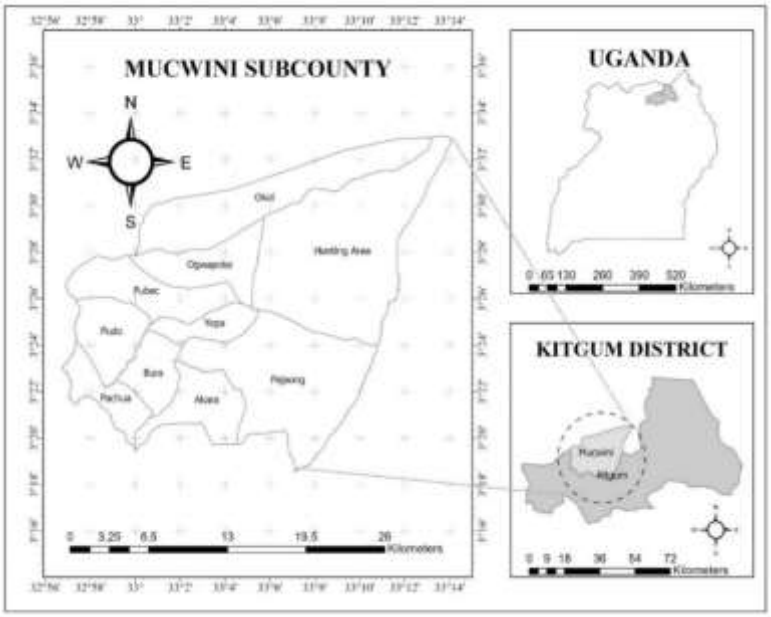

Figure 1. Map of the Study Area

2.2 Sampling Design and Sample Size

The target population of the smallholder farmers was selected using multistage sampling technique. First, the Sub County was purposively selected based on the limited researched information regarding the coping strategies of smallholder farmers to the effects of climate change [26]. From the Sub County, all the nine parishes and villages were considered for sampling. Finally, we interviewed (N=360) smallholder

farmer households and were randomly and proportionally selected from the nine parishes;(n=30)for Akara, (n=55) for Bura, (n=43) for Pachua, (n=45) for Pubech, (n=46) for Pudo, (n=40) for Yepa, (n=27) for Pajong, (n=37) for Ogwapoke and (n=37) for Okol, had five focus group discussions with smallholder farmer groups and interviews with Agricultural extension workers (AEO), District Agricultural Officer(DAO) and District Veterinary Officer (DVO) [27].

A cross sectional survey research design was employed to collect primary data on the effects of climate change on smallholder farmers, with the help of semi-structured questionnaires guaranteeing primary data collection from the main respondents (smallholder farmers) [28]. The surveys were carried out by trained enumerators. The permission for the survey was approved by Chief Administrative Officer (CAO) of Kitgum, on the behalf of other stakeholders. The farmers list provided by the village leaders and the agricultural officers were sampled randomly [29].

During the survey, three areas of information were documented; personal farmers 'bio-data, farmers' experiences on climate change and events, and famers' daily coping strategies to climatic change. Other important information about climate change and events were also obtained from the focus group discussions and Key informants' interviews [30].

2.3 Data Analysis

In reducing the effects of climate change, smallholder farmers employed a number of coping strategies which were collected, analyzed and summarized using the descriptive statistics (Frequency, percentage etc.) obtained from the Statistical Package for Social Sciences (SPSS), version 25. Comparative statistical tools such as correlation analysis was also used to assess correlation significance of the coping strategies the effects of climate change. The level of significance was set at (0.01) [31].

Table 1. Demographic Characteristics of the Respondents

Variable	Frequency	Percent (%)
Gender		
Male	205	57
Female	155	43
Age		
18 -30 Years Old	80	22.2
31-40 Years Old	156	43.3
41-50 Years old	94	26.1
Over 51Years Old	30	8.3
Heads of the family		
Male	302	83.9
Female	58	16.1
Education level		
Non- formal education	25	6.9
Primary School	176	48.9
Lower Secondary school (Forms I to IV)	102	28.3
High Secondary School (Form V to VI)	20	5.6
Post-Secondary school e.g. Diploma, degree, Vocational	37	10.3
Marital status		
Single	60	16.7
Married	92	25.6
Cohabiting	60	16.7
Divorced	45	12.5
Separated	20	5.6
Widow	58	16.1

