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Examining the Ability of Communities to Cope with Food Insecurity due to Climate Change

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Abstract: The changing climate has negatively impacted food systems by affecting rainfall patterns and leading to drought, flooding, and higher temperatures which reduce food production. This study examined the ability of communities to cope with food insecurity due to the changing climate in the Serere and Buyende districts, which are two different agro-ecological zones of Uganda. We administered 806 questionnaires to households, a sample size which was determined using Yamane's formula, with the snowball sampling method used to select the households. The questionnaire sought information, including that regarding the respondents' resources, the effects of climate change on households, and the coping mechanisms employed to reduce the impact of climate change on food security. The data collected was coded and analyzed using the statistical package for the social sciences (SPSS). Agriculture was found to be the main source of income for 42.4% of male adults and 41.2% of female adults in Serere. In Buyende, 39.9% of males and 33.7% of females rely on selling animal, poultry, and food crops. Aggregate results further showed that 58.3% of females and 42.2% of the males from both districts had suffered from the impacts of climate change, and that the effects were more evident between March and May, when communities experienced crop failure. The study further found that the percentage of households who had three meals a day was reduced from 59.7% to 43.6%, while the number of households with no major meals a day increased from 1.3% to 1.6%. We also found that 34.3% of households reported buying food during periods of crop failure or food scarcity. Moreover, despite reporting an understanding of several coping mechanisms, many households were limited in their ability to implement the coping mechanisms by their low incomes. This reinforced their reliance on affordable mechanisms, such as growing drought-resistant crops (32.7%), rearing drought-resistant livestock breeds (26.1%), and reducing the number of meals a day (14.5%), which are mechanisms that are insufficient for solving all the climate-related food insecurity challenges. We recommend that the government intervenes by revising policies which help farmers cope with the negative effects of climate change, promoting the sensitization of farmers to employing

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the coping mechanisms, and subsidizing agricultural inputs, such as resistant varieties of crops, for all to afford.

Keywords: food security; climate change; coping mechanisms; crop failure; food production; resistant varieties

1. Introduction

Food security is the state whereby all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. Food security has multiple dimensions including availability, access, utilization, and stability [1,2]. A projected rapid population growth would be the leading cause of food insecurity and widespread undernourishment across Africa [3]. Notably, cases where many small-farm communities have access to food with limited or no nutritional value may increase. The high levels of food underutilization are further manifested through the increase in obesity and the malnutrition of children, of which Africa and Asia are set to be the biggest victims [4]. Food insecurity is caused predominantly by climate change, price variability [5], and conflict [6]. There is a projected 20% decrease in output per adult by the end of the century due to the combined effect of climate change on food consumption and labor supply [7]. Moreover, urbanization in low- and middle-income countries is a high contributor to food insecurity, since food affordability and utilization is heavily determined by the income dimensions of people as a result of decreases in production and increases in access to food via trade mechanisms [8]. This pushes the burden of food production to a few individuals, who rely predominantly on small-scale production. While towns are attractive for their economic opportunities and potential for a better life, many people struggle to get by [9]. Fewer food-secure households depend more on short-cycle food crops compared with better-off households [10]. The high dependency of better-off households on the formal food retail outlets exposes them to unhealthy food items [11].

Climate change is a global issue, impacting people and their property negatively and with varying dimensions. Due to growing population sizes, especially in Africa, there is a noticeable stress on the available resources, predominantly land. This has led to increased land-use change with, for example, forests and permanent wetlands turned into farmland, so as to improve food security. This causes destruction of the ecosystem services, further exacerbating climate change [12]. While some communities experience increases in the occurrence and intensity of river floods and forest fires, others have reported increased drought. Overall, many regions are experiencing rising daily temperatures and declining rainfall [13,14]. These extreme climate conditions have negatively impacted everyone globally, making low-income and poor communities more vulnerable. The poor are also expected to be the worst hit by climate change due to their inability to cope with the negative effects [15]. While climate change cannot be completely eliminated, interventions to limit its impact have been proposed. However, the cost of implementing the adaptation measures has been prohibitive to many poor communities [16,17]. A case in point is the farming communities in Uganda, which heavily rely on rain-fed agriculture for their livelihood because of their inability to afford smart farming practices. Only a few farmers with a large number of assets and entitlements, such as land, education, and access to governmental resources, have the capacity to create buffers for the shocks that will result from climate change [18]. Moreover, agricultural land acquisition may not necessarily address the food security needs in many countries because of local land practices. Large-scale land acquisitions, often used to acquire huge chunks of land for agriculture, are focused almost entirely on serving the financial interests of transnational companies and local elites with the support of host governments [19]. As a result of these land acquisitions, more food is produced for export, leaving local communities food insecure. Faced with

short rain seasons and long drought periods, farmers are often faced with low productivity and reduced yield, creating food, hunger, and malnutrition [20].

The vulnerability of communities to climate change, and their ability to adapt to and cope with climate shocks, has been extensively studied. In order to promote equity in climate change adaptations, several social dimensions have been proposed. Among these is gender, which takes into consideration the roles of men and women, targeting them differently in order to tailor climate change interventions [21–23]. For instance, a higher percentage of wives were found to adopt crop-related strategies, whereas husbands were found to prefer employing livestock and agroforestry-related strategies [24]. Women have been observed to have less access to resources, including labor and money, and are less assured to benefit from investments, making it harder for them to adapt compared to men [25,26]. Migration has also been cited as one of the coping mechanisms to the effects of climate change [25].

Government support for climate change adaptation is mostly given through policies and budgeting for implementation plans at the various administrative structures. Policy actions targeted at sustainable agriculture and rural development can help tackle the challenges posed by climate change [27]. Furthermore, policies targeting early warning, weather-based crop insurance, and disaster risk planning can, if put in place, address the direct impacts of droughts and migration (which, as an adaptation strategy, impacts on local communities), and help prevent and resolve conflict in vulnerable regions [28]. There was an observable imbalance in gender-related policies with regard to climate change interventions, characterized by inconsistencies in allocations by gender at subnational levels, with sharp differences between estimated and actual budgets, and with gendered activities not addressing structural inequalities [29]. However, due to other concerns, such as economic development, several climate change interventions may be undermined [30]. The production of improved crop varieties is one of the major investments governments have made towards addressing climate adaptation challenges in communities, addressing dietary and food access needs [31].

