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CLIMATE RISK SCREENING FOR FOOD SECURITY IN KARENGA AND KAPCHESOMBE DISTRICTS, EVIDENCE FOR POLICY, UGANDA

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Abstract

Geographically, the Karenga and Kapchesombe Districts communities close to the Mount Elgon and Kidepo Valley National Parks, respectively are the focus of the climate change risk analysis. The influence of climate change on the availability of food is examined in this study, along with the methods employed by small-scale farmers in the two districts to adjust to changing family food requirements. A decrease in crop and fodder output is one of the implications of climate change and seasonal variations on food security. It has been noted that rainfall variability is the main factor affecting households' food security. 74.4 percent of the 379 respondents were able to adapt to addressing challenges related to food shortages through buying less expensive food, having meals for 4 days a week, reducing the size of meals in 7 days, and restricting consumption to certain times; but more respondents reported reducing the number of meals. In Karenga, meals were not regular and the majority missed critical meals such as breakfast and lunch which was replaced by local brew. The main barriers to food security were: inadequate financial resources, not being knowledgeable, looking at climate change as a natural calamity, lack of skills of adaptation, and inadequate labor to produce more food.

Keywords: Climate change, Food security, Adaptation, Barriers

1 Introduction

Climate is a significant issue in East Africa in general and Uganda in particular because it affects all facets of development, primarily agriculture and household livelihoods. After all, Uganda's agriculture is rainfed (Sebukera *et al*., 2023; Tiyo *et al*., 2015; Okonya *et al*., 2013). Thus Uganda's agricultural sector, which is dominated by small-holder farmers implementing livestock keeping and mixed crop farming is vulnerable to the adverse impacts of climatic changes and high seasonal variability in the country

(PanelDalson *et al*., 2022; IPCC 2014; Egeru *et al*., 2014; FAO, 2010). The growing consensus in the scientific literature (FAO, 2010; IPCC, 2020; IPCC, 2021) has established the adverse impacts of climate change on agriculture as very sensitive because sound climate-smart agriculture is the basis of food security. This study postulates that food security is enhanced in terms of sufficient food production, quality, availability, and access to food that is affordable. The same authors underpin the accumulation of Greenhouse gases least caused by developing countries in the atmosphere, which is responsible for unpredictable seasonal changes rendering the people vulnerable to adverse effects of extreme climate events and food insecurity due to their suppression effects on agricultural and food production, with dire effects of food security.

According to literature (FAO, 1996; FAO, 2022, When a community lacks access to sufficient safe, nourishing food for normal growth, development, and active, healthy life—all in line with the UN Sustainable Development Goals (SDGs) II no hunger in families and households it is considered food insecure. This renders communities vulnerable and impedes normal growth and development. Contrary, communities are food secure when equipped with physical, social, and economic access to adequate, safe, and nutritious food that meets dietary needs and food preferences for active and healthy lives (FAO, 1996; FAO, 2009; FAO, 2022 a, b; Giller, 2020). According to the scientific community (Okonya et al., USAID, 2012; Kansiime et al., 2012; Maponya & Mpandeli, 2012), Uganda has traditionally suffered significant financial losses as a result of extreme weather occurrences like protracted droughts and torrential downpours. The anticipated effects of climate change have compounded the damage, impeding progress in vital domains including food security, health, economic growth, and water resource management.

Uganda's hunger condition is presented as a total quandary by analysis of the Global Hunger Index (2018), even with the government's agricultural modernization initiative. Despite Uganda's reputation as the breadbasket of East Africa, the Global Hunger Index (GHI) of 2018 shows that hunger has increased among the country's population, with a score of 31.2 compared to 26.4 in 2016. Uganda's GHI Index score of 31.2 is higher than that of its immediate neighbors (Kenya, 23.3; Tanzania, 29.5; Rwanda, 28.7) as well as the sub-Saharan Africa regional average of 29.4 (GHI, 2018). The important role that young people and the vulnerable play in building food systems that uphold the right to sufficient food for the present and the future is examined in the 2023 Global Hunger Index. According to USAID (2012), the Karamoja sub-region is one of the most vulnerable regions in Uganda to challenges of climate change and seasonal variability due to low adaptive capacity and inability to access adaptation skills and technology. Indeed, the GHI (2022) has also stated that the national progress against hunger has stagnated. This study adds that factors such as corruption, lack of sufficient agro-inputs, extension services, and skill in part explain the agricultural and food security stagnation in the country. Indeed, the GHI (2022) figures reveal the overlapping crises facing Uganda showing the inadequate food systems, at local, national, and regional levels simply highlighting the extent and level of vulnerability of the population in the country. Analysis from USAID (2012) and GHI (2022), 'reveals that the stagnation against hunger is high at an alarming levels in certain parts of the country, exacerbated by climatic extremes especially in northern, northeastern and eastern Uganda'.

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Analytical studies (Sebukeera *et al*., 2023; FAO, 2022a; Okonya *et al*., 2013; USAID, 2012; Kansiime, 2014; GHI, 2018; UNFCCC, 2008) with consensus that the historical weather and climate indicate that, there is rise in average temperature of about 1.3°C since 1960, with the greatest increase in January and February; decrease in annual rainfall at a rate of 3.5 cm per annum,. With greater reductions in the wet months (March to May). Indeed, extreme events can have a high cost. USAID (2012) has pointed out that climate impacts of the greatest significance for agriculture and food security are temperature rises and more frequent occurrences of drought that will diminish soil moisture and accelerate soil erosion, affecting land arability and reducing the extent of agricultural land. The high impact of climate change on food security will reduce the number of days in which conditions are conducive to growth resulting in shorter growing seasons. On the other hand, an increase in extreme droughts and floods increases stress on crops due to great incidences of temperature extremes, decreasing yields of key food crops such as groundnuts, beans, bananas, and cassava. These situations cause food scarcity coupled with low adaptive capacity poor agronomy and inadequate agro-inputs undermining food security, causing food shortages among the local communities.

Studies have shown that African small-scale farmers have perceived and responded differently tackling food shortages (Sebukeera *et al*., 2023; Okwango *et al*., 2017; Chaplin *et al*., 2017; Mugaga *et al*., 2022), but these studies have not been generally throughout Uganda. None of these studies have focused on the district areas of Karenga and Kapchesombe (North Karamoja and Sebei sub-regions respectively). This study focuses on food security analysis in the districts of Karenga and Kapchesombe because these areas are in fragile ecosystems and vulnerable to climate change and adjacent to the national parks of Kidepo Valley and Mount Elgon National Parks. The small-scale farmers in Karenga and Kapchesombe place a lot of emphasis on agricultural production, yet the households are food insecure due to low adaptive capacity, poor agronomic techniques, lack of access to adaptation technology, and food scarcity which is a function of the stated factors. This study is different because it seeks to investigate food security status in households and analyze adaptation strategies in the study area. It posits, that the food situation varies from one homestead to another, and from lowland to highland agroecologies in the study area.