Widowers	25	6.9

Table 2. Locations of the Study Area

Variable	Frequency	Percent (%)
Akara	30	8
Bura	55	15
Pachua	43	12
Pubech	45	13
Pudo	46	11
Yepa	40	11
Pajong	27	8
Ogwapoke	37	10
Okol	37	10

Table 3. Main Economic Activity of the Respondents

Variable	Frequency	Percent (%)
Crop production	150	41.7
Animal Rearing	40	11.1
Trade/Business	80	22.2
Formal Job/Salaried work	10	2.8
Causal Work	5	1.4
Selling charcoal/firewood	5	1.4
Selling local brew	60	16.7
Artisan/skills technician	8	2.2
Other (Specify)	2	6

Table 4. Verifying Incidences of Climate Change

Variables	Frequency	Percent (%)
Experienced Drought		
Yes	293	81.4
No	66	18.3
Experienced floods		
Yes	290	80.6
No	70	19.4
Experienced famine		
Yes	261	72.5
No	99	27.5

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis of Respondents

Table 1, Table 2, Table 3 present the summary of socioeconomic characteristics of the households surveyed in the study area. It showed that the majority of the agricultural households were male- headed (86.9% of household heads) which reflects patriarchal cultural practices in Africa whereby women are looked as "inferior" and are not allowed to talk on behalf of the households (Lasejane, 2006) [32]. Only 43.3% of the respondents were between the age 31-40 years old, meaning they are beyond the age cap of youth. The majority of the smallholder farmers stopped their education in primary seven (48.9%), which is why many scholars consider farming as an economic activity for low- level educated persons [33]. The study also revealed that the majority of framers were married (25%), meaning that they take farming seriously as the main source of earning for their family. The study also revealed that crop production

formed the major economic activity in the surveyed area (41.7% of the respondents were crop farmers) [34].

3.2 The Effect of Drought and Coping Strategies of Smallholder Farmers to Climate Change

The study showed that there was a drought phenomenon in the Sub County in the last 10 years (81.4%), see Table 4. During this time period especially in 2017, the water availability was significantly below the normal level expected over the year. It means the supply of water could not meet the existing water demand for crops, animals and humans [35].

The results of this study indicated that there was a significant positive correlation between drought and reduction in food consumption between the smallholder farmers in Mucwini Sub County up (r = 0.763); from thrice to once or none in a day. The findings of other scholars are also in support of this [36], [37].

The study also found out that the smallholder farmers in Mucwini Sub County coped with drought by sales of productive assets such as land, animals, and oxen (r = 0.956) [38]. The farmers sold off their productive assets such as land and farm tools in order to buy food resources and other basic needs for the households. However, the previous did not agree with this finding which maintained that that smallholder farmers coped up with drought by practice of agro- forestry intervention in order to improve on the soil fertility and rainfall, according to the studies done by [39], [40]. Also other studies by some scholars indicated that off-farm employment opportunity such as trade and agro-processing; diversification of farming enterprises, growing early maturing crops, efficient water uptake and drought tolerant crops; saving of food, borrowing of food and mortgaging of crops, consuming of wild food resources, indigenous weather forecast forcast, keen observation of celestial bodies and change of cloud in the sky were ones of the ways of copings with drought by smallholder farmers [41].

Table 5. Coping Mechanisms to Drought

Coping Mechanisms	**Frequency (N=293)**	**Percent (%)**
Migration	31	10.6
Sales of productive assets	230	78.5
Reduce food consumption	195	66.6
Engagement in food for work programs	94	32.1
Borrowing of Money	75	25.6

Table 6. Proportion of Productive Assets Sold

Productive Assets	Frequency (N=230)	Percent (%)
Animals	165	71.7
Bicycles	3	1.3
Land	17	7.4
Others	45	19.6

Table 7. Correlation Analysis of Effects of Climate Change and heir Coping Strategies

	1	2	3	4	5	6
1. Drought in the last ten years	-					
2. Sales of productive assets	.956**					
3. Flood in the last 10 years	-.234**	-.244**				

4. Reduction in food consumption	.763**	.766**	-.638**			
5. Famine in the last ten years	.769**	.805**	-.303**	.797**		
6. Migration in search of water and food.	.749**	.754**	.897**	.687**	.745**	-

The relationship between famine and coping strategies of smallholder farmers to climate change in Mucwini Sub County. The results of findings showed that (r = 72.5%) of the respondents had famine in the last ten years due to climate change that was between 2010 to 2020. Due to decline in harvest, the food stuffs produced was not enough to finish the one complete year. The study showed that the smallholder farmers in the area coped up with famine by reducing food consumption frequency and sales of productive assets such as land, bicycle and animals (r= 0.76) in order to get income to buy food stuffs in the households. This finding agreed with studies done by [42].