This study therefore sought to assess the ability of communities to cope with food insecurity due to climate change. This was achieved by assessing factors employed by communities in coping with the effects of climate change on agricultural activities.

2. Materials and Methods

2.1. Theoretical Framework

A community's ability to cope with food insecurity hinges on their ability to deal with the risks to which they are exposed. Failure to deal with the risks will make communities become food insecure. Figure 1 shows the theoretical framework used in this study.

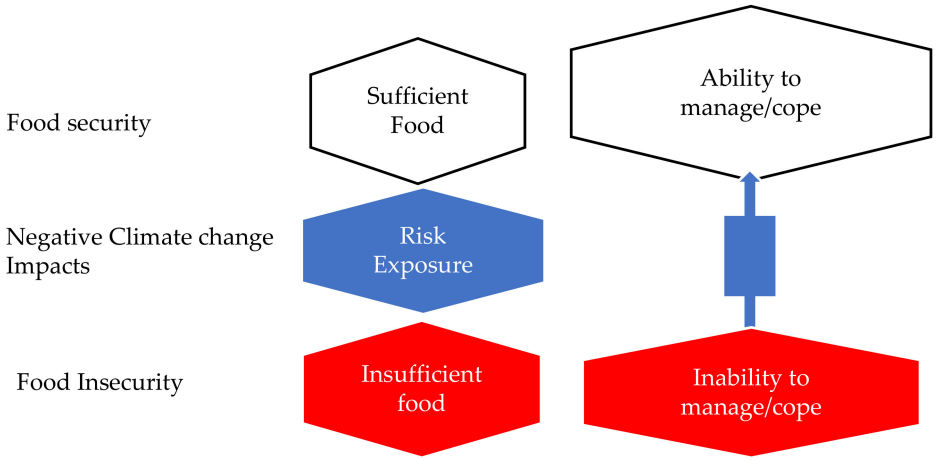


Figure 1. Theoretical framework that guided this study, which assesses the ability of communities to cope with food insecurity due to climate change.

In the face of climate change, agricultural productivity faces risks due to increased heat, drought, insect outbreaks, and reduced water supplies, among others [32]. These factors lead to reduced agricultural yields, among other negative effects, which in turn lowers food availability. Exposure to risks makes communities vulnerable to food insecurity. As a means of reducing the negative impacts, one has to learn how to cope with the difficult conditions. Coping with climate change stress on agriculture requires the adoption of mechanisms which can limit the negative effects. These adaptation responses and mitigation mechanisms, such as adopting technological changes, input substitution, and crop switching, are used to mitigate the negative impact of warming and improve crop yields [33]. Hence, a community's ability to cope with food insecurity hinges on their ability to deal with the risks to which they are exposed. Such coping mechanisms include a household's education level, its dependency ratio, and the amount of land and fertilizer, among others [34,35]. However, the extent to which the adaptation strategies are adopted is variable, and is influenced by both biophysical and socioeconomic considerations [36]. Therefore, households that are able to counter the negative impacts of climate change by employing the adaptation mechanisms are able to maintain agricultural production. Hence, such households are considered to be food secure. On the other hand, failure to deal with the risks makes communities food insecure [37,38]. Communities that are food insecure are unable to maintain a consistent food supply for either their own consumption or for income generation. Figure 1 shows the theoretical framework that guided this study.

2.2. Survey Administration

To explore the community's ability to cope with food insecurity, we carried out a survey in the Buyende and Serere districts of Uganda and administered 806 questionnaires. The questionnaire included information on respondents' resources, the effects of climate change on their agricultural production, and the coping mechanisms that they employed to reduce the impact of climate change on food security. The survey was generally conducted in English, but those who did not understand English were interviewed through interpreters who were recruited from within the communities. The sample size was estimated using Yamane's formula [39–41]. The Equation (1) that was used assumed a 95% confidence level with $p = 0.05$, and is expressed as follows:

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

where n is the sample size, N is the population size, and e is the level of precision.

Selection Procedure

The respondents were randomly selected from the different subcounties that make up the two districts (Serere and Buyende). Snowball sampling was adopted in the study [42–46]. A random sample of individuals was drawn from a given finite populations of 323,067 and 285,903 people in Buyende and Serere, respectively. In the model that we used, each individual in the sample is asked to name k different individuals in the population, where k is a specified integer; for example, each individual may be asked to name his "k best friends," or the "k individuals with whom they most frequently associate," or the "k individuals whose opinions they most frequently seek," etc. (For the sake of simplicity, we assume that an individual cannot include himself or herself in their list of k individuals). The individuals who are not in the random sample, but who are named by individuals from within the random sample, form the first stage. Each of the individuals in the first stage is then asked to name k different individuals. (This assumes that the question asked of the individuals in the random sample and of those in each stage is the same and that k is the same.) [44,45]. The individuals who are neither in the random sample nor in the first stage are named by individuals who are in the first stage. Each of the individuals in the second stage is then asked to name k different individuals. The individuals who are not in the random sample nor in the first or second stages, but who are named by individuals

who are in the second stage form the third stage. Each of the individuals in the third stage is then asked to name k different individuals. This procedure is continued until each of the individuals in the sth stage has been asked to name k different individuals [46].

This method was performed to make sure that the data obtained using the snowball sampling procedure can be utilized to make statistical inferences about various aspects of the relationships present in the population [47]. The relationships present, in the hypothetical situation where each individual in the population is asked to name k different individuals, can be described using a matrix with rows and columns corresponding to the members of the population, with rows for the individuals performing the naming and columns for the individuals who are being named [48,49].

2.3. Description of the Study Area

This study arose from the need to achieve one specific objective: to examine the resilience and adaptation strategies of farmers across the different agro-climatological zones under the project 'Towards a food secure Uganda under a changing climate'. The study was conducted in the Kyoga basin, during the period between 10 January 2021 and 23 February 2021 in the Buyende and Serere districts of Uganda.

The Buyende district is geographically located in the Busoga subregion in Eastern Uganda, and covers an area of approximately 726.1 square miles [50], with an average elevation of about 1080 m above sea level (Figure 2). The Serere district is located in Eastern Uganda, in the Teso subregion, and covers approximately 1965.4 square km [50], with an average elevation of 1095 m above sea level (Figure 3). These areas normally experience two rainfall seasons, the first from March to May, and the second from September to November.

