

Climate variability and trends in coffee yields among smallholder farmers in Bunyangabu District, Uganda. A cross-sectional study.

Caleb Nahabwe*, Rev. Dr. Gershom Nuwemuhwezi, Dr. Wycliffe Tumwesigye

Directorate of Graduate Studies, Research Innovation, Bishop Stuart University

Page | 1

Abstract

Background

In recent years, climate change has increasingly threatened the livelihoods of millions of smallholder coffee farmers. The study aims to assess the average coffee yields of smallholder farmers over the past decade to climate change.

Methodology

A cross-sectional mixed-methods research design was employed to comprehensively investigate the impacts of climate change on coffee yield and the adaptation strategies of smallholder farmers in Bunyangabu District. This design combined quantitative and qualitative approaches to provide a holistic understanding of the complex issues involved. Statistical analysis, including descriptive statistics and inferential tests (correlation, regression), was employed to identify patterns, trends, and relationships between variables.

Results

The findings showed substantial declines in coffee yields over the past decade. Among farmers producing 501–1000 kilograms a decade ago, 46.4% had fallen below 500 kilograms, while 64.7% of those producing 1001–1499 kilograms had declined to 501–1000 kilograms. The highest yield category (>1500 kilograms) had a retention rate of only 18.8%. Overall, 69.6% of farmers reported yield declines, while 22.7% reported improvements. Yield change was significantly associated with its direction ($\chi^2 = 392.00$, $p < .001$, Cramer's $V = 1.00$), with 77.3% reporting declines and 22.7% improvements. Climate variability was the most reported driver (71.2%; $\chi^2 = 70.296$, $p < .001$), followed by pests and diseases (38.0%) and soil degradation (33.2%; $\chi^2 = 44.449$, $p < .001$). Poor agronomic practices were not significant ($\chi^2 = 0.010$, $p = 0.920$).

Conclusion

Climate variability was the predominant perceived driver of declining coffee yields among smallholder farmers in Bunyangabu District.

Recommendation

The government, through the Uganda Coffee Development Authority and Ministry of Agriculture, should establish a comprehensive coffee yield monitoring system that tracks annual productivity at the household level.

Keywords: Climate change, Average coffee yields, Smallholder farmers, Poor agronomic practices, Bunyangabu District.

Submitted: September 05, 2026 **Accepted:** September 16, 2026 **Published:** September 23, 2026

Corresponding author: Caleb Nahabwe

Email: caleb.nahabwe@gmail.com

Directorate of Graduate Studies, Research Innovation, Bishop Stuart University

Background

Agriculture and livelihoods in developing countries are highly dependent on climatic conditions. Smallholder farmers are particularly vulnerable to climate variability because their agricultural production systems often depend heavily on rainfall and have limited capacity to cope with climatic shocks (Mubiru et al., 2018; Mkonda et al., 2018). In recent years, climate change has increasingly threatened the livelihoods of millions of smallholder coffee farmers.

Coffee cultivation is particularly sensitive to changes in temperature and rainfall, making farmers vulnerable to declining productivity and changing production conditions (Craparo et al., 2015; Shiferaw & Kefale, 2021). Increasing temperatures, changing rainfall patterns and extreme weather events can adversely affect coffee growth and productivity, thereby threatening household incomes and livelihoods.

Agriculture remains an important component of Uganda's economy and provides employment and livelihoods for a large proportion of the population (Uganda Bureau of Statistics [UBOS], 2021). However, smallholder farmers across Uganda face a wide range of agricultural production risks, with climate change and variability presenting increasing risks and vulnerabilities. In Uganda, climate variability, including unpredictable rainfall, droughts and other extreme weather events, is already affecting agricultural production and rural livelihoods (Mubiru et al., 2018; Turyahabwe et al., 2022). These climatic changes create uncertainty in agricultural planning and can affect crop productivity, household food security and farmers' incomes.

Smallholder coffee farmers, who form an important part of the coffee production system, are particularly vulnerable to the impacts of climate change. Coffee farmers often operate with limited financial and technological resources and have restricted access to extension services, credit and other inputs required to respond effectively to changing climatic conditions (Cuni-Sanchez et al., 2022; Mulinde et al., 2019). Climate variability can affect coffee production through changes in temperature and rainfall, as well as through increased exposure to pests, diseases and extreme weather events (Mubiru et al., 2018; Craparo et al., 2015). Studies have shown that climate-related changes can significantly influence coffee productivity, with increasing temperatures associated with declining coffee yields in East African coffee-growing areas (Craparo et al., 2015). Understanding these vulnerabilities is therefore important for developing appropriate adaptation and support strategies for smallholder coffee farmers.

In Uganda, coffee production is also increasingly influenced by changing climatic conditions. Research on coffee-growing landscapes has documented farmers' perceptions of climate risks and the adaptation strategies they use to cope with these risks (Mulinde et al., 2019). More recent projections indicate that future climatic changes may alter the suitability of different areas for coffee production in Uganda, with potential implications for coffee productivity and the livelihoods of coffee-dependent households (Mulinde et al., 2022). Smallholder coffee farmers in Bunyangabu District, like farmers in other coffee-producing areas of Uganda, may therefore face challenges associated with changing rainfall patterns, increasing temperatures and extreme weather events. These challenges may disrupt

traditional farming practices and affect coffee yields and household income.