The scholars argued that the smallholder farmers could cope up with famine by sales of productive assets such as land, livestock, seeds and reduction in food consumption rate. Nevertheless, other scholars argued that smallholder farmers could also cope up with famine by borrowing money from friends or banks, mortgaging of land, food for work, food aid, consumption of low nutrient crops such as sorghum and cassava, allocation of more fund for food purchases as opposed to crop investment and growing of drought tolerant crop such as sweet potato [43], [44], [45].

Table 8. Coping Mechanisms to Famine

Coping Mechanisms	Frequency (N=261)	Percent (%)
Migration	40	15.3
Sales of Productive asset	230	88.1
Reduce food consumption	261	100
Engagement in food for work programs	14	5.4
Borrowing of Money	4	1.5

3.3 The Effect of Floods and Coping Strategies of Smallholder Farmers to Climate Change in Mucwini Sub County

The results of the study showed that (80.6%) of the smallholder farmers experienced the effect of floods in the last 10 years in study area, see table 04. Considering the focused group discussions, smallholder farmers coped up with floods by migrating from the flooding areas to uplands. This finding agreed with the study done by [46], their findings revealed that relocation to safer areas formed the basis of the coping mechanism to floods by smallholder farmers. On the otherhand, coping mechanisnms to floods in other findings include purchases of foods from the market and storing them awaiting floods incidence. In this particular study, there is a significant positive correlation between reduction in food consumption rates, sales of productive assets and floods, see table 07. The scholars argued that growing fast-maturing varities of crops field crops and vegetable and sales of some animals to raise money for other basic needs. Some households resorted to growing food crops that were more tolerant such as rice and yams to flood. Theses coping strategies disagreed with the findings of Cao etal;2005, Neufelt and Thorlakson;2012 and Simelton et al; 2015). These scholars found out that the smallholder farmers coped up with floods through reliance on material aids and social support such as food, clothes,medical supllies, innovative farming systems such as terracing on the hilly areas and agro- forestry interventions.

Table 9. Coping Mechanisms to Floods

Coping Mechanisms	Frequency (N=290)	Percent (%)

Migration	194	66.9
Sales of Productive asset	150	51.7
Reduce food consumption	156	53.8
Engagement in food for work programs	23	7.9
Borrowing of Money	7	2.4

4. CONCLUSION

In this research, we assessed the effects of climate change and how the smallholder farmers coped up with them in Mucwini Sub County Kitgum District. Using 360 smallholder farmer household heads across the nine parishes in the Sub County as the study sample size, we found that the two most widely practiced coping strategies to the effects of climate change by smallholder farmers were sales of productive assets and reduction in food comsumption rates.

This is very impressing because if access to climate information by smallholder farmers could be improved, a large number of smallholder farmers could be shielded off from the adverse effects of droughts,floods and famines due to climate change.However, a relatively small percentage (1.5%) of the household heads interviwed acessed borrowing of money from finacial institutions as famine occurred as cmpared to 2.5% and 25.6% when flood and drought erupted respectively. Using the correlation analysis, the study established that there is significant positive correlation between drought,famine and flood, and sales of production assets and food consumption among smallholder farmers in Mucwini Sub County Kitgum District.

In the light of the above,the study recommends that government and development partners should make their focuss on strengthening the agricultural extension services by improving on the provision of local climate information, researching on adverse-climate tolerant crop and animal resources, investing on water for production projects and renting out idle pieces of land for additional source of earnings to the farmers to curtail the need of land sales to enhance coping strategies of stallholder farmers Northern districts of northern Uganda.

Abbreviations

UBO: Uganda Bureau of Statistics; SPSS: Satistical Package for Social Sciences; IPCC: Intergovernmental Panel on Climate Change; CC: Climate Change; BUSUREC: Bishop Stuart University Resreach Ethics Committee.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Opiyo Baranabas	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	
Osiru David		✓		✓		✓		✓	✓			✓		✓
Ssemakula Edward	✓	✓		✓	✓		✓			✓		✓	✓	
Kalibwani Rabecca	✓		✓		✓		✓	✓	✓		✓		✓	✓
Malinga. M.Geoffrey	✓	✓		✓	✓	✓			✓	✓		✓	✓	✓

