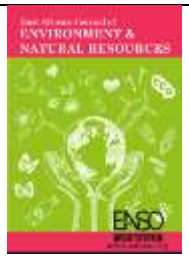

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*Original Article*

# Farmers Coping and Adaptation Mechanisms to Perceived Changes and Variability in Climate

*George Oriangi[1*], Elaijah Edekebon[1], Daniel Ochieng Ologe[2] & Yazidhi Bamutaze[2]*

[1] Gulu University P. O. Box 166, Gulu, Uganda.
[2] Makerere University, P. O. Box 7062, Kampala, Uganda.
[*] Correspondence ORCID: https://orcid.org/0000-0002-4744-4034; Email: g.oriangi@gu.ac.ug

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*Perceptions, Climate change, Variability, Coping, Adaptation.*

## ABSTRACT

There is a growing global concern about the detrimental effects of climate change and variations on rain-fed agriculture. This study determined households' perceptions of changes and variations in climate and institutional roles in farmers' coping and adaptation mechanisms to changes and variations in climate in Paicho Sub County (S/C), Gulu district in Northern Uganda. Data was collected through structured household interviews and analyzed using regression analysis and descriptive statistics. Findings showed that respondents perceived rainfall and temperature to be the climatic parameters that had changed most with rainfall onset largely unpredictable. The major coping mechanisms to changes and variations in climate included: buying food from the market, exchange of labor for food, and getting food help from relatives, community, and food agencies while, the major adaptation mechanisms included: getting jobs outside agriculture, adjustment of planting dates, diversification of production, carrying out mixed cropping, and growing improved crop and animal varieties. Additionally, the gender ($P<0.05$), the size of the land ($P<0.05$), and the age of the household head ($P<0.05$) were found to be the most significant factors influencing adaptation mechanisms. Furthermore, the role of existing institutions in community adaptation to changes and variations in climate included: making decisions on planting time, providing access to information relevant to coping and adaptation, providing access to credit, governing entitlements, and capacity building. In conclusion, there is a need for better and new crop varieties that can survive under changed and varied climatic conditions, and a need for more enhanced adaptation mechanisms.

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## INTRODUCTION

Strong trends in climate change and variability are already evident, the likelihood of further changes is projected, and the increasing scale of potential climate effects on crop yields gives urgency to addressing agricultural coping and adaptation more coherently (Howden et al., 2007; IPCC, 2007; UNFCCC, 2003; Tetteh et al., 2020). Thus, communities in many parts of the world have often tried to use a range of coping mechanisms as a way of responding to experienced impacts with a short-term vision in order to reduce the effects of changes and variations in climate on yield reduction (UNFCCC, 2003; UNDP, 2005; Morton, 2007; Alejandro, 2013; Arragaw & Woldeamlak, 2017; Makame & Shackleton, 2020). The coping mechanisms are often based on experience accumulated over the years and transmitted from generation to generation (Cooper et al., 2008). They include: collection of wild foods, purchasing food from the market, in-kind (food) payment, support from relatives and friends, sales from livestock and household valuables, migration and wage labor in exchange for food, reduction in the number of meals served each day, reduction in the portion/size of meals and consumption of less preferred food (Quay, 2008; Osbahr et al., 2010; Fana & Snake, 2012; Kyekyeku, 2012; Bardege et al., 2013; Arragaw & Woldeamlak, 2017). Farmers have also managed to cope by water rationing during periods of drought, rain water harvesting, re-use of water for example water from washing clothes or utensils to irrigate crops in the backyard gardens and nurseries, carrying out mixed cropping, adjustment in land and crop management (Kabat et al., 2012; Gyampoh et al., 2008; Bhatta & Aggarwal, 2016). Furthermore, communities have also employed coping mechanisms such as reliance on social networks i.e. sharing of information, emotional support, cash loans, petty trade, temporary migration; women making handicrafts to sell in nearby markets and relying on friends for support (Osbarhr et al., 2010; Mekuyie & Mulu, 2021). Furthermore, FAO (2007); Kumar et al. (2008) and Cooper et al. (2008), indicated that people can cope with climate variability effects through getting jobs outside agriculture, asking for food aid and resorting to fruit trees as a strategy to cope with famine periods.