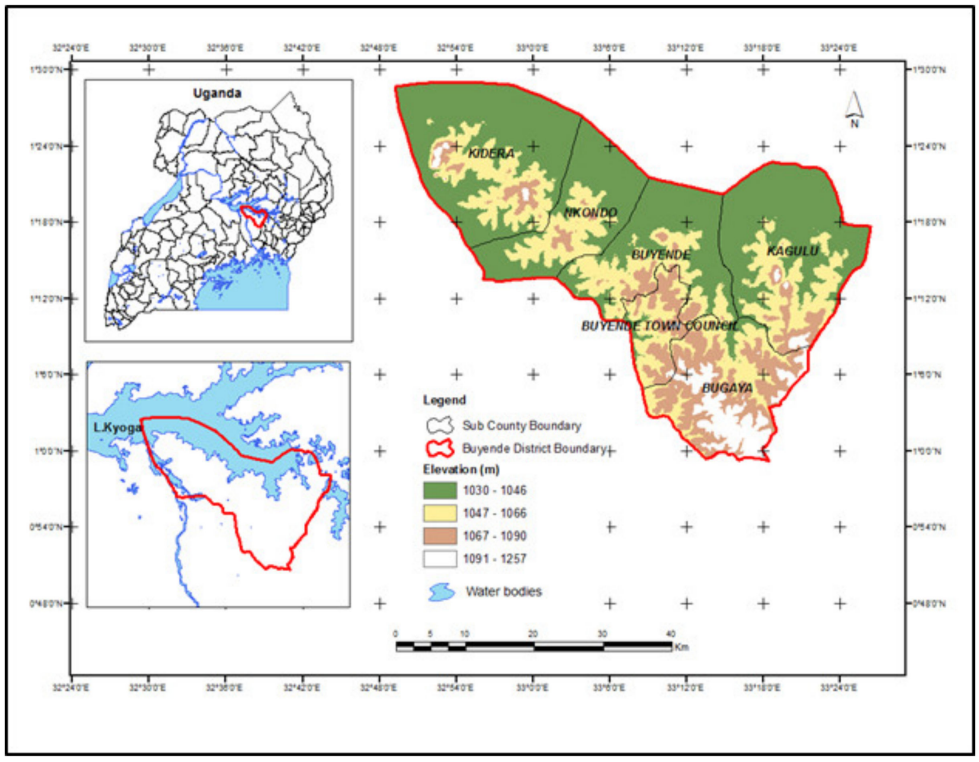


Figure 2. Map of the Butene District.

The respondents were randomly selected from the different subcounties that make up the two districts (Serere and Buyende). A proportionate sampling procedure was used to determine the sample of households based on number of households in each district using national household survey [51]. The sample size was determined according to [52] and is presented using the Equation (1).

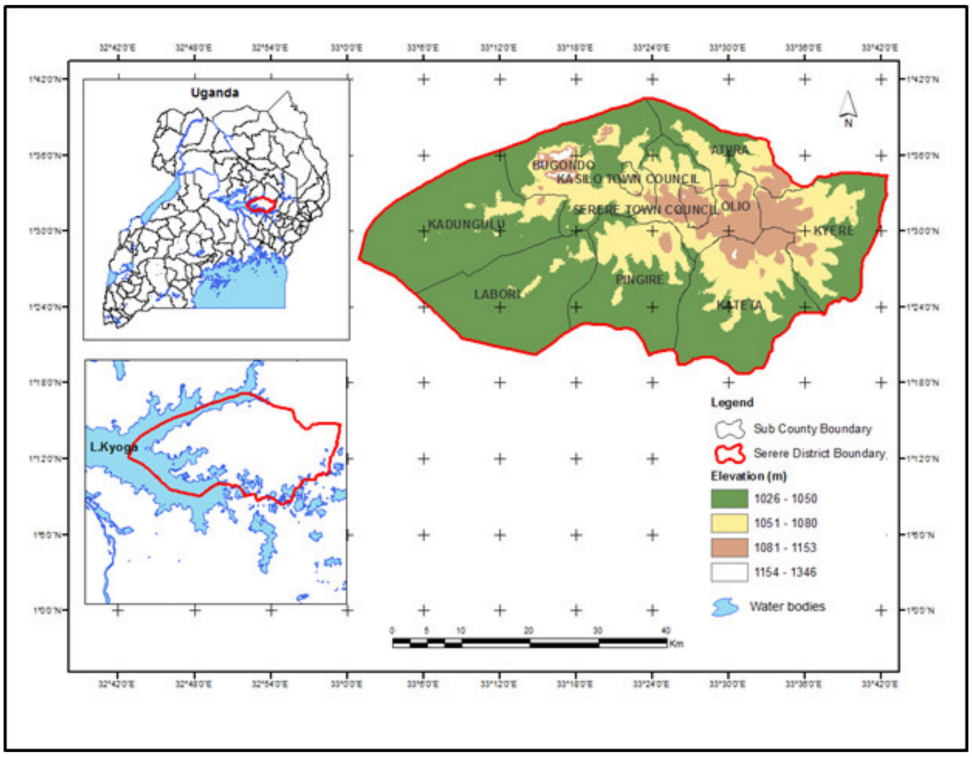


Figure 3. Map of the Serere District.

2.4. Data Analysis

Quantitative data from household surveys were coded and analyzed in SPSS Version 20. Descriptive statistics were generated and results were presented as either percentages or counts in both graphical and table forms. Chi-square tests were computed and used to determine the association between the communities' perceptions of the effects of climate change and the coping mechanisms employed to reduce the impact of climate change on food security at a 5% level of significance. The chi-square test was further used to analyze and compare sociodemographic and economic variables and to establish significant differences between socioeconomic groups (gender, age, education, income, house head type) and food security. The primary data on community residents' perceptions of climate change and variability (changes in temperature and rainfall) were backed with an empirical trend analysis [53]. Qualitative information was recorded and typed out in Microsoft Word and summarized thematically. Content analysis was then used in the analysis of qualitative data [54,55].

3. Results

3.1. Sociodemographic Characteristics

The sociodemographic results are presented in Table 1. The results include gender, age of respondent, education level, household head type, and number of household members. From the survey results (Table 1), we can see that: 51.3% were males and 48.7% were females; 49.3% of the respondents had completed secondary and tertiary level of education, which meant that they could easily respond to the given questions; 9% of the respondents had no formal education while 41.7% had completed primary level; 80.3% of the households were male-headed, 18% female-headed, 1.2% were child-headed, and only 0.5% were headed by older people (i.e., a grandparent). About 64.1% of the number of household members belonged to the below 18, 18–25, and above 50 age categories (the dependent categories), while 35.9% belonged to the 26–35 age category, which is the independent category.