FAO (1996) introduces four dimensions of food security (physical availability of food; economic and physical access to food; food utilization; and food stability) which must always be there in a food-secure community. For this study, the first dimension of food security 'food availability' will be adopted for this study. Parameters such as temperature standardization for the Karenga, effect of rainfall variability on agriculture; how changes in rainfall variability affected crop production; climate change variability effects on food security; rainfall variability as a major factor affecting households; whether there is adaptation or not; adaptation strategies to food insecurity; and strategies to mitigate food security challenges were analyzed because they influence food production and security.

Therefore the purpose of this study was to: examine households' food security in the study areas.

Their choice is due to the areas being vulnerable to climatic changes. The study objectives were to: 1) determine climatic changes in Karenga and Kapchesombe districts; 2) assess the impact of climate change on food security in Karenga and Kapchesombe districts; 3) evaluate small-scale farmers

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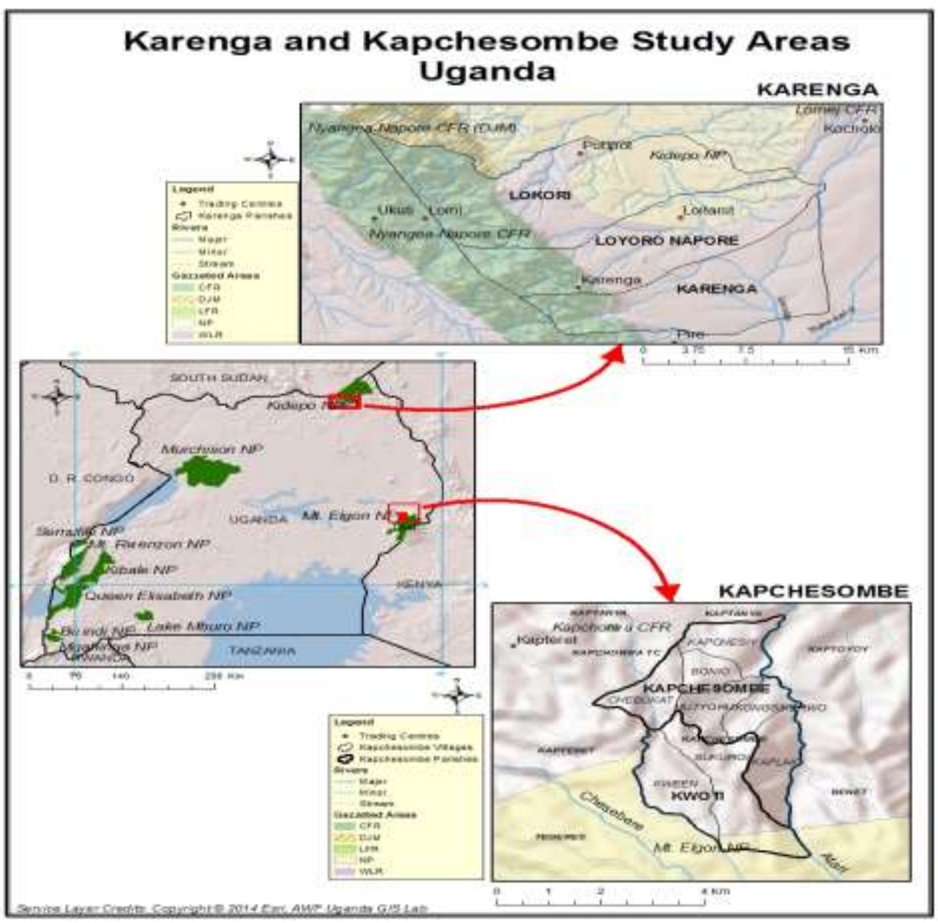
strategies to address food security in Karenga and Kapchesombe districts; 3) and Propose recommendations to address challenges of food security in the two districts.

2 Study area

This study was done five kilometers within areas bordering Kidepo Valley and Mount Elgon National Parks for Karenga and Kapchesombe districts respectively (figure 1). Karenga is located at the latitudes of 03° 54'N – 33°51'E along the South Sudan and Kenya borders. The local communities here are the Ateker-speaking Nyangia and Napore ethnic groups related to the major Ateker-speaking Karimojong. Most of the people derive their livelihoods from mixed agriculture (farming and livestock keeping). Karenga area lies in agroecological zone 5 characterized by one main agricultural season of rainfall (Tiyo *et al*., 2015).

Kapchesombe is located at 1°09' N and 34°33' E at the border with Kenya and on the edge of Mount Elgon, a fragile ecosystem to the impacts of climate change. Areas are chosen due to fragile agroecologies (lowland & highland). Both areas are adjacent to protected Areas of Kidepo Valley and Mount Elgon National Parks for the Karenga and Kapchesombe districts respectively. The local communities in Kapchesombe are the Sabiny-speaking Kalenjin ethnic group, largely from Kenya (*Ibid*).



Location map: Karenga and Kapchesombe districts

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Source: African Wildlife Foundation – GIS Department

3 Materials and methods

3.1 Study design

Climate data (precipitation and temperature) were secondary data obtained from the Uganda Meteorological Authority (UMA) and analyzed to demonstrate seasonal variations in weather by standardization of seasonal and annual weather data to determine the changes in weather and climatic variability, and the trend gives the picture of the behavior of rainfall and temperature over the season under analysis. The smallholder farmers provided data on perception of food security and climatic and seasonal variability. After clearance from the office of the president the Resident District Commissioners (RDCs) and the District Local Governments, data was collected from the respondents with the aid of research assistants after they were trained in the administration of data collection tools.

3.2 Sampling techniques

A representative sample of 622 respondents was interviewed, and obtained through stratified, purposive, and simple random sampling. Finally, 607 respondents' questionnaires were valid whereas 15 were invalidated due to incomplete answers. In terms of gender, 41.5 and 58.5 percent represented males and females respectively. Data was abstracted in a three-month period after training the 4 research assistants in data collection using the tool.