In addition to the aforementioned coping mechanisms, several adaptation mechanisms have been devised to counteract the concerns posed by the effects of climate change and variability on rain-fed agriculture (Kilembe, et al., 2012; Sultan et al., 2013; Tetteh, 2020). Adaptation to climate change are adjustments or interventions which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate. Agriculture is a major land use across the globe but in its many different facets in various localities of developing countries, agriculture remains highly sensitive to changes and variations in climate (Vermoulen et al., 2008; Bello et al., 2012; Eschenbach, 2013; Mekuyie & Mulu, 2021). Furthermore, the means and capacity in developing countries to adapt to changes and variations in climate are limited due to low levels of education, low levels of technology, limited supporting institutions and limited access to financial assets. These conditions combine to create a state of high vulnerability to climate change and variability in much of the developing world and greatly affecting food production (IPCC, 2007; Hepworth & Gouden, 2007; FAO, 2008). Hence, it is critical to identify and evaluate adaptation options to climate stressors in specific places to effectively manage the current and future climate risks. It should be recognized that adaptation is an ongoing process that is part of the good risk management

 

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whereby drivers of risk are identified and their likely effects on systems under alternative management are assessed. In this respect, adaptation to climate change is similar to adaptation to climate variability (Smit & McCathy, 2001). The changes that are likely to occur in climate require famers to alter their agricultural practices; sorghum, for instance is more heat resistant and therefore does better than maize in places where rainfall decreases. However, the question is whether communities that are used to and have a preference to maize will switch to sorghum or another more suitable staple crop (Ziervogel et al., 2008; Bardege, 2013). Ziervogel and Eriksen (2010) assert that the major challenge is how to adapt to climate stressors and accomplishing this task needs a multidisciplinary strategy which should be adapted to location specific circumstances (IPCC, 2007). According to IPCC (2007), Ellina and Tirpark (2006), and Bardege et al. (2013), a rapid, coordinated and multidisciplinary response is needed to respond to the risks posed by climate change and variability on agriculture and hence, various forms of adaptation strategies exist and these include; (i) Anticipatory adaptation which involves improved land management. (ii) Autonomous adaptation involving growth and diversification of production, change in market demands and food supply practices (McKinney, 2009). (iii) Technological adaptation involving introduction of irrigation techniques, introduction of new crop hybrids and making better use of scarce water (Ziervogel & Ericksen, 2010; Ludi, 2009). (iv) Planned adaptation involving introduction and growing of new crop varieties, improved water management, change in planting dates, integration of crops, livestock, forestry and fishery sectors at farm and catchment levels (Ludi, 2009; Marshal et al., 2009). (v) Public adaptation which involves early warnings on floods and droughts and improved institutional settings (Vermoulen et al., 2008). (vi) Private adaptation which constitutes migrating from water stressed areas and semi-arid areas, and going for off farm employment opportunities (UNDP, 2005). (vii) Main stream adaptation which involves creation of enabling policies, research and dissemination of crop varieties and breeds adapted to changing climatic conditions. However, the major challenge is how to adapt to climate variability and change without threatening sensitive livelihood systems. This will require analyzing and changing farming and food systems, learning from community-based approaches, generation and use of technology, overcoming biotic stress in crops through crop breeding, targeting investments in understanding where different biotic stress dominate and matching crops to future climate in a way that accounts for uncertainties (Smit & Wandel, 2006). According to Schneider et al. (2007), there is evidence of an adaptation deficit, and acting now to narrow the deficit can yield immediate benefits (Nail et al., 2008). In the context of Uganda, crop production is a key sector to the economy, employing an estimated 68% of the working population (Uganda Country Commercial Guide, 2023). In the financial year 2022/2023 alone, UBOS estimated that about 68% of Uganda's working population was employed in agriculture, about 24% of Uganda's Gross Domestic Product was generated from agriculture, which brought 35% of the export earnings, and accounting for about 24% of the GDP. However, because of over-dependence on rain-fed agriculture, most farmers are vulnerable to the effects of climate variability and change. To make matters even worse, Uganda is labeled as one of the most unprepared and most vulnerable countries in the world, yet it has the least adaptive capacity, making location specific adaptation the most immediate priority for the country (Hepworth & Gouden, 2007). Therefore, this study aimed at determining (a) farmers coping and adaptation mechanisms to climate change and variability and (b) the role that institutions play in climate change coping and adaptation.