Table 1. Serere respondents' characteristics.

Variable	Frequency (n = 400)	%
Gender		
Male	205	51.3
Female	195	48.7
Education level		
None	36	9
Primary	167	41.7
Secondary	145	36.3
Tertiary	52	13
Household Head type		
Male-headed	321	80.3
Female-headed	72	18
Older person-headed	2	0.5
Child-headed	5	1.2
No. Household members (in years)		
Below 18	313	27.4
18–25	260	22.8
26–35	221	19.4
36–50	189	16.5
Above 50	159	13.9

The Buyende district survey results (Table 2) show that both male and female respondents were equal (50% and 50%, respectively). Only 13.3% of the respondents had completed secondary and tertiary levels of education, which meant that they could easily respond to the given questions, while 86.7% of the respondents had no formal education or had completed primary. However, those who did not understand English were interviewed through interpreters who were recruited from within the communities. We found that 82.8% of the households were male-headed, 15.3% were female-headed, 1.5% were older people-headed, and only 0.5% were headed by children. The below 18, 18–25, and above 50 age categories (the dependent categories) had about 68% of the number of household members, while 32% belonged to the 26–35 age category, which is the independent category.

Table 2. Buyende respondents' characteristics.

Variable	Frequency (n = 406)	%
Gender		
Male	203	50
Female	203	50
Education level		
None	88	21.7
Primary	264	65
Secondary	53	13.1
Tertiary	1	0.2
Household Head type		
Male headed	336	82.8
Female headed	62	15.3
Older person headed	6	1.5
Child headed	2	0.5
No. Household members (in years)		
Below 18	373	36.1
18–25	234	22.6
26–35	193	18.7
36–50	138	13.3
Above 50	96	9.3

3.2. Resource Availability

Resource availability considered household assets, access to water resources, and household income.

3.2.1. Household Assets

The household assets were analyzed in terms of individual control of and access to the respective assets used to cope with climate change. Results from two districts (see Figures 4 and 5) indicate that men generally control and access the resources (assets), followed by a combination of both men and women, while children (girls and boys) have little access to and control over assets.

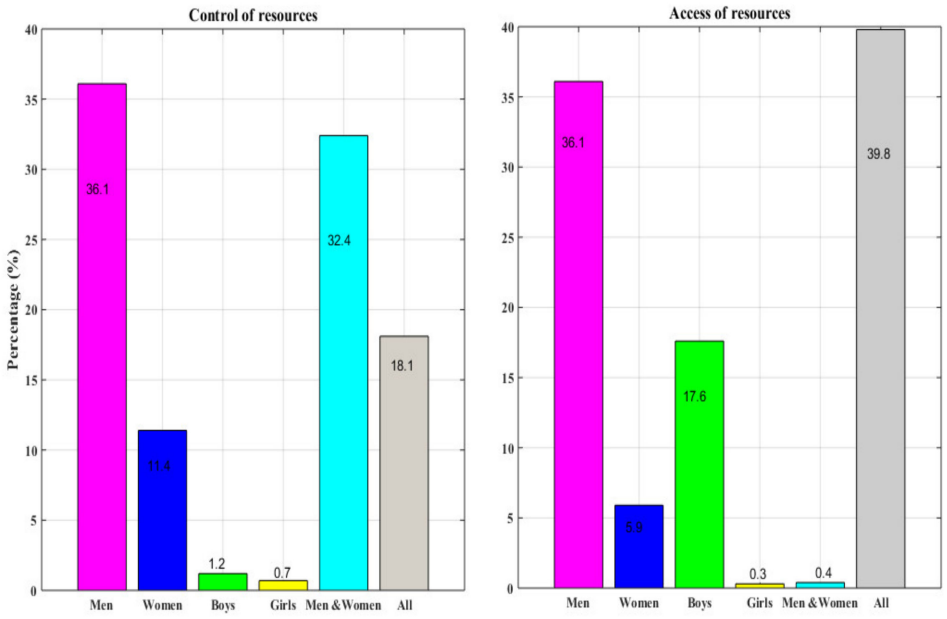


Figure 4. Control of and access to household assets for the Serere district.

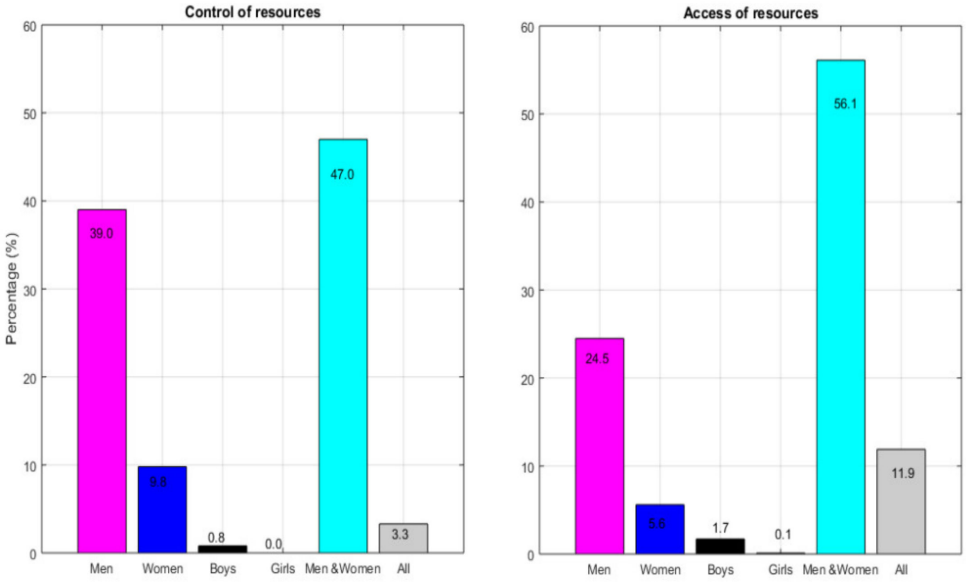


Figure 5. Control of and access to household assets for the Buyende district.