3.3 Analytical methods

3.3.1 Standardization of yearly and seasonal meteorological data

To calculate the variability of climate change, seasonal weather changes (temperature and precipitation) were determined in this study by standardizing seasonal and yearly meteorological data. The trend provides an overview of how temperature and rainfall have changed throughout the 30-year climatological period under consideration. In 30 years, one expects the rainfall and the temperature average to be normal; however, this may not necessarily be correct as there can be fluctuations on either side of the normal average. This was determined by the formula:

$$Y = MX + C$$

for climate change standardization to reflect precipitation and temperature behavior in a climatological period usually 30 years or more: -

- where M is the gradient and takes the value of negative or positive,
- When M is negative, this shows that the trend is declining;
- When M is positive this shows that the trend is increasing;
- R^2 indicates the statistical significance of the trend process. If the value of R^2 is small this tells us that the process is not significant. If the value of R2 is large (big in value), then the process is significant. For instance, significance is great from 50% or more ($R^2 \geq 0.5$) and significance is less from below 50% ($R^2 \leq 0.5$);
- Y = the y axis and X = is the x axis of the trend graph.

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3.3.2 Bivariate analysis

To investigate potential correlations between each independent variable and the dependent variable, cross-tabulations were performed. All pertinent variables at that level were taken into consideration for bivariate level analysis after the significance level of the connections was established for the P-value (P=0.05). This was done using Pearson's chi-square test.

The chi-square test statistic (χ^2) used is of the form; $$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 3.1$$

Where $\chi^2 = Chi - square$

Oij=the observed frequency in the ith row and jth column

Eij=the expected frequency in the ith row and jth column

Chi-square is tested at a 0.05 level of significance

i=1………………………………………………..r

j=1……………………………………………….c

Most of the descriptive statistics of the variables measured were presented in frequencies, charts, and tables to give meaning to the data. Variables analyzed included: rainfall variability effect on agriculture; how changes in rainfall and weather affected crop production; climatic and seasonal variability effects on food security; adaptation strategies to food security and required support to address food security. Qualitative data was analyzed to complement the quantitative data in aiding the discussions.

4 Results

4.1 Temperature Standardization for Karenga District

Seasonal and climatic changes in temperature were standardized for Karenga. Figure 1 shows the trend in temperature in Karenga District. Specifically, the analysis aimed at providing an understanding of the seasonal changes in the trend behavior of the temperature in the period under review across 30 years. Results indicate considerable change in climatic behavior within the seasons in 30 years showing temperatures in Karenga are increasing at a significant rate (y= 0.171 indicating a positive trend and is significant at R^2 = 0.7021). Meaning that Karenga temperatures are increasing and the local atmosphere is warming up. There were more hot/warm days than cool days and more incidences of drought (prolonged days without rainfall). Given the low amounts of rainfall the area receives, the increasing temperature trend, reduced rainfall, and increased rainfall variability cause a reduction in crop yields and threaten to undermine food security in Karenga.

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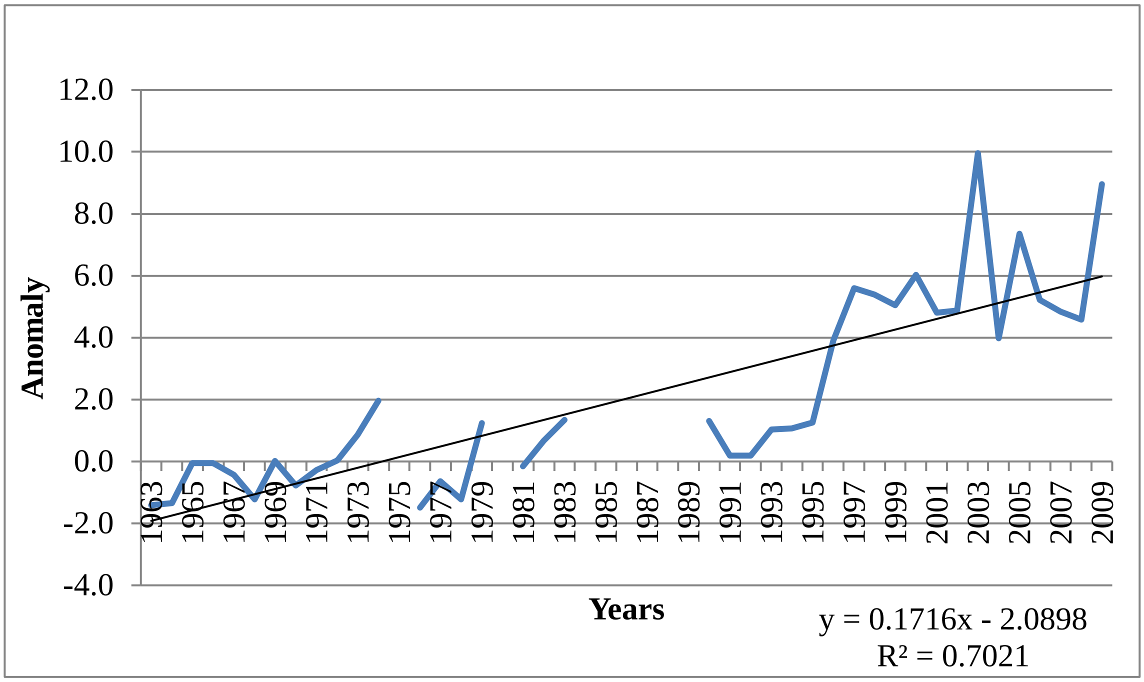

Figure 1: Karenga mean annual maximum temperature (oC) trend

Source: Uganda National Meteorological Authority (UNMA).

4.2 Seasonal changes in precipitation: standardization for Karenga

The gradient intercept is positive y= 0.00229, then the gradient trend is positive. The rainfall trend for Karenga, during the period 1960 – 2011 was analysed and showed a slight increasing trend (R^2 = 0.1069) (Figure 2). The results indicate instability and an insignificant increase in precipitation. Indeed, reduced rainfall and increased rainfall variability reduce crop yield and threaten food security in low-income and agriculture-based economies such as Uganda. Thus, the impact of climate change through high seasonal rainfall variability is detrimental to countries that depend on rain-fed agriculture such as Uganda as the main source of livelihoods.