In understanding how people adapt to climate change and variability, it is important to recognize the role that institutions play in influencing behavior. Institutions are structures and mechanisms of social order and cooperation governing the behavior of a set of individuals within a given human collectivity (Amaru & Netra, 2013). There are three types of institutions

 

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(a) formal and informal, taking a number of different forms e.g. local councils, religious institutions, family networks and clan/elders' networks (African Climate Change Resilience Alliance (ACCRA), 2012). (b) Command and control institutions which are historically the most common and are responsible for regulating domestic environmental problems through direct regulations and economic instruments such as charges and taxes and (c) Persuasive/information institutions such as mass media and market-based institutions dealing with exchanges and trade (Parvin, 2012; Davison, 2003; Kauffman & Hill, 2021). Institutional roles in influencing coping and adaptation to climate change and variability include but not limited to information gathering and dissemination, resource mobilization and allocation, skill development and capacity building, providing leadership skills, and relating with other decision makers (Amaru & Netra, 2013). Additionally, these institutions often play a central role in influencing how different social groups gain access to and are able to use assets and resources. This study suggests that coping and adaptation mechanisms to climate change and variability are inevitably local and that institutions influence coping and adaptation by structuring impacts and vulnerability, mediating between individual and collective responses to climate impacts and thereby shaping outcomes of adaptation. Institutions also act as the means of delivery of external resources to facilitate adaptation, and thus govern access to such resources (Agrawal, 2008).

According to Agrawal (2008), local government actors were identified in playing practical roles in adaptation practices and these include; promoting tree planting and reforestation, selection of appropriate crop varieties, soil and water conservation, controlled bush burning, information sharing, research and capacity building. Furthermore, the capacity of communities to respond to climate stressors depends on knowledge flows through a broad range of institutions and the ability of institutions to act collectively at multiple scales (Hepworth & Gouden, 2007). In rural Uganda, institutions are both formal and informal and take a number of different forms e.g. local councils, religious institutions, family networks and clan/elders' networks (African Climate Change Resilience Alliance (ACCRA), 2012). Each of these has its own internal rules, structures and norms that shape individual behavior. Institutions are important in the context of climate change and variability because of their significant role in influencing adaptation responses since livelihood decisions and activities are based on past practices e.g. traditional seasonal calendars dictate on when crops should be planted. Institutions may stop people from deviating from common practices, but certain institutions and norms can prevent people from adapting to more appropriate practices and livelihoods and often govern entitlements to key natural resources (Jones & Boyd, 2011).

## Materials and methods

### *Location of the study area*

The study was conducted in Paicho Sub County, Gulu district in northern Uganda (*Figure 1*) in July 2012. Paicho Sub County geographically lies between latitudes 2° 52'-2°55' N and longitudes 32° 27'- 32° 29' E. The total area covered by the Sub County is 592.7 square kilometers (UBOS, 2011). The Sub County is bordered by Awach Sub County in the north, Atanga Sub County in the north east, Awere and Puranga in the east, Odek Sub County in the south east, Lalogi and Koro Sub Counties in the south and Bungatira Sub County in the west (Figure 1)

 