The vulnerability of smallholder coffee farmers is further influenced by their dependence on coffee as a source of household income. Limited access to financial resources, agricultural information, improved technologies and alternative livelihood opportunities may reduce farmers' ability to cope with climate-related production losses (Cuni-Sanchez et al., 2022; Turyahabwe et al., 2022). In addition, fluctuations in agricultural production can have implications for household food security because many smallholder farmers combine cash-crop production with food-crop cultivation. Climate-related reductions in agricultural productivity can therefore affect both household income and food availability (Mubiru et al., 2018).

Coffee production and food security are consequently closely interconnected in smallholder farming systems. Farmers may use income from coffee sales to purchase food, meet household needs and pay for essential services, while food crops may provide subsistence during periods of low coffee income. However, climatic shocks that reduce both coffee and food-crop production can increase household vulnerability and constrain farmers' ability to meet their livelihood needs (Cuni-Sanchez et al., 2022; Mubiru et al., 2018). Understanding changes in coffee productivity over time is therefore important for assessing the implications of climate variability for smallholder farmers and their households.

Despite evidence that climate change and variability affect coffee production in Uganda, there remains a need to examine how coffee yields have changed over time among smallholder farmers in specific coffee-producing districts. Assessing historical coffee yields alongside climatic conditions can provide useful evidence on changes in productivity and the potential contribution of climate variability to these changes. Therefore, this study aims to assess the average coffee yields of smallholder farmers in Bunyangabu District over the past decade and examine changes in coffee productivity in relation to climate variability. The study aims to assess the average coffee yields of smallholder farmers over the past decade to climate change.

METHODOLOGY

Study area

The study was carried out in Bunyangabu District located in the Western Region of Uganda. The park lies between latitude $0^{\circ} 06'$ South and $0^{\circ} 46'$ North and longitudes 29°

$47'$ West and $30^{\circ} 11'$ East. It shares borders with Kabarole District to the north, Kamwenge District to the east, Kasese District to the south, and Bundibugyo District to the west.

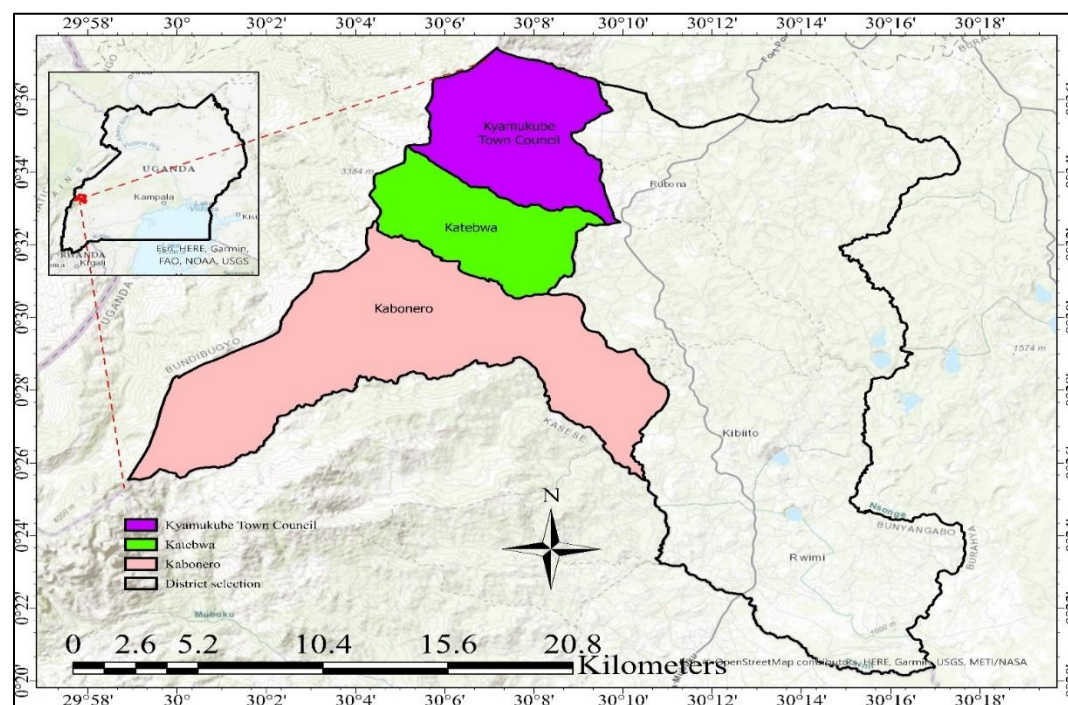


Figure 1: Map of Uganda showing location for Bunyangabu District

The study area is a key Robusta coffee-producing area dominated by smallholder farmers, making it an ideal microcosm for studying their livelihoods and contributions to national output. The district experiences a tropical climate with distinct wet and dry seasons, warm temperatures ($17-25^{\circ}\text{C}$), and highly variable rainfall that can cause both droughts and floods. Its varied topography includes rolling hills, fertile valleys, rivers, streams, mountains, and highlands, while soils range from lateritic and vertisols to acidic acrisols, generally with low fertility. Vegetation types consist of tropical rainforest, savanna, and montane forests, depending on altitude and rainfall. Critically, the district faces erratic weather patterns - prolonged droughts, unpredictable rains, and increased pests and diseases - that threaten coffee yields and quality. Since most smallholders