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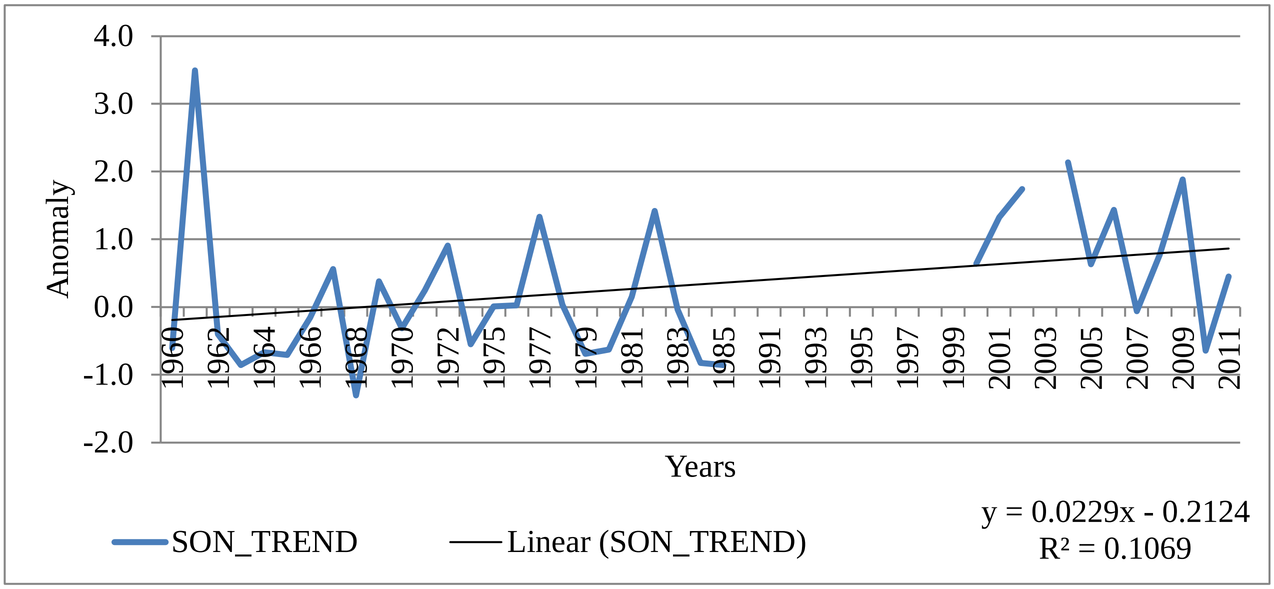

Figure 2 Karenga seasonal rainfall trend (1960 - 2011):
Source: UNMA

4.3 Perceived effects of rainfall variability on agricultural (crop) production

Analysis of perceived effects of precipitation (rainfall) variability was analyzed. Results show a large proportion (n= 373; 61.4%) perceived the effect to be bad on household agricultural production; 19.1% (n=116) reported that its effect was very bad. It's only a small proportion (n=3; 0.5%) that were not affected. The results indicate that the impact was felt by the respondents more people in Kapchesombe (80.9%) than in Karenga (42.1%) (Figure 3). Mountain ecosystems are high Agroecological zones and therefore prone to receiving great impact due to high seasonal variability such as the communities of Kapchesombe in Mount Elgon. High precipitation variability affects soil moisture and plant roots' access to soil water thus affecting plant growth and maturing. Many times this leads to poor growth and yields translating into insufficient harvests and food insecurity.

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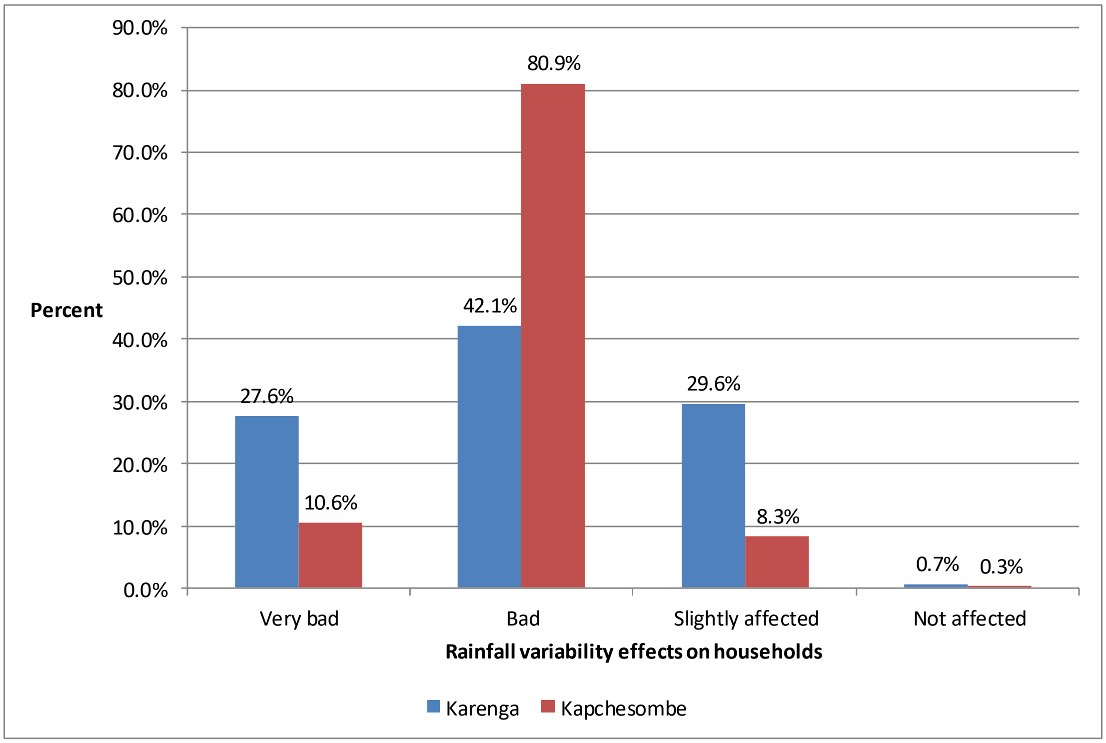

Figure 3. Rainfall change and rainfall variability affect agricultural production.