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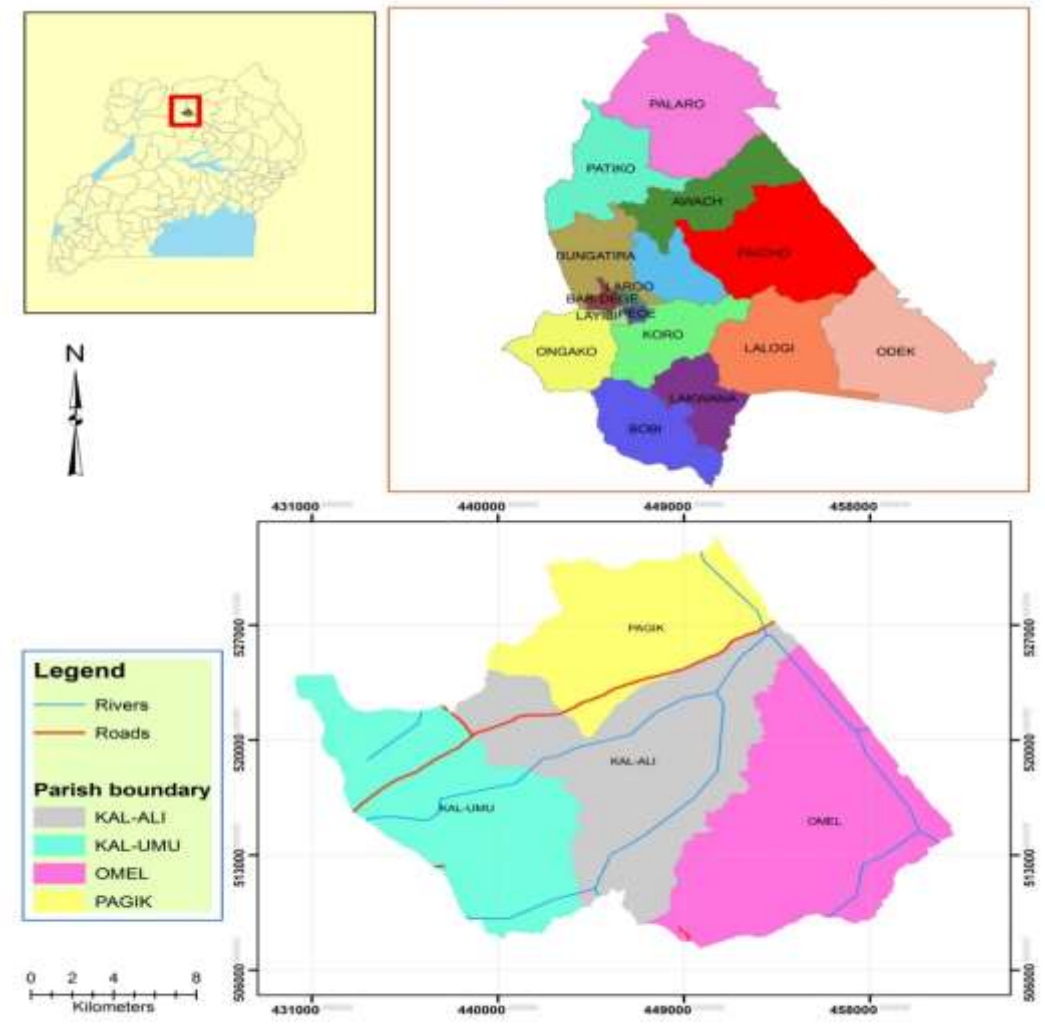
**Figure 1: Location of Paicho Sub County in Gulu District in Northern Uganda**




### *Climate*

Paicho Sub County experiences a tropical type of climate (wet and dry) (NEMA, 2009). The average total annual rainfall received is 1500 mm with the monthly average rainfall varying between 1.4 mm in January and 230 mm in August. Normally the wet season extends from April to October with the highest peaks during May, August, and October, while the dry season begins in November and extends up to March as illustrated in Figure 2. Rainfall is mainly convectional characterized by afternoon and evening occurrences. Occasionally the area experiences long droughts and irregular rains which are recently becoming more frequent with negative effects on crop yields (WFP, 2009). The average maximum temperature is $30^0$C (Figure 2) and the average minimum temperature is $18^0$C. Relative humidity is high during the wet season and low in the dry season (UBOS, 2011). Although the annual rainfall totals are theoretically good enough to support crop growth, its temporal distribution appears to be constraining since the rains come in one season, consequently, there is one crop growing season coupled with occasional experiences of long droughts and irregular rains (WFP, 2009; NEMA, 2009) hence, threatening crop production and affecting the yield potential of the area.