rely on rain-fed agriculture, their livelihoods are exceptionally vulnerable to climatic variability. This makes Bunyangabu a relevant site to investigate climate change impacts on coffee production, assess farmer resilience, and document indigenous or introduced adaptive strategies, with the goal of informing broader policy and interventions.

Study design

A cross-sectional mixed-methods research design was employed to comprehensively investigate the impacts of climate change on coffee yield and the adaptation strategies of smallholder farmers in Bunyangabu District. This design combined quantitative and qualitative approaches to provide a holistic understanding of the complex issues involved. Quantitative component involved a cross-sectional survey

that was conducted among a representative sample of smallholder coffee farmers in Bunyangabu District. Data was collected on coffee yields, socio-economic characteristics, demographic information, and climate-related variables. Statistical analysis, including descriptive statistics and inferential tests (correlation, regression), was employed to identify patterns, trends, and relationships between variables. Qualitative component involves an in-depth key informants interview and focus group discussions was conducted with a subset of survey participants to delve deeper into farmers' perceptions, experiences, and adaptation strategies related to climate change. Thematic analysis was used to identify key themes and patterns in the qualitative data.

The quantitative and qualitative findings were triangulated to provide a comprehensive and nuanced understanding of the challenges faced by smallholder coffee farmers in Bunyangabu District. This integrated approach allowed for the identification of causal relationships, underlying factors, and the effectiveness of adaptation strategies (Kishaija et al., 2022). Descriptive statistics, including frequencies, percentages, and means, were used to summarize the data. To complement the quantitative findings, an interpretive approach was employed through in-depth interviews and focus group discussions to explore respondents'

perceptions, experiences, and coffee yields. Thematic analysis was used to identify key themes and patterns in the qualitative data. This mixed-methods design provided a comprehensive understanding of the factors affecting small farmer in Bunyangabu District.

Sampling procedure

From the reconnaissance of the study area Bunyangabu district was composed of seven sub counties and three (Kyamukube, Kabonero and Kateebwa), were purposively chosen for study due to dominance of coffee growing. From the seven villages, four villages with the highest human population were purposively selected. With the support of the local field guide and local leaders, households in the selected villages were enlisted. Simple random sampling was used to select respondents from the compiled list of households in the village. The sampling of respondents targeted the youth, women and men above 18 years of age. The sample size was derived using Yamane's formula, $n = \frac{N}{1+Ne^2}$ where n is sample size, N is the population size and e is the acceptable error value of 0.05, making 392 respondents (Mugagga, 2017; Mugagga et al., 2019)

Using the formula, the sample size (n) was 392 respondents, distributed in villages as indicated in Table 1.

Table 1: Sample size per village in selected sub-counties in Bunyangabo District

Sub county	Households	Proportion	Sample size
Kateebwa	4,761	23.4%	92
Kabonero	8,969	44.0%	172
Kyamukube	6,645	32.6%	128
Total	20,375	100%	392

A sample of 20,375 respondents was determined using the sampling formula, considering the precision level of $\pm 5\%$. Due to resource constraints with larger sample number, redetermination was done until 392 sample size. Given the potential for variability in the population, a maximum variability of 0.5 was assumed

Data collection methods and tools

Secondary and primary methods of data collection were used. A combination of questionnaires, focus group

discussions and key informant interviews was applied to collect data and this facilitated a deeper understanding of the variables. Secondary data sources included journal articles, reports from governmental and non-governmental agencies and weather stations.

The primary data sources included household questionnaire interviews, key informant interviews, focus group discussions and physical observations (conducted through field visits to observe and record or photograph the state of the wetland resource, kinds of destruction/encroachment and existing conservation and restoration

projects/institutions). The survey questionnaire was administered to households of the local communities of selected villages. The study hired research assistants who were trained to administer the questionnaires to the respondents. The research assistants were conversant with the local language to aid in the interpretation of the questions for those who could not read or understand. The questionnaire collected data on local community socio-economic and demographic attributes, effects of climate change on coffee yields, perceptions of climate change, their adaptation strategies.

Key respondents such as environmental field officers, local leaders and heads of Non-Government Organisations (NGOs) and Community Based Organisations (CBOs) were also interviewed using key informant interview guide. The key informant interviews (KIIs) enabled the study to collect data on opportunities for enhancing local community participation in restoration activities. The KIIs were also used to triangulate data collected using the participant survey.