Source: Field data

4.4 Perceived effects of rainfall variability on agricultural (crop) production

Effects of changes in rainfall and seasonal variability effects on crop production were analyzed. 34% reported it being drought; 18.2% indicated floods; 16.9% stated intense rainfall; while 15.8% said it was storm that affected agriculture most. However, 9.1% indicated the onset and cessation of seasonal precipitation as a major challenge; and a small proportion (4%) reported that there was longer rainfall season, especially in the mountains. Various weather conditions, such as hailstorms and strong winds, had an impact on crops. Destroyed farmhouses, shattered flowers and stalks, shredded leaves, and low-quality crop leaves; Variations in the start and end of the rainy season had an impact on Mount Elgon and Karenga. Karenga was primarily affected by flooding, Reduced cropland and size, lower yields, rotting of roots and tubers, fungal disease outbreaks, blight, early crop harvests, water logging, and crop devastation are some of the issues associated with soil erosion. Extended periods of seasonal water shortage brought about by drought resulted in crop failure, wilting, and drying out; termite and insect pest infestations also increased. They had an impact on all of the area's food crops, including wheat, millet, sorghum, sunflower, pawpaw, sweet potatoes, bulrush, maize, sesame, beans, cabbages, lettuce, Irish potatoes, and bananas. Resulting, for the most part, in substantial food shortages, inadequate yields, crop failure, and nutrition scarcity in the research regions.

***Table 1*: How changes in rainfall and weather variability affected crop production**

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Climate change event	Effect on crop production	Crop affected	Percentage (%) households
Storm (severe winds, gales, and hail on Mount Elgon and Karenga).	Debris-covered foliage, shattered blossoms and stems, a collapsed farmhouse, and subpar crop leaves	Sweet potatoes, cassava, pawpaw, bulrush, corn, sesame, beans, sorghum, sunflower, cabbages, lettuce, bananas, Irish potatoes, and wheat	15.8
Variations in the start and end of the rainy season have an impact on both	Reduced agricultural output, low-quality grain, planting too soon or too late, and crop wilt brought on by irregular and premature rainfall	Sorghum, beans, potatoes, cassava, groundnuts, bulrush, millet, maize.	09.1
Floods mainly in Karenga	Reduced cropland and size, lower yields, rotting of roots and tubers, fungal disease outbreaks, blight, early crop harvests, water logging, and crop devastation are some of the issues associated with soil erosion.	Wheat, barley, cow peas, sunflower, millet, simsim, beans, Pease, cassava, groundnuts, cabbage, Irish potatoes, and water melon	18.2
Extreme/intensive & heavy rainfall mostly in Kapchesombe	Crops unable to mature and dry well, rotting of beans, tubers, and roots, poor yields, poor seed and grain quality, soil erosion, blocked access roads, and decreased agricultural yields	Beans, sorghum, groundnuts, sweet potatoes and sunflower	16.9
Drought/prolonged dry spell and season	Crop wilt, crop failure, crop drying up, increased termite and insect pests attacks	Cow peas, groundnut, sorghum, sweet potato, maize, millet, soya beans, cassava, bulrush	34
Longer and more rainfall in Mount Elgon-Kapchesombe	longer growing seasons and higher yields. The growing season lasted more than six months, lengthening the time of gestation.	Sweet potatoes, sorghum, maize, beans, cassava, groundnut, peas, garden pea, tomato, cow pea and soya beans	04
Total			**102**

The total is more than 100% due to multiple responses.

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Source: Field data

4.5 Climate change effects on food security

Analysis of climatic and seasonal variability effects on food security assessed revealed that both Karenga (99.3%) and Kapchesombe (100%) experienced declining crop yields. Respondents perceived that they experienced declining annual agricultural production by 49.2% and 39.9% for Karenga and Kapchesombe respectively. Other effects reported were experiencing increasing food prices in the market (89.6%) especially in Karenga as opposed to Kapchesombe (3.0%). 47.5% of the respondents have substituted market products. Other effects reported included disease outbreak, drought and malnutrition (14.4%, 10.7% and 4.3% respectively (Figure 5). These results mean most impacts are on the declining crop yields which undermines food security. Declining animal production was reported by 49.0% and 40.0% for Karenga and Kapchesombe respectively, worsening the household income leading to food insecurity.