Generally, the annual variations in total rainfall amounts and average annual maximum temperature for the period 1990 to 2009 for

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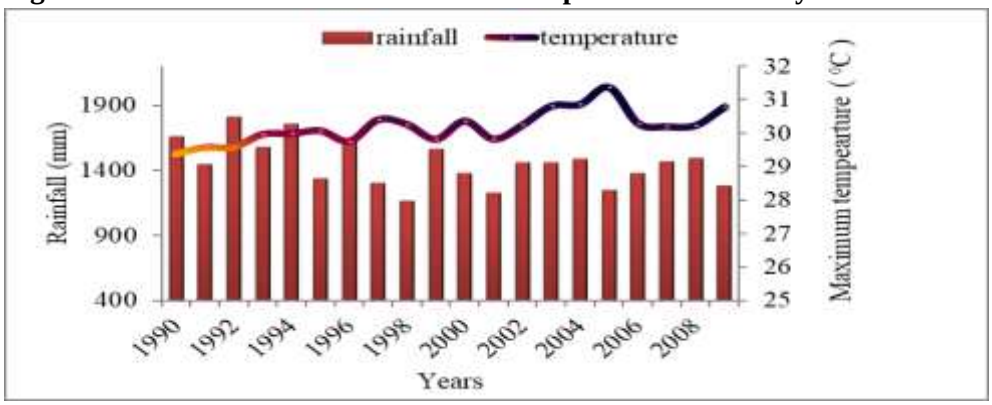
Paicho Sub County, Gulu district are illustrated in Figure 2.

**Figure 2: Annual rainfall and maximum temperature variability for Gulu station**




***Soils***

Paicho Sub County contains Leptosol soils characterized by a high percentage of sand (NEMA, 2009). These soils are susceptible to erosion, have low water retention capacity, high rate of water infiltration and moderate fertility (UBOS, 2011) hence may require addition of fertilizers for maximum output of crop yields but given the low incomes of the population in Paicho Sub County (UNDP, 2012), purchase of fertilizers and other modern agricultural inputs is limited for most households resulting to low crop yields.

***Topography***

The Sub County consists of a complex landscape with relatively uniform topography marked with a sharp contrast of Aswa river which was formed as a result of up warp and down warp of underground rocks accompanied by faulting. Generally, the altitude ranges from 1000 to 1200 meters above sea level (Gulu Lancashire Local Agenda 21, n.d.).

***Land use types***

There are various land use types in Paicho Sub County, namely, agriculture which is rain-fed, dominated by subsistence farmers, and is the dominant land use employing over 90% of the total population. The major crops grown include finger millet, maize, sorghum, beans, peas, sesame, ground nuts, cassava, and potatoes. The major crops that contribute to household income include; groundnuts, beans, cassava, and sesame (WFP, 2009). Other land use types include afforestation, fishing in swamps and streams, settlements, transport and communication, and small-scale lumbering (UNDP, 2012).

***Population***

The total population of Paicho Sub County in 2002 was 24,876 people for 5242 households according to UBOS (2002). In 2011, the population was estimated to have grown to 32,100 of which 15,900 were male and 16,200 were female with 5,779 households (Okello, 2010). The sub-county has a low social economic status with 62% of the population living below the poverty line (UNDP, 2012) and this has a negative implication on crop production. The main option for income is the sale of crops and others include casual labor and the sale of forest products. However, a smaller proportion of the population is involved in petty trade activities such as selling crop produce, brewing and selling alcohol, and selling local consumable goods, handcrafts, and