Focus group discussions (FGDs) were conducted with different categories of resource user groups and social categories. Respondents to include in the FGDs 8-12 people per village were purposively selected with guidance from local leaders and a field guide to ensure all participants selected have something to contribute about the discussion (Cuni-sanchez et al., 2022). The different categories enabled the study to identify and interrogate any variation in perception and impacts of climate change and their mitigation strategies. The study moderated each FGD, guided by a checklist and a field guide, and each session lasted about one hour.

Key secondary sources included production and yields from the Uganda Coffee Development Authority (UCDA), which provides data on current coffee trends over time. Weather and climate data from the Uganda National Meteorological Authority (UNMA) helped track rainfall and temperature patterns in the region. In addition, relevant documents from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) offered policy insights and national strategies on climate change adaptation in agriculture. Where applicable, reports from NGOs and development partners working in the district, such as those supporting climate resilience and

adaptation, were also being reviewed for practical community-level experience.

Validity and Reliability

To ensure validity, climate change and agricultural supervisors developed and reviewed all data collection tools, and the tools were pilot-tested in a neighbouring area. This helped to identify ambiguous questions and make necessary corrections before the actual data collection began, ensuring alignment with key variables drawn from the literature on climate change and coffee. Reliability was ensured through standardised administration of data collection tools and by training research assistants on ethical considerations, neutrality, and consistency in data collection. The use of triangulation i.e., combining interviews, questionnaires, and observations further strengthened reliability by cross-verifying data from multiple sources.

Data Analysis

To address the study objectives and examine the effects of climate change on coffee production among smallholder farmers in Bunyangabu District, both quantitative and qualitative analytical approaches were employed.

The quantitative data collected through the cross-sectional survey were analysed using R statistical software. Descriptive statistics were employed to summarize the data, including measures of central tendency (mean, median, mode) and dispersion (standard deviation, range) for key variables such as coffee yield, farm size, and household income. To assess the relationship between climate variables (temperature, rainfall) and coffee yield, correlation analysis was conducted.

Furthermore, regression analysis was used to model the impact of climate variables, socio-economic factors, and other relevant variables on coffee yield. To compare coffee yields across different groups (e.g., age, gender, farm size), analysis of variance (ANOVA) was employed. Additionally, to explore potential non-linear relationships between variables, non-parametric statistical tests, such as Spearman's rank correlation coefficient, may be considered.



Student's Journal of Health Research Africa

e-ISSN: 2709-9997, p-ISSN: 3006-1059

Vol.7 No. 3 (2026): September 2026 Issue

<https://doi.org/10.51168/xgvr7d44>

Original Article

The qualitative data collected through in-depth interviews and focus group discussions was analyzed using thematic analysis. Audio recordings and transcripts were coded to identify recurring themes and patterns related to farmers' perceptions of climate change, adaptation strategies, and challenges. Thematic analysis involved identifying, coding, and categorizing data to generate insights into the qualitative data.

The findings from the quantitative and qualitative analyses were integrated to provide a comprehensive understanding of the research problem. Triangulation of data was used to validate and corroborate findings from both data sources. The interplay between quantitative results (average coffee yield, correlation coefficients) and qualitative insights

(farmers' perceptions of yield changes) was explored to deepen understanding of the factors influencing coffee production.

Ethical considerations

To safeguard participant rights and uphold research integrity, this study adheres to stringent ethical principles. Informed consent was obtained from all participants, emphasizing voluntary participation, data confidentiality, and potential risks and benefits. Participant anonymity was maintained through data coding and secure storage.

RESULTS

The demographic characteristics

Table 2: Demographic characteristics

Characteristic	Frequency (n=392)	Proportion (%)
Gender		
Female	143	36.5
Male	249	63.5
Age		
Below 25 years	24	6.1
25 - 34 years	103	26.3
35 - 44 years	113	28.8
45 - 54 years	96	24.5
Above 55 years	56	14.3
Marital status		
Single	25	6.4
Married	326	83.2
Divorced	21	5.4
Widowed	20	5.1
Level of education		
No schooling	55	14.0
Primary	157	40.1
Secondary	132	33.7
Tertiary	48	12.2
Experience with coffee		
Below 5 years	13	3.3
5 - 10 years	41	10.5
11 - 15 years	86	21.9
Above 15 years	252	64.3
Size of the land under coffee		
Below 1 acre	107	27.3
1 - 2 acres	182	46.4
3 - 5 acres	73	18.6
Above 5 acres	30	7.7
Coffee farming is the main source of income (Yes)	358	91.3
Access to agricultural credit (Yes)	255	65.1
Member of a coffee farmers group (Yes)	180	45.9

The sample is characterized by a majority of male farmers (63.5%), reflecting common gender disparities in agricultural land ownership and decision-making in many smallholder contexts, while the age distribution shows a substantial cohort of middle-aged farmers (35-54 years,

53.3%) with extensive farming experience (64.3% having over 15 years), suggesting deep traditional knowledge but potentially limiting exposure to new agricultural innovations. Critically, the high dependence on coffee as the main income source (91.3%) combined with small landholdings (73.7% farming ≤ 2 acres) creates significant

economic vulnerability to climate-driven yield fluctuations, as these farmers have limited livelihood diversification options to buffer against production shocks. While educational attainment appears relatively limited (only 12.2% with tertiary education), potentially constraining the adoption of complex climate adaptation strategies, the reasonably high access to agricultural credit (65.1%) presents a crucial opportunity for investing in resilience-building measures.