3.2.2. Access to Water Sources

The access to water sources was analyzed considering the different available sources of water. Results from the two districts (see Figures 6 and 7) indicate that the majority of

respondents access water from boreholes, which were used by 41.5% of males and 45.5% of females in the Buyende district, and 34.7% of males and 32% of females in the Serere district. Wells are the second major source of water, while lakes and dams are the least-used source of water due to the costs and risks of accident associated with dams. Generally, for the two districts combined, males have higher access to water sources compared to female.

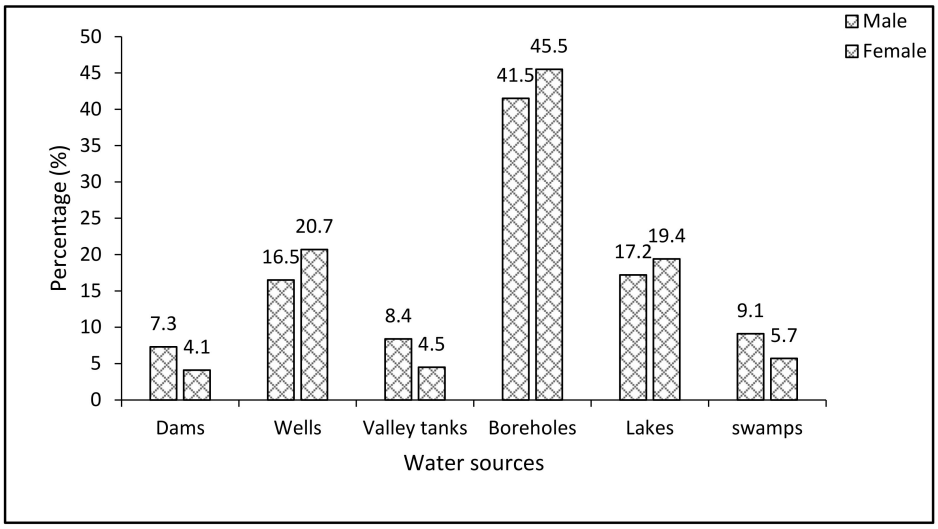


Figure 6. Access to water sources in the Buyende district.

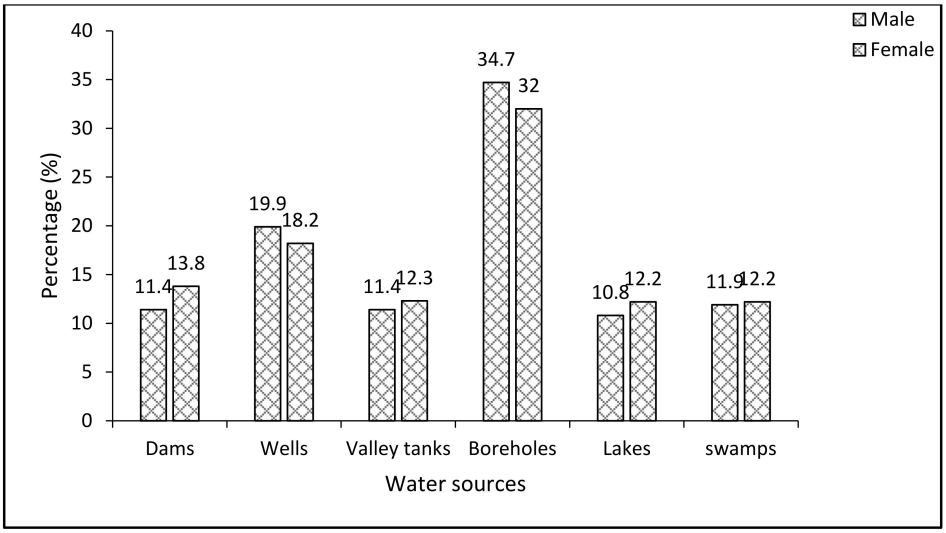


Figure 7. Access to water sources in the Serere district.

3.2.3. Household Income

In Serere (see Figure 8), the main source of income for the females is poultry and animal husbandry (41.2%), followed by food crops (25.2%), cash crops (14.2%), small business (12.7%), with 4.5% earning income from salaried household heads, and 2.3% from wood fuel. On the other hand, the main source of income for men is poultry and animal husbandry (42.4%), followed by food crops (22.3%), cash crops (14.1%), small business (12.5%), with 6.8% of men earning income from their salaries, and 1.9% earning income from wood fuel.

In Buyende (Figure 8), the main source income for females is food crops (39.9%), followed by poultry and animal husbandry (35.8%), cash crops (17.0%), small business (6.3%), with 1.0% for salary work, and 0.2% from wood fuel, whereas for the men, the main source of income is poultry and animal husbandry (36.0%), followed by food crops (33.7%), cash crops (17.4%), small business (8.4%), 2.5% for salary work, and 2.0% from wood fuel.

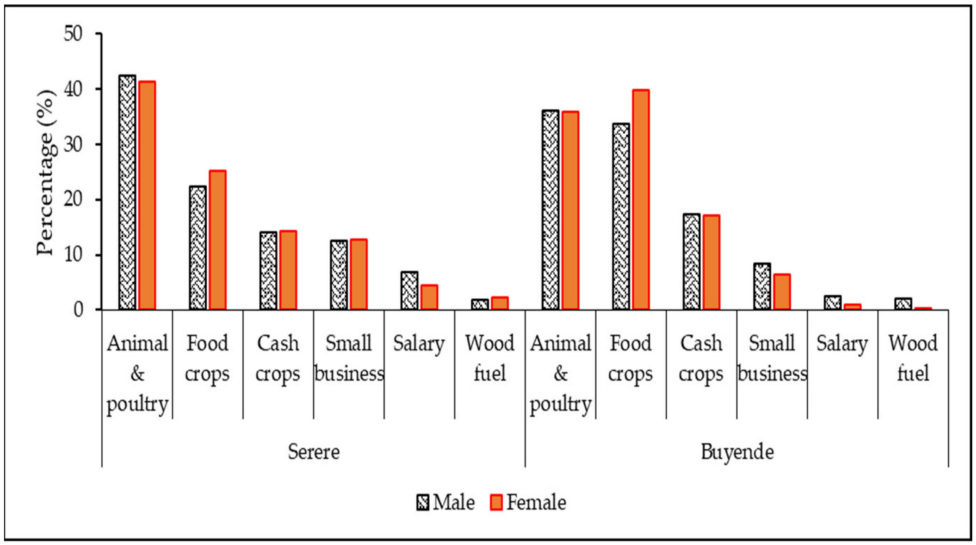


Figure 8. Household sources of income for both the Serere and Buyende districts.