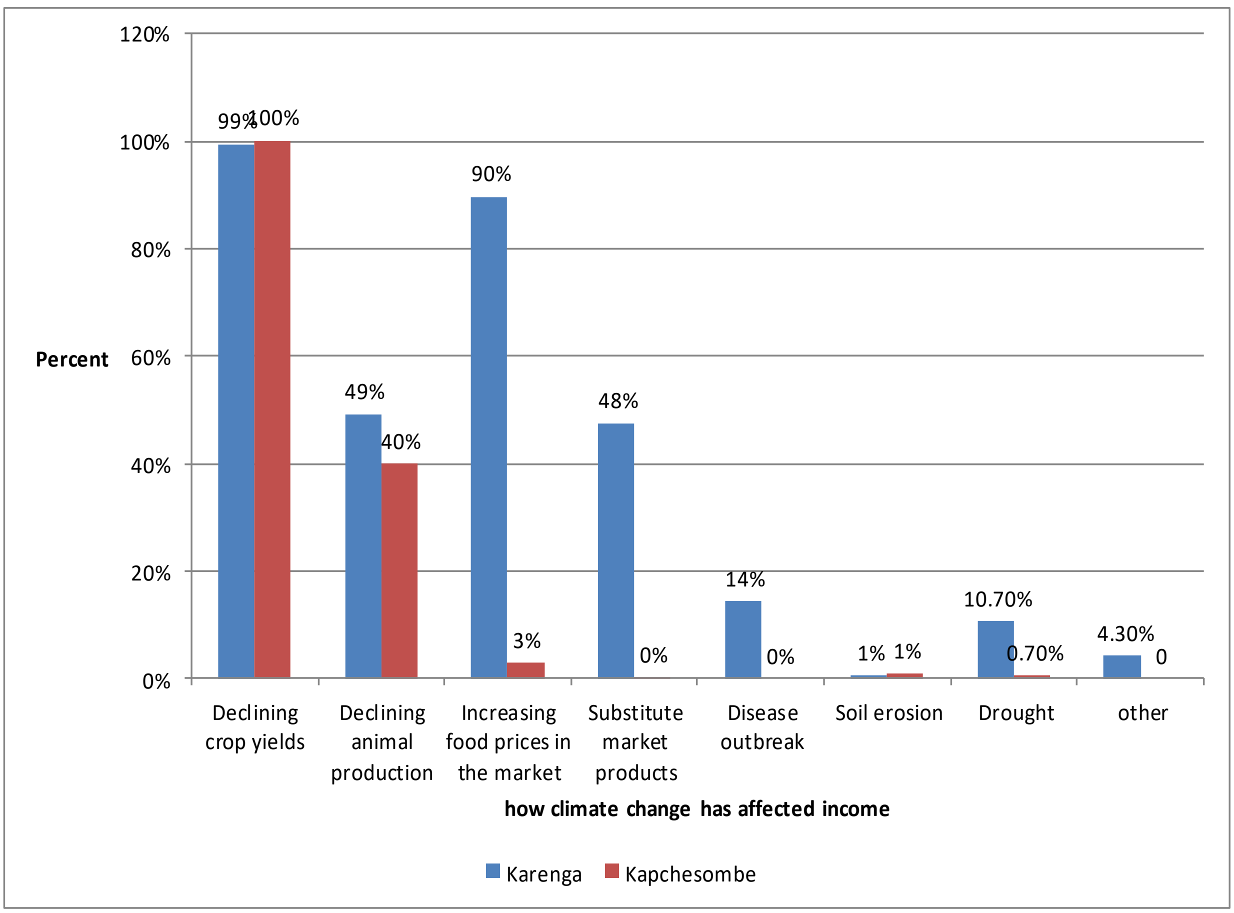

Figure 5: Climate change effect on household income in Karenga and Kapchesombe

Source: Field data

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When disaggregated, the effect on household economy revealed that it was felt by more households in Kapchesombe than in Karenga (93.1% and 63.8% respectively) (Table 2). More (p=.000) effect in Kapchesombe.

Table 2: Climate change and rainfall variability effects on household economy in Karenga and Kapchesombe

Variable	Agro- ecologies				Chi-square	p-value
	Karenga		Kapchesombe			
	Frequency	**Percentage**	**Frequency**	**Percentage**		
Yes	194	63.8	282	93.1	79.221	.000
Slightly little	104	34.2	17	5.6		
Not at all	6	2.0	4	1.3		
Total	**304**	**100**	**303**	**100**		

Source: Field data

4.6 Climate change and variability effects on food security

When the effects of climate variability on food security were evaluated, a significant majority (96.7%, n =587) said that the variability of the climate had a different effect on their food production and security; likewise, a significant majority (97.4%, n =533) reported a reduction in the production of crops; 37% (n =205) indicated a decrease in grazing land; 56.1% (n =307) revealed the production of fodder; and 45.2% (n =247) indicated an increase in water for livestock. When cross-tabulated, the results show main effects being decline in crop production which is on negative note. Other effects reported were an increase in fodder production (96%, 99%; and 53%, and 60% respectively for Karenga and Kapchesombe. When disaggregated, both Karenga and Kapchesombe reported a decline in crop production by 96% and 99% respectively.

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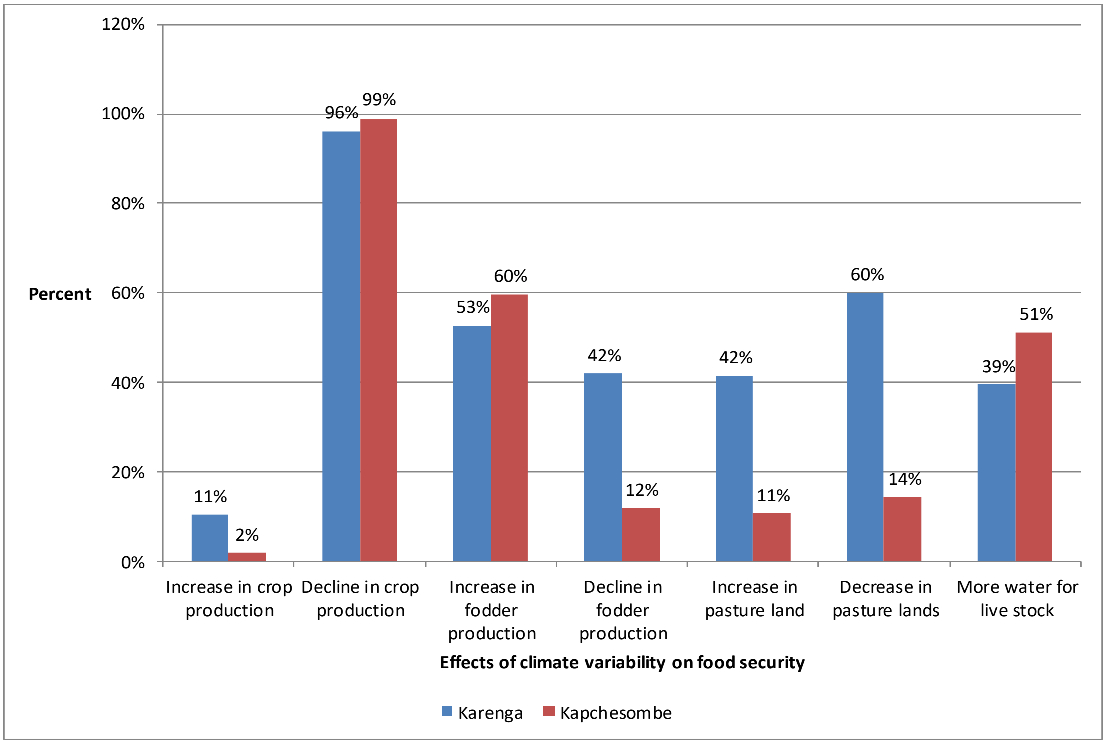

Figure 6: Rainfall variability effects on food security in Karenga and Kapchesombe
Source: Field data

4.7 Small-scale farmers' adaption to effects of climate change

Evaluation of small-scale farmers' adaption to effects of climate change was done. A large proportion (n=429; 74.4%) had put in place strategies for adaptation, while (n=148; 25.6%) had no adaptation strategies. Results show that more farmers adapted in Kapchesombe (90.8%) than those in Karenga (58.4%) with differences at significant level (p<.001) while (41.6%) for Karenga and (9.2%) Kapchesombe did not adapt. In Karenga, the respondents reported: 'they were not knowledgeable'; in Kapchesombe 'they were not knowing where to report' and 'lack of support from relevant authorities' (Table 3).

Table 3: Small-scale farmers' adaptation to climate change in Karenga and Kapchesombe

Variable		Frequency	Percent
Whether the respondent has been able to address challenges of climate change	No	148	25.6
	Yes	429	74.4
Total		**577**	**100**
	Not knowledgeable	50	35.7
	Inadequate financial resources	6	4.3
	Don't know where to report	57	40.7

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Reasons for not being able to address challenges of climate change	Those in authority don't care	20	14.3
	Inadequate manpower/labor	3	2.1
	Looks at them as natural calamities	4	2.9
Total		**140**	**100**

Source: Field data

4.8 Small-scale farmers' strategy to address food challenges in households

This study investigated food security as adaptation strategy among the small-scale farmers in terms of availability of meals and the quantity households had on daily basis. The results showed that almost all households interviewed in Karenga and Kapchesombe (99.7%) and 86.5%) respectively reported having inadequate food to feed at their households (Table 4). Respondents reported adapting by buying less expensive foods to have all the meals in the week (56.0% and 96.9%) for Karenga and Kapchesombe respectively. In Karenga, it was reported that 43.4% had meals for four days in a week. Kapchesombe, a large proportion (91.6%) of the respondents reduced the size of the meals in the week (Table 4).