The nearly even split in farmer group membership (45.9% versus 54.1%) suggests room for improved collective action, which has been shown to significantly enhance smallholders' access to information, resources, and markets for climate adaptation (Wollenberg et al., 2019). This demographic configuration implies that climate vulnerability is mediated not just by environmental exposure but by socioeconomic factors including land size, income diversification, and social capital.

There is a need for targeted interventions that address these specific demographic realities: gender-inclusive programs

that ensure women's participation in adaptation planning, knowledge transfer approaches that build upon existing experiential knowledge while introducing science-based practices, financial products tailored to smallholders' needs for climate investment, and strengthened farmer organisations to facilitate collective learning and action. As noted by Djoudi et al. (2016), understanding these intersecting social dimensions is essential for developing equitable and effective climate adaptation strategies that reach the most vulnerable smallholders whose livelihoods are threatened by climate change.

Coffee yields of smallholder farmers over the past decade to climate change

The transition matrix of coffee yields over the past decade reveals a pronounced pattern of attrition and a concerning downward shift in productivity among smallholder farmers. A significant proportion of farmers previously in higher yield brackets have fallen into lower categories, indicating widespread yield decline rather than stable or improved production.

Table 3: Coffee yields reported by farmers

	Coffee yields 10 years ago				
	Below 500 (n=132)	501 - 1000 (n=138)	1001 - 1499 (n=85)	Above 1500 (n=16)	Not applicable (n=21)
Current Yields					
Below 500kgs	48 (36.4%)	64 (46.4%)	21 (24.7%)	0 (0%)	11 (52.4%)
501 - 1000kgs	71 (53.8%)	34 (24.6%)	55 (64.7%)	7 (43.8%)	9 (42.9%)
1001 - 1499kgs	13 (9.8%)	33 (23.9%)	4 (4.7%)	6 (37.5%)	1 (4.8%)
Above 1500kgs	0 (0%)	7 (5.1%)	5 (5.9%)	3 (18.8%)	0 (0%)

From the Table 2, a staggering 46.4% of farmers who a decade ago produced between 501 and 1000 kilograms have now fallen below 500 kilograms, and nearly two-thirds (64.7%) of those in the 1001-1499 kilograms range have dropped down to the 501-1000 kilograms bracket. This pattern of cascading decline is further evidenced by the

minimal upward mobility; very few farmers in any lower category managed to advance to a higher yield bracket, and the highest category i.e., above 1500 kilograms shows the lowest retention rate (18.8%), suggesting even the most productive farms are not immune to these pressures.

Coffee yield changes and direction of change

Table 4: Coffee yield change experience and direction of yield change

	Did you experience a change in the yield of coffee?		
	No (n=39)	Yes (n=353)	Overall (n=392)
Direction of change			
No change	39 (100%)	0 (0%)	39 (9.9%)
Declined	0 (0%)	273 (77.3%)	273 (69.6%)
Improved	0 (0%)	80 (22.7%)	80 (20.4%)

Note. $\chi^2(n) = 392.00$, $p < .001$, Cramer's V = 1.00.
** $p < .001$

The chi-square test of independence revealed a perfect and statistically significant association between farmers' experience of yield change and its direction ($\chi^2 = 392.00$, $p < .001$, Cramer's V = 1.00), demonstrating that all farmers who reported no yield change maintained stable production while those experiencing changes faced predominantly negative outcomes (77.3% declines versus 22.7% improvements).

The concerning prevalence of yield declines (affecting 69.6% of all farmers) suggests significant climate vulnerability in coffee production systems, highlighting the urgent need for targeted adaptation interventions.

The finding that 22.7% of farmers reported yield improvements (20.4% of all farmers) despite climate challenges indicates that successful adaptation strategies exist.

Farmers reasons for change in the coffee yields

Table 5: Reasons for change in the coffee yields

Reason	Frequency (n=392)	Proportion (%)	χ^2	p-value
Climate variability				
Yes	279	71.2	70.296	<0.001***
No	113	28.8		
Soil degradation				
Yes	130	33.2	44.449	<0.001***
No	262	66.8		
Pests and diseases				
Yes	149	38.0	22.541	<0.001***
No	243	62.0		
Poor agronomic practices				
Yes	195	49.7	0.010	0.920
No	197	50.3		

The overwhelming attribution of yield changes to climate variability by most farmers (71.2%, $\chi^2 = 70.296$, $p < 0.001$) clearly identifies it as the predominant perceived driver of

productivity challenges, significantly outweighing other factors such as soil degradation (33.2%) and pests and diseases (38.0%). This perception is not merely anecdotal but aligns strongly with the established biophysical impacts

of climate change on coffee systems. The fact that pests and diseases were cited by more than a third of farmers (38.0%) is particularly noteworthy.