3.3. Climate Change and Its Effects to the Communities

The results show that the perceptions of climate change (e.g., awareness of increase in temperature, changes in rainfall intensity, and changes in rainfall days) were significantly associated with the respondent's sex in the Serere district (see Table 3). We found that 52.8% of the male and 47.2% of the female respondents were aware of the changing climate. Additionally, the level of education was found to influence respondents' awareness of climate change. Both male (42.2%) and female (58.3%) respondents (Table 4) reported that climate change is impacting them, and that they have observed significant increases in temperatures, changes in rainfall days, and increase in number of lightning days.

3.4. Variability in Seasons

The March–May (MAM) rainfall season was reported to be more variable (37%), followed by the June–August (JJA) dry season (32%), September–November (SON) rainfall season (16%), and the December–February (DJF) dry season (15%) (See Figure 9). However, in the Buyende district (see Figure 9), the DJF season was reported to be the most variable (39%), followed by the MAM (29%), SON (18%), and JJA seasons (14%).

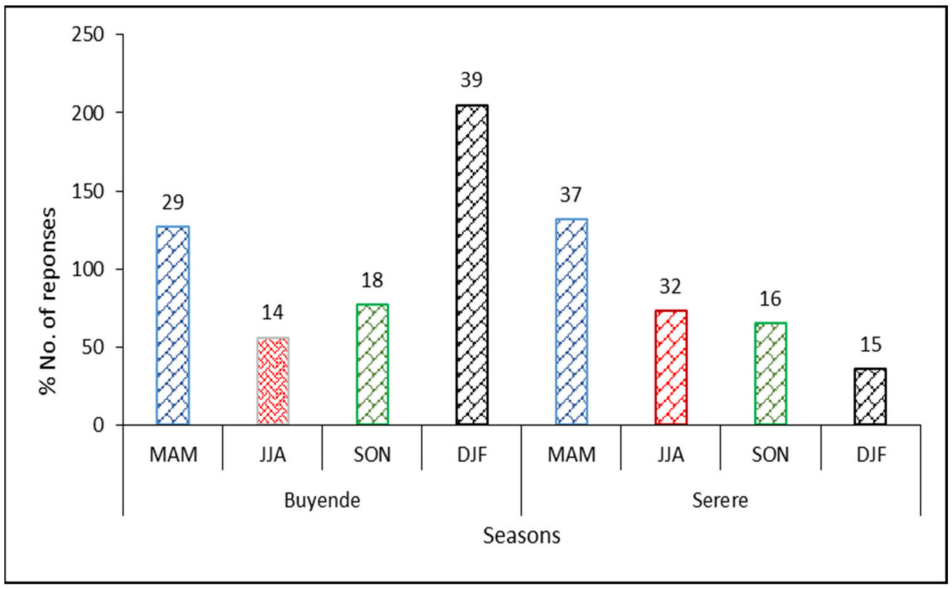


Figure 9. Variations of seasons in the Serere district and the Buyende district.

Table 3. Perceptions of climate change in the Serere district.

Sociodemographic Characteristics	Perceptions														
	Aware of Climate Change/Variability			Change (Rise) in Temperature			Changes in Rainfall Intensity			Changes in Rainfall Days			Changes (Increase) in Lightning Days		
	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.
Sex	8.040	2	0.018 *	56.992	2	0.000 *	146.187	2	0.000 *	177.071	2	0.000 *	2861	1	0.091
Marital status	2.151	8	0.976	11.808	8	0.160	8.170	8	0.417	8.271	8	0.407	5.544	4	0.236
Age of respondent	7.135	8	0.522	4.233	8	0.835	5.659	8	0.685	7.976	8	0.436	5.755	4	0.218
Education level	3.130	6	0.792	7.765	6	0.256	15.537	6	0.016 *	13.911	6	0.031 *	1.491	3	0.684
Household head type	0.755	8	0.999	11.764	8	0.162	23.630	8	0.003 *	24.072	8	0.002 *	0.734	4	0.947

* Significant at 95%.

Table 4. Perceptions of climate change in the Buyende district.

Sociodemographic Characteristics	Perceptions														
	Aware of Climate Change/Variability			Change (Rise) in Temperature			Changes in Rainfall Intensity			Changes in Rainfall Days			Changes (Increase) in Lightning Days		
	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.	X^2	df.	Sig.
Sex	0.490	1	0.484	28.786	1	0.000 *	0.013	1	0.909	12.970	1	0.000 *	48.420	2	0.000 *
Marital status	1.469	3	0.689	1.896	3	0.594	2.787	3	0.426	4.109	3	0.250	2.375	6	0.882
Age of respondent	2.330	6	0.887	5.796	6	0.446	3.278	6	0.773	12.458	6	0.052	17.272	12	0.140
Education level	2.743	3	0.433	2.765	3	0.429	4.493	3	0.213	5.514	3	0.138	5.261	6	0.511
Household head type	1.682	3	0.641	1.872	3	0.599	1.290	3	0.731	2.791	3	0.425	1.441	6	0.963

* Significant at 95%.

3.5. Food Security

In order to understand if the communities were food secure, the data on major crops grown, crop uses, times of the year households have enough food, patterns of food production in the past five years, current major meals, and past major meals were used to assess food security status in both the Serere and Buyende districts. Results (see Table 5) show that cassava (19.5%) is the major crop grown in both districts, followed by maize (18.5%), sweet potatoes (17.4%), groundnuts (8.8%), and the minor grown crop is rice (1.8%). In respect to crop uses (see Table 6), sweet potatoes emerged to be the major food crop (26.6%), followed by cassava (17.1%), maize (11.4%), beans and ground nuts (11.1%), and rice (0.8%) as the least used food crop, while maize is considered to be the major cash crop (23.8%) across the two districts, followed by sorghum (19.3%), millet (17.9%), cassava (17.1%), with banana and vegetables (0.9% each) as the minor cash crops grown in the two district (see Table 6).

Table 5. Main crops grown.