4.9 Poor food storage undermines food security

Food storage is one of the greatest things that should be taken seriously in ensuring food security. During the study, it was observed that sometimes grains, nuts and seeds were initially stages outside for drying up the seeds to have the desired moisture content once dry. However, many households lost seeds do the 'careless storage' in compounds and inside the houses where the harvested produce was vulnerable to 'human pests', rats, weevils and birds. Admittedly, this had toll on quantities that passed through the scarcity season when crops are in the field and there is near-nothing in the food reserves. The hardest hit being the young children who were provided the substitute of waste residues from the local beer locally known as 'Kwete'. Plate 1 demonstrates poor food security practice.

Plate 1: Local sorghum hanging in tree in Karenga

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Source: Field data

Table 4: Status of food in households in light of climate change and adaptation strategies

Variables		Sub-county			
		Karenga (lowland)		Kapchesombe (highland)	
		Frequency	**Percent**	**Frequency**	**Percent**
Whether the quantities of food to feed the household is adequate due to climate change?	No	303	99.7	262	86.5
	Yes	1	0.3	41	13.5
Total		**304**	**100**	**303**	**100**
Less expensive food	Meals in all 7days	169	56	247	96.9
	At least 4 of 7days	131	43.4	5	2
	Once in a while	1	0.3	3	1.2
	Hardly 1 a day	1	0.3		
Total		**302**	**100**	**255**	**100**
Borrow food	Meals in all 7days	97	35.8	29	24.6
	At least 4 of 7days	9	3.3	14	11.9
	Once in a while	103	38	74	62.7
	Hardly 1 a day	62	22.9	1	0.8
Total		**271**	**100**	**118**	**100**
Limit portion size	Meals in all 7days	110	36.3	153	91.6
	At least 4 of 7days	84	27.7	4	2.4
	Once in a while	97	32	10	6.0
	Hardly 1 a day	12	4		
Total		**303**	**100**	**167**	**100**
Restrict consumption	Meals in all 7days	132	43.9	148	90.8
	At least 4 of 7days	16	5.3	4	2.5
	Once in a while	76	25.2	11	6.7
	Hardly 1 a day	77	25.6		
Total		**301**	**100**	**163**	**100**
Reduce number of meals	Meals in all 7days	143	47	145	95.4
	At least 4 of 7days	125	41.1	1	0.7
	Once in a while	31	10.2	6	3.9
	Hardly 1 a day	5	1.6		

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Total		**304**	**100**	**152**	**100**
Reduce number of people eating at home	Meals in all 7days	141	46.5	12	80
	At least 4 of 7days	12	4	1	6.7
	Once in a while	70	23.1	2	13.3
	Hardly 1 a day	80	26.4		
Total		**303**	**100**	**15**	**100**

Source: Field data

5. Discussion

The Global Hunger Index in Uganda

According to Sebukeera *et al.* (2023), Uganda is one of the fastest growing economies in Africa and has been regarded as the 'bread basket' of Eastern Africa due to good soils and fairly reliable rainfall and therefore, the country should ultimately be food secure. According to FAO (2009) and FAO (1996), a country is food secure when there is access to adequate nutritious and safe food for active life, normal growth and development. However, despite possessing good edaphic and rainfall characteristics, severe weather events such as drought and floods have historically imposed heavy costs in Uganda. The Global Hunger Index (GHI) (2018) pointed that hunger amongst Uganda's population has risen evidenced by a score of 31.2 compared to a score of 26.4 in 2016. It is reported that, despite the country being the breadbasket of East Africa, Uganda's GHI score was higher than its immediate neighbours (Kenya, 23.3; Tanzania, 29.5; Rwanda, 28.7) and the sub Saharan Africa and this is worrisome. This study analysed Climate Risk Screening for Food Security in Karenga and Kapchesombe Districts, in Uganda. Did this by the following activities in the study areas: temperature and rainfall standardization to confirm climatic and seasonal variability; effect of climate change variability on agriculture; how changes in rainfall affected crop production; how rainfall variability affected food security; small-scale farmers' adaptation to challenges of climate change; and strategies to address food security. This study (as is presented in discussion) posits that the aforementioned parameters analysed lead towards household food insecurity.

Temperature and precipitation standardization

Results for temperature and precipitation standardization for Karenga District indicated that temperatures are increasing and local atmosphere is warming up. There were more hot/warm days than cool days and more incidences of drought (prolonged days without rainfall). In terms of rainfall, the results indicate instability and insignificant increase in precipitation. Indeed, reduced rainfall and increased rainfall variability reduce crop yield and threaten food security in low income and agriculture-based economies such as Uganda. Thus, the impact of climate change through high seasonal rainfall variability is detrimental to communities that depend on rain-fed agriculture such as in northern part of the country and the Karamoja region for their main source of livelihoods. This findings agrees with Sebukeera *et al.* (2023) and USAID (2012) who maintained that given the low amounts of rainfall the

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area receives, the increasing temperature trend, reduced rainfall and increased rainfall variability causes reduction in crop yields and threaten to undermine food security in Karenga and Kapchesombe districts. This study adds that natural resource factors such as climatic and seasonal variability, can affect agronomy and agricultural calendar thus undermining crops growing, adequacy of solar energy and moisture for crops growth, maturing and ripening, as well as drying thus occasioning food and livelihoods insecurity.

Perceived effects of rainfall variability on agricultural (crop) production

Analysis of perceived effects of precipitation (rainfall) variability was done and it was reported that the effect of rainfall variability to be bad on the household agricultural production and the communities of Mountain Elgon, who felt the impact more than for their counterparts in the low agro-ecology of Karenga, therefore, prone to receiving great impact due to high seasonal variability in Mount Elgon. High precipitation variability affects soil moisture and plant roots access to soil water and thus affecting plant growth and maturing. Many times leading to poor growth and yields translating into insufficient harvests and food insecurity.