The significant attribution of yield changes to soil degradation by a substantial minority of farmers (33.2%, $\chi^2 = 44.449$, $p < 0.001$) reveals a critical underlying vulnerability within the coffee production system, where chronic soil fertility decline interacts synergistically with climate stressors to drive yield losses.

The near-equal split on poor agronomic practices (49.7% vs. 50.3%, $\chi^2 = 0.010$, $p = 0.920$) suggests farmers do not view their own management as a primary systematic cause, indicating either a potential knowledge gap or an externalization of responsibility that could hinder the adoption of improved practices.

Discussion

The overwhelming attribution of yield changes to climate variability by most farmers (71.2%, $\chi^2 = 70.296$, $p < 0.001$) identifies climate variability as the predominant perceived driver of productivity challenges. This proportion was substantially higher than those attributing yield changes to pests and diseases (38.0%) and soil degradation (33.2%), suggesting that farmers predominantly experience climate-related factors as the most immediate constraint to coffee production. This perception is consistent with evidence that climatic changes can adversely affect coffee growth, development, yield, and quality.

Increased temperatures can directly stress coffee plants, accelerating berry development and shortening the growth cycle, thereby compromising bean quality and weight, including the occurrence of poorly developed or “empty” berries (Craparo et al., 2015; Ovalle-Rivera et al., 2015). Similarly, changes in flowering patterns associated with climate variability can alter coffee sensitivity to temperature and other climatic stresses, with consequences for yield (Kath et al., 2023). Erratic rainfall and prolonged dry spells can further disrupt flowering and fruit development, contributing to variability in coffee productivity (Kath et al., 2023; Ovalle-Rivera et al., 2015). The high proportion of farmers identifying climate variability therefore suggests that they perceive changes in climatic conditions as a

tangible and immediate threat to coffee productivity rather than simply as a future environmental concern.

The prominence of climate variability also has implications for agricultural extension and adaptation programming. Farmers may be particularly receptive to interventions that directly address climate-related production constraints, including the use of climate-resilient coffee varieties, water harvesting, soil-moisture conservation, and shade management. However, these interventions should be implemented alongside broader agronomic measures because climate-related stresses interact with other production constraints rather than operating independently.

Pests and diseases were identified by 38.0% of farmers, making them another important perceived contributor to yield changes. This finding is particularly relevant because climatic conditions can influence the distribution, development, and population dynamics of agricultural pests and diseases. Changes in temperature may alter insect development and reproduction, while climatic stress can weaken plants and increase their susceptibility to biological threats (Ghini et al., 2011; Jaramillo et al., 2011). Climate change has also been associated with shifts in the distribution of coffee pests, including the Coffee Berry Borer (*Hypothenemus hampei*), potentially exposing coffee-growing areas at higher elevations to pest pressures that were previously less pronounced (Jaramillo et al., 2011; Ovalle-Rivera et al., 2015).

The coexistence of climate variability and pest and disease pressures indicates that coffee farmers may face interacting rather than isolated production constraints. Drought and irregular rainfall can increase plant stress, while favourable temperature conditions may support pest development and spread. Consequently, pest and disease management should form part of broader climate-smart coffee production strategies rather than being treated solely as a separate, reactive intervention. Integrated pest management, regular field monitoring, appropriate cultural practices, and climate-resilient production approaches may therefore be important components of efforts to reduce yield losses.

Soil degradation was identified by 33.2% of farmers, with the association being statistically significant ($\chi^2 = 44.449$, $p < 0.001$). Although this proportion was lower than that identifying climate variability, the finding highlights an

important underlying vulnerability within the coffee production system. Declining soil fertility, loss of organic matter, and deterioration of soil structure can reduce the capacity of soils to retain water and supply nutrients, potentially increasing the vulnerability of coffee plants to drought and other climatic stresses (Lal, 2011).

Healthy soils are important for agricultural resilience because soil health influences water availability, nutrient cycling, crop productivity, and the capacity of agricultural systems to withstand environmental stresses (Lal, 2011). Sustainable land management practices can also contribute to climate adaptation by improving soil condition and reducing vulnerability to climate-related stresses (Branca et al., 2013). The relatively lower proportion of farmers identifying soil degradation may partly reflect the slower and less immediately visible nature of soil deterioration compared with noticeable changes in rainfall or temperature. This finding highlights the importance of extension services in demonstrating the relationship between soil health, water retention, nutrient availability, and resilience to climatic variability. Integrated soil fertility management, mulching, organic matter incorporation, erosion control, and appropriate nutrient management could therefore complement climate adaptation interventions.

In contrast, farmers were almost evenly divided regarding poor agronomic practices, with 49.7% attributing yield changes to this factor and 50.3% not doing so ($\chi^2 = 0.010$, $p = 0.920$). The non-significant result indicates that there was no statistically significant difference between farmers who attributed yield changes to poor agronomic practices and those who did not. This suggests that farmers did not perceive poor agronomic practices as a dominant or consistently experienced explanation for changes in coffee yields. Nevertheless, the near-even distribution indicates that agronomic management remains relevant to a substantial proportion of farmers and should not be overlooked in intervention planning.