Type of Crop	(%)
Banana	3.8
Cassava	19.5
Sweet potatoes	17.4
Beans	7.1
Maize	18.5
Millet	8.7
Sorghum	8.6
Ground nuts	8.8
Simsim	3.9
Rice	1.8
Vegetables	1.9
Total	100

Table 6. Crop use.

Type of Crop	Use (%)	
	Food Crop	**Cash Crop**
Banana	5.6	0.9
Cassava	17.1	17.1
Sweet potatoes	26.6	2.2
Beans	11.1	2.2
Maize	11.4	23.8
Millet	5.4	17.9
Sorghum	5.4	19.3
Ground nuts	11.1	3.6
Simsim	2.0	10.3
Rice	0.8	1.8
Vegetables	3.5	0.9
Total	100	100

Figure 10 shows that across the two districts, the major time of the year with enough food is during the rainy season (72%) followed by the dry season (24%), throughout the year (3%), and not sure with (1%). Furthermore, 74% of respondents reported that food production across the two districts (Serere and Buyende) in the past five years has greatly decreased, and only 24% reported that over the past five years food production has been increasing (See Figure 11). Results shown in Table 7 indicate that the number of respondents eating three meals per day has decreased from 59.7% in the past five years to 43.6% in the present moment, while the number of respondents eating two meals per day has increased from 35.9% in the past five years to 52.1% in the current situation (See Table 7).

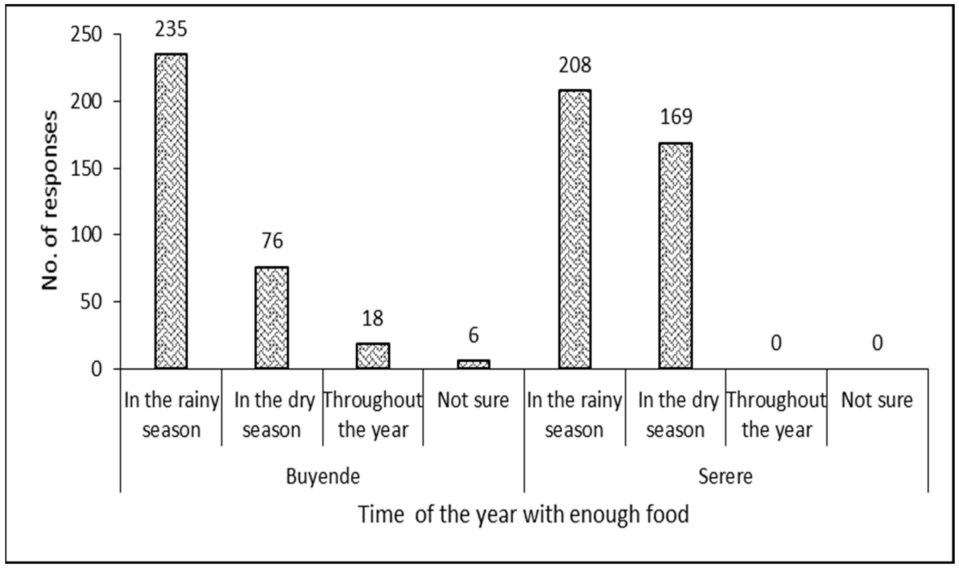


Figure 10. Time of the year when food is enough.

Table 7. Patterns of meals.

No. of Meals per Day	Current (%)	Past 5 Years (%)
Three meals	43.6	59.7
Two meals	52.1	35.9
One meal	2.7	3.1
None	1.6	1.3
Total	100	100

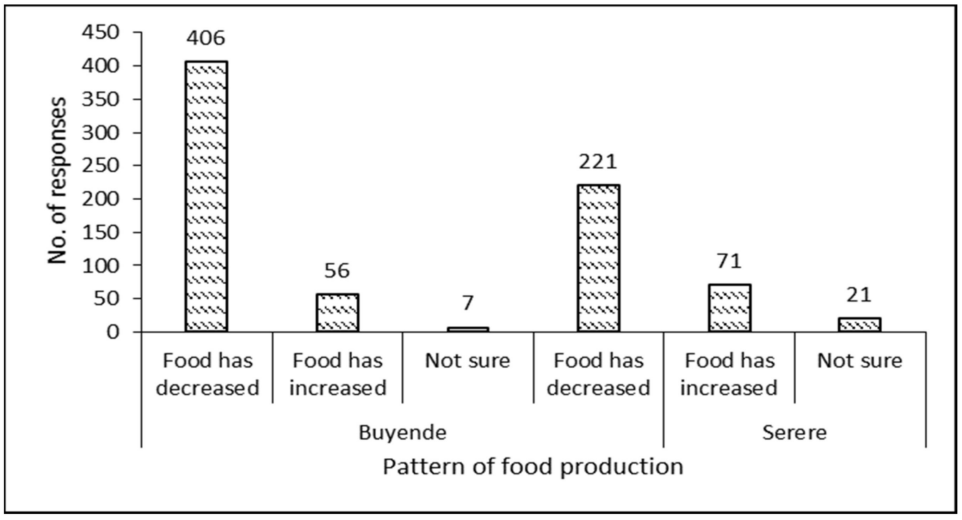


Figure 11. Pattern of food production in the last five years.

3.6. Coping Strategies

3.6.1. Coping Mechanisms Employed by Communities

Communities in the two districts employed various ways of coping with the different impacts of climate change and climate variability. These coping mechanisms have been applied differently considering the changes in rainfall availability, changes in food availability, and crop failures. The majority of respondents across the two districts opt to use the growing of drought-resistant crops (32.7%), followed by rearing drought-resistant livestock breeds (26.1%), and eating fewer meals a day (14.5%) (See Table 8). For changes in

food availability and crop failures, the majority of the respondents opt to buy food (34.3%) (See Table 9).

Table 8. Coping with changes in rainfall availability.

Strategy	Percent (%)
Settling down with family/reduced nomadism	13.5
Growing drought-resistant crops	32.7
Using drought-resistant livestock breeds	26.1
Having less/fewer meals a day	14.5
Nothing/not sure/just look on	13.2
Total	100

Table 9. Coping with seasonal changes in food availability.