C: **C**onceptualization	I: **I**nvestigation	Vi: **Vi**sualization
M: **M**ethodology	R: **R**esources	Su: **Su**pervision
So: **So**ftware	D: **D**ata Curation	P: **P**roject administration
Va: **Va**lidation	O: Writing- **O**riginal Draft	Fu: **Fu**nding acquisition
Fo: **Fo**rmal analysis	E: Writing- Review& **E**diting	

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

This study was approved by Bishop Stuart University Research Ethics Committee (BSUREC) andthepermission to conductthe research was later granted by the Chief Adminisrtrative Officer of Kitgum. Written informed consentand assent were obtained from the adult participants and persons under the age of 18, respectively.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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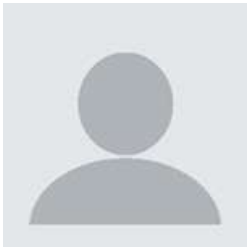
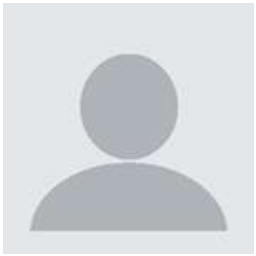
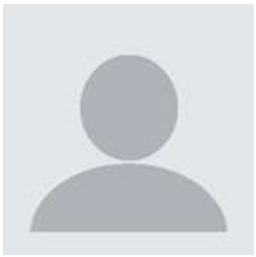
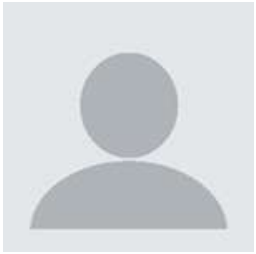
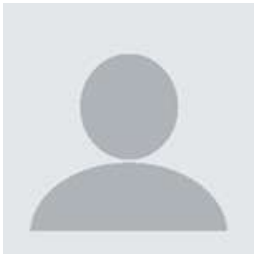
BIOGRAPHIES OF AUTHORS

	**Opiyo Baranabas,** is a researcher and faculty member in the Department of Agriculture, Faculty of Applied Sciences, Bishop Stuart University, Mbarara, Uganda. He specializes in agricultural research with a focus on climate change and its effects on smallholder farmers. As the lead and corresponding author, he has contributed significantly to investigating coping strategies of smallholder farmers to climate change effects in Northern Uganda. His research aims to inform government policies and development partners on sustainable agricultural interventions for climate-vulnerable farming communities in Sub-Saharan Africa. Email: lalogi03@gmail.com
	**Osiru David,** is a researcher and faculty member in the Department of Agriculture, Faculty of Applied Sciences, Bishop Stuart University, Mbarara, Uganda. He specializes in agricultural research with a focus on climate change impacts and adaptation strategies among smallholder farming communities. As a co-author, he has contributed significantly to investigating the coping strategies of smallholder farmers to the effects of climate change in Northern Uganda. His research supports the development of sustainable agricultural policies and interventions for climate-vulnerable communities in Sub-Saharan Africa.
	**Ssemakula Edward,** is a researcher and faculty member in the Department of Agriculture, Faculty of Applied Sciences, Bishop Stuart University, Mbarara, Uganda. He specializes in agricultural research with a focus on climate change variability and its impacts on smallholder farming communities in Uganda. As a co-author, he has contributed to investigating the coping strategies of smallholder farmers to the effects of climate change in Mucwini Sub County, Kitgum District, Northern Uganda. His research aims to promote sustainable agricultural practices and climate-resilient farming systems in Sub-Saharan Africa.
	**Kalibwani Rabecca,** is an academic and researcher affiliated with the Department of Agriculture, Faculty of Applied Sciences, Bishop Stuart University, Mbarara, Uganda. Her scholarly work centers on smallholder farming systems, rural livelihoods, and climate change vulnerability in Uganda. She has actively contributed to field-based research examining how rural farming households in Northern Uganda respond to climate-induced challenges such as droughts, floods, and famines. Her work seeks to bridge the gap between research findings and practical policy recommendations for improving food security and agricultural resilience in Sub-Saharan Africa.

	**Malinga M. Geoffrey,** is a researcher and faculty member in the Department of Biology, Faculty of Sciences, Gulu University, Gulu, Uganda. With a strong background in biological and environmental sciences, he brings an interdisciplinary perspective to agricultural and climate change research. His contribution to the study on smallholder farmers' coping strategies to climate change in Northern Uganda reflects his commitment to addressing environmental challenges affecting rural communities. His research bridges biological sciences and agricultural sustainability, aiming to develop evidence-based solutions for climate-resilient livelihoods in the Sub-Saharan African region.