Overall, the findings demonstrate that farmers perceive coffee yield changes as resulting from a combination of climatic, biological, soil-related, and management factors, although climate variability was the most frequently reported factor. These factors are likely to interact: climatic variability can intensify environmental stresses, while diversified and resilient agricultural systems can help buffer

production against climate variability and reduce vulnerability to pest and disease pressures (Lin, 2011). Therefore, interventions focused exclusively on a single perceived cause may not adequately address the interconnected constraints affecting coffee productivity.

The findings consequently support an integrated approach to coffee production that combines climate adaptation, soil-health management, pest and disease control, and improved agronomic practices. Such an approach would respond to the concerns most frequently expressed by farmers while also addressing less visible underlying production constraints. Extension programmes should therefore link farmers' experiences of climate variability with practical measures for improving soil health, conserving moisture, managing pests and diseases, and strengthening overall farm resilience.

Conclusion

Climate variability was the predominant perceived driver of declining coffee yields among smallholder farmers in Bunyangabu District.

Recommendations

The government, through the Uganda Coffee Development Authority and Ministry of Agriculture, should establish a comprehensive coffee yield monitoring system that tracks annual productivity at household level to enable early detection of decline patterns, while implementing a stratified support program that provides differentiated assistance based on farmers' current yield category - rehabilitation support for those in the lowest bracket, sustainable intensification practices for middle brackets to halt further decline, and resilience strategies to protect highest-yielding farms as community assets.

Acknowledgement

First and foremost, I render all glory, honor, and praise to God Almighty, the Source of wisdom, strength, and divine grace, whose mercy has sustained me throughout this scholarly pursuit. It is by His unfailing guidance and providence that I have been able to bring this research to fruition.



Student's Journal of Health Research Africa

e-ISSN: 2709-9997, p-ISSN: 3006-1059

Vol.7 No. 3 (2026): September 2026 Issue

<https://doi.org/10.51168/xgvr7d44>

Original Article

I am profoundly indebted to Bishop Stuart University for granting me the academic platform upon which this intellectual journey was anchored. My heartfelt appreciation extends to the University Administration, Faculty, and Staff, whose dedication, mentorship, and institutional support created an enabling environment for both academic excellence and personal growth.

With deep respect and admiration, I extend my sincerest gratitude to my supervisors, Dr. Tumwesigye Wycliffe and Rev. Dr. Gershom Nuwemuhwezi, for their exceptional mentorship, insightful critiques, and steadfast encouragement. Their scholarly rigor, patience, and commitment to excellence profoundly enriched this work, and it has been an honor to learn under their wise supervision.

To my beloved wife, Mrs. Oliver Nahabwe Nalongo, and my cherished family, I owe an immeasurable debt of love and gratitude. Your prayers, unwavering faith, and countless sacrifices have been the pillars upon which this achievement rests. Your belief in my calling and purpose fortified my resolve during the most demanding stages of this endeavor. Truly, this accomplishment belongs to you as much as it does to me.

I am equally grateful to the Bunyangabu District community, particularly the smallholder farmers, key informants, and local leaders who graciously shared their experiences and insights. Their resilience, openness, and cooperation form the very heartbeat of this study and lend authenticity to its findings.

Lastly, my appreciation extends to my friends, colleagues, and all who, in diverse yet meaningful ways, contributed to the success of this academic pursuit. Your encouragement, moral support, and gestures of goodwill rendered this journey not only bearable but profoundly fulfilling.

To all who stood with me in faith, knowledge, and perseverance, thank you.

List of abbreviations

UBOS: Uganda Bureau of Statistics

UNMA: Uganda National Meteorological Authority

UCDA: Uganda Coffee Development Authority

CBOs: Community Based Organisations

NGOs: Non-Governmental Organisations

MAAIF: Ministry of Agriculture, Animal Industry and Fisheries

KIIs: Key Informant Interviews

FGDs: Focus Group Discussions

Source of funding

The study was not funded

Conflict of interest

The author did not declare any conflict of interest

Data availability

Data is available upon request

Author contribution

Caleb Nahabwe; Conceptualisation, Funding acquisition, Methodology, Writing – original draft, Resources

Rev. Dr Gershom Nuwemuhwezi; Supervision, Validation, Visualisation, Data curation, Formal analysis, Investigation

Dr Wycliffe Tumwesigye; Project administration, Supervision, Writing – review & editing

Author biography

Caleb Nahabwe Is a student of a master degree of science in climate change and food security at Bishop Stuart University