	Percent (%)
Buying food (e.g., beans and maize flour)	34.3
Settling down with family/reduced nomadism	7.5
Growing crops	16.7
Increased production	19.6
Having less/fewer meals a day	15.9
Nothing/not sure/just look on	6.1
Total	100

3.6.2. Effectiveness of Coping Mechanisms

A Chi-square test was performed to test for the effectiveness of the coping mechanisms employed to overcome the effects of climate change and climate variations across the two districts (Serere and Buyende). The results (Table 10) indicate that the most effective coping mechanisms that are significantly associated with the respondents' sociodemographic characteristics are: growing drought-resistant crops, having fewer meals a day, growing a variety of crops, and early planting and harvesting.

Table 10. Effectiveness of the coping mechanisms.

Coping Mechanism	X^2	df.	Sig.
Settling down with family/reduced nomadism	2.049	6	0.915
Growing drought resistant crops	74.444	38	0.000 *
Using drought resistant livestock breeds	6.753	8	0.564
Having less/fewer meals a day	152.979	36	0.000 *
Nothing/not sure/just look on	7.461	6	0.280
Buying food (e.g., beans and maize flour)	8.383	8	0.397
Growing a variety of crops	93.416	40	0.000 *
Early planting and harvesting	160.561	46	0.000 *
Using improved or resistant varieties of crops	10.456	8	0.234

* Significant at 95%.

4. Discussion

In both districts in the different agro-ecological zones, less than 50% (Serere, 49.3% and Buyende, 13.3%) of the respondents had formal education up to at least secondary level. There were also female- and child-headed households. This is of great importance to the two districts, as the prevalence of food insecurity is higher among female- and child-headed households, possibly because they frequently have less access to adult labor and may lack the means to seek employment away from their families. Additionally, there is less access to and control of assets (see Figures 4 and 5) by women and children, which may also explain why female- and child-headed households are more vulnerable to food insecurity. Generally, female- and child-headed households are more vulnerable to food insecurity because of their tighter time schedules and income constraints.

Low education levels were reported in the two districts. This implies that many households are restricted to earning income from agricultural activities and blue-collar jobs. Furthermore, low levels of education limit the use of smart farming practices that can help communities cope with the effects of climate change. This leaves many households prone to crop failure since they mainly rely on a few coping mechanisms, which often cater for specific risks. It is therefore important for government to sensitize communities to climate change and invest in promoting smart farming methods amongst farmers. This will enable farmers to grow off-season crops and therefore improve food security.

The main crops grown in the area are mostly for household food supply, and provide low incomes to the respective households which opt for selling off some of the crops. These crops can only raise a reasonable amount of income if stored and sold during the period of scarcity. This may not happen, however, since many households are unable to adopt the costly food conservation mechanisms required. Hence, the low incomes generated during the crop seasons may not be able to provide the food requirements during the time of scarcity. We recommend that the government of Uganda train farmers on food conservation and promote market identification to limit farmer exploitation.

From the results, both districts mainly rely on growing crops for food and income (for example, the 41.2% of females and 42.4% of males from Serere, where their major source of income is from selling animal, poultry, and food crops, and likewise the 39.9% of females and 36% of males from Buyende). Food access is based on the ability to procure food. Buying food, especially for a population which relies predominantly upon agriculture for their income generation, is not practical. This is because the little which is produced is divided between food supply for the households and for sale. This is the same reason many families have resorted to the reduction of the number of meals eaten in a day, indicating that they are food insecure. The fact that these communities mainly rely on rain-fed subsistence agriculture means that they are very likely to incur losses in case of harsh climatic conditions. It is therefore of paramount importance to strengthen the policy of providing early warning of major climate events and weather forecasting, weather-based crop insurance, and disaster risk planning to address the direct impacts of climate change.

The limited access to assets by many women means that they are less likely to cope with the effects of climate change. For instance, bicycles used to access distant water sources are mainly owned by men. This implies that whenever men are away from home, women may not be able to effectively access water. It is therefore important to empower rural women to improve their financial standing in order to be able to cope with the challenges.

With the growing population, there are also limitations to increasing land under cultivation, a method which can address the problem of low yields. This has therefore led many households to use the same pieces of land continuously, further reducing the fertility of the soil. The high pressure exerted by the growing populations also makes the limited available land a resource for competition, which leave some households without land due to their inability to afford the land because of the growing costs. Such households are left to depend on renting land each season. This land tenure system limits the respective households to planting short-term crops, which further depletes the fertility of the land. This leads to lower crop yields and heightens the risks of food insecurity. It is therefore important to sensitize communities to methods of utilizing the little land available to maintain productivity. This may be in form of identifying market demands and adopting the cultivation of high value crops.

Communities reported their ability to cope with the impacts of climate change and climate variability in different ways. For instance, in order to cope with changes in rainfall availability, changes in food availability, and crop failures, a majority of respondents across the two districts reported that they rely on growing drought-resistant crops (32.7%). This is followed by rearing drought-resistant livestock breeds (26.1%) and reducing the number of meals they eat in a day (14.5%). With regard to changes in food availability and crop failures, a majority of respondents buy food (34.3%). However, given the limited levels of education among communities and their high reliance on agriculture, many risk becoming

food insecure. This is because many are unable to afford to buy food. While the drought-resistant crops have been mainly used to cope, accessibility to a range of varieties is subject to government interventions, who mainly conduct the research to produce new drought-resistant crops. These varieties further come at an extra cost, which many households may not be able to afford in large quantities. We recommend that the government of Uganda subsidizes the purchase of drought-resistant varieties to improve access.

5. Conclusions and Recommendations

The changing climate has negatively impacted food systems, affecting rainfall patterns and leading to drought or flooding, among other negative effects. This study examined the community's ability to cope with food insecurity due to the changing climate in the Serere and Buyende districts of Uganda. We administered 806 questionnaires to households, seeking to assess household resources, the effects of climate change to households, and the coping mechanisms employed to reduce the impact of climate change on food security. We found that many households are either food insecure or at risk of food insecurity. This was manifested through a reduction in the number of meals per day respondents ate in order to save on food consumption. Furthermore, many households are heavily reliant upon crop production, which is often negatively affected by climate change. Moreover, many of these households were limited by low education levels and low incomes from efficiently adopting the coping mechanisms. It is therefore important to enhance government interventions to enable low-income earners to cope with the effects of climate change on agriculture, which would improve food security among communities by revising policies that promote each community's ability to cope with the effects of climate change, providing advisory and sensitization services, weather forecasting, and subsidies, among others. These will increase the number of households who are able to maintain food production even under the effects of climate change.

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