Effects of rainfall variability on agricultural (crop) production revealed key climatic events that affected crops included: drought, floods, intense rainfall, storms (gales), and long rain season (especially in the mountain). Crops were impacted differently by these variations. For example, high winds and hailstorms tore up leaves, shattered flowers and stalks, damaged farm houses, and low-quality crop leaves. Variations in the start and end of the rainy season had an impact on Elgon Mountain and Karenga. Karenga was primarily affected by flooding, and Reduced cropland and size, lower yields, rotting of roots and tubers, fungal disease outbreaks, blight, early crop yields, drainage problems, and crop devastation are some of the issues associated with soil erosion. Extended periods of seasonal water shortage brought about by drought resulted in crop failure, wilting, and drying out; termite and insect pest infestations also increasedThese had an impact on all of the area's food crops, including wheat, millet, sorghum, sunflower, cabbages, lettuce, Irish potatoes, pawpaw, sweet potatoes, bulrush, maize, and sesame. resulting, for the most part, in substantial food shortages, inadequate yields, crop failure, and nutrition insecurity in the research regions. These results concur with those of Pandel Dalson et al. (2022), Solomon et al. (2017), and Okonya et al. (2013), who noted that the environmental impacts of climate change can have a variety of effects on crops, such as reduced soil moisture content, crop destruction, and pest outbreaks. These variously affect agronomy, weed effects and poor maturing of crops with poor yields. These undermine bumper harvest thus affecting food and nutrition security. This study posits that, food security is a multidimensional issue. Its linked to healthcare, political conflicts, leadership, strategic vision, commercial and economic interests, agricultural production, dietary systems, global food industry trade policies, and the environment. In Uganda, these dimensions abound and therefore, the absence of extension services, credit facilities, agro-inputs, and farm-school support all undermine food security. The situation is further complicated by high household poverty rates that undermine agricultural production at all levels.

Impacts of climate change on food security

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Climatic and seasonal variability effects on food security assessed revealed that both Karenga and Kapchesombe experienced declining crop yields and declining annual agricultural production. This effect was further reported that the communities are experiencing increasing food prices in the market especially in Karenga as opposed to Kapchesombe leading to substituting of market products, a clear indication of shortage of food in the households. Other effects reported included disease and pest outbreaks particularly increase in termite attacks due to increase drought prevalence. Food shortage reportedly led to food insecurity in households and malnutrition in the infants. This is unpleasant because, cases of children impairment and retardation in growth and development was reported in Karenga. This study adds that decline in crop yields is a function of several factors (lack of extension support, agro-inputs, credit facilities, lack of skills and failure to suppress diseases and pests, poor soils and edaphic conditions, and excessive climatic events) undermine crop production, with failure to handle post-harvest losses undermines food security and livelihoods. Declining animal production was also reported this is worsening the household income leading to lack of money and poverty with low purchasing power hence food insecurity. The effect on household economy was felt more in Kapchesombe than in Karenga. This finding is in agreement with panelDalson *et al.* (2022), Peter *et al.* (2010), FAO (2009) and FAO (1996) emphasized that food security is possible only when essential factors of food production exists and farmers can access forces of agricultural production making them self-reliant. This study adds that empowered households will produce adequate food for food security, nutrition, for sale and income thus with enhanced resilience. This study further posits that efforts should be geared towards adoption and promoting climate-smart agriculture and related adaptation technology, improved agronomy, suppression of weeds and pests and diseases and linkage to markets for agricultural sales.

Small-scale farmers' adaption to effects of climate change

Evaluation of small-scale farmers' adaption to effects of climate change was done revealed that, a large proportion of the respondents put in place strategies for adaptation. Only a small proportion of population had no adaptation strategies. Results show that more farmers adapted in Kapchesombe than those in Karenga with differences at significant level and few had not adapted in both areas. In Karenga, the respondents reported: 'they were not knowledgeable'; in Kapchesombe 'they were not knowing where to report' and 'lack of support from relevant authorities. This finding raises the question of inadequate extension service support to the farmers. According to Maponya & Mpandeli (2012), Tiyo *et al.*(2015) and Turyasingura & Chavula (2022), extension service support to farmers is educational and skills them to do the right thing in agronomy for the best yields. This study adds that extension service provides practical sessions, skills in agronomy and disease suppression. Local government should support extension services as a part of agricultural modernization to prepare the farmers in various components of food security. Food security entails dedication of farmers in securing the crops, protecting them from late planting, to suppression of weeds, insect pests and timely harvesting and post-harvest management to avoid losses through storage pests, crop loss through decomposition and theft.

Small-scale farmers' strategy to address food challenges in households

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This study investigated food security as adaptation strategy among the small-scale farmers in terms of availability of meals and the quantity households had on daily basis, indeed as the main objective. The results showed that almost all households interviewed in Karenga and Kapchesombe reported having inadequate food to feed at their households (Table 4). Respondents reported adapting by buying less expensive foods to have all the meals in the week. In Karenga, it was reported that some of the households had meals for four days in a week. In Kapchesombe, a large proportion of the respondents reduced the size of the meals in the week (Table 4). These strategies are temporal due the shortages reported. Food for effective child growth and development, satisfaction and good health and nutrition and accessible will entail effective food production (climate-smart agricultural calendar that conserves water, soil, with agro-inputs) with intervention technology at the centre of production to meet the farmers targets for food security and improved livelihoods. Connection to reliable markets, storage and transport facilities and access roads provided will do well in food, nutrition and households' livelihoods' security.

Conclusions

The study analysed and found out that temperature in Karenga and Kapchesombe was rising (warming up and rainfall increase was low) and effect of rainfall and seasonal variability on agriculture was negative due the adverse effects of intense rainfall, wind and drought events which affected crops variously shredding the leaves, breaking of flow stocks; soil erosion and floods reduced sizes of crops. These effects had dire consequences of crop production due to poor yields translating into food shortages. Food and income insecurity was reported overwhelmingly high at households' level. Declining agricultural production due to high seasonal variability, and lack of credit facilities, farm agro-inputs and inadequate agronomic skills due to lack of extension exacerbated household food and income security, an impact most noted in Karenga than in Kapchesombe. For food production, access, utilization to be effective, an integrated approach of extension services to farmers, credit facilities, effective agronomy and weeds and pests suppression skills and adaptation technology and attendant skills should be provided so that small-scale farmers address farming as an economic enterprise integrated with traditional knowledge.

Future research direction

1. Farm-level mitigation to climate change environmental degradation in the farms by small-holders in Karenga and Kapchesombe.

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Conflict of interest

The authors would like to affirm that there was no conflict of interest in the research undertaking and the principal researcher followed the recommended research ethics and protocol.

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