Rev. Dr Gershom Nuwemuhwezi is a research supervisor at Bishop Stuart University

Dr Wycliffe Tumwesigye is a research supervisor at Bishop Stuart University

References

1. Branca, G., Lipper, L., McCarthy, N., & Jolejole, M. C. (2013). Food security, climate change, and sustainable land management: A review. *Agronomy for Sustainable Development*, 33, 635–650. <https://doi.org/10.1007/s13593-013-0133-1>
2. Craparo, A. C. W., van Asten, P. J. A., Läderach, P., Jassogne, L. T. P., & Grab, S. W. (2015). Coffee arabica yields decline in Tanzania due to climate change: Global implications. *Agricultural and Forest Meteorology*, 207, 1–10. <https://doi.org/10.1016/j.agrformet.2015.03.005>
3. Cuni-Sanchez, A., Twinomuhangi, I., Aneseyee, A. B., Mwangi, B., Olaka, L., Bitariho, R., Soromessa, T., Castro, B., & Zafra-Calvo, N. (2022). Everyday adaptation practices by coffee farmers in three mountain regions in Africa. *Ecology and Society*, 27(4), 32. <https://doi.org/10.5751/ES-13622-270432>
4. Ghini, R., Bettiol, W., & Hamada, E. (2011). Diseases in tropical and plantation crops as affected by climate changes: Current knowledge and perspectives. *Plant Pathology*, 60(1), 122–132. <https://doi.org/10.1111/j.1365-3059.2010.02403.x>
5. Jaramillo, J., Muchugu, E., Vega, F. E., Davis, A., Borgemeister, C., & Chabi-Olaye, A. (2011). Some like it hot: The influence and implications of climate change on coffee berry borer (*Hypothenemus hampei*) and coffee production in East Africa. *PLoS ONE*, 6(9), e24528. <https://doi.org/10.1371/journal.pone.0024528>
6. Kath, J., Byrareddy, V. M., Reardon-Smith, K., & Mushtaq, S. (2023). Early flowering changes robusta coffee yield responses to climate stress and management. *Science of the Total Environment*, 856, 158836. <https://doi.org/10.1016/j.scitotenv.2022.158836>
7. Lal, R. (2011). Soil health and climate change: An overview. In B. P. Singh, A. L. Cowie, & K. Y. Chan (Eds.), *Soil health and climate change* (pp. 3–24). Springer. https://doi.org/10.1007/978-3-642-20256-8_1
8. Mkonda, M. Y., He, X., & Sandell Festin, E. (2018). Comparing smallholder farmers' perception of climate change with meteorological data: Experience from seven agroecological zones of Tanzania. *Weather, Climate, and Society*, 10(3), 435–452. <https://doi.org/10.1175/WCAS-D-17-0036.1>
9. Mubiru, D. N., Radeny, M., Kyazze, F. B., Zziwa, A., Lwasa, J., Kinyangi, J., & Mungai, C. (2018). Climate trends, risks and coping strategies in smallholder farming systems in Uganda. *Climate Risk Management*, 22, 4–21. <https://doi.org/10.1016/j.crm.2018.08.004>
10. Mulinde, C., Majaliwa, J. G. M., Twinomuhangi, R., Mfitumukiza, D., Komutunga, E., Ampaire, E., Asimwe, J., Van Asten, P. J. A., & Jassogne, L. (2019). Perceived climate risks and adaptation drivers in diverse coffee landscapes of Uganda. *NJAS: Wageningen Journal of Life Sciences*, 88(1), 31–44. <https://doi.org/10.1016/j.njas.2018.12.002>
11. Ovalle-Rivera, O., Läderach, P., Bunn, C., Obersteiner, M., & Schroth, G. (2015). Projected shifts in *Coffea arabica* suitability among major global producing regions due to climate change. *PLoS ONE*, 10(4), e0124155. <https://doi.org/10.1371/journal.pone.0124155>
12. Shiferaw, A., & Kefale, D. (2021). Effects of climate variability on coffee production and determinants of adaptation mechanisms: The case of small-holder farmers at Dara Woreda, South Ethiopia. *Frontiers*, 1(4), 54–64. <https://doi.org/10.11648/j.frontiers.20210104.12>
13. Turyahabwe, R., Turybanawe, L. G., Asaba, J., Mulabbi, A., & Geofrey, M. (2022). Factors affecting adoption of climate change adaptation strategies by small holder farmers in mountain and lowland agro-ecological zones of Eastern Uganda. *Forum Geographi*,



Student's Journal of Health Research Africa

e-ISSN: 2709-9997, p-ISSN: 3006-1059

Vol.7 No. 3 (2026): September 2026 Issue

<https://doi.org/10.51168/xgvr7d44>

Original Article

36(2),
<https://doi.org/10.23917/forgeo.v36i2.16231>

136–148.

14. Uganda Bureau of Statistics. (2021). *Statistical abstract 2021*. Uganda Bureau of Statistics.

PUBLISHER DETAILS

Page | 14

Student's Journal of Health Research (SJHR)

(ISSN 2709-9997) Online

(ISSN 3006-1059) Print

Category: Non-Governmental & Non-profit Organization

Email: studentsjournal2020@gmail.com

WhatsApp: +256 775 434 261

Location: Scholar's Summit Nakigalala, P. O. Box 701432,
Entebbe Uganda, East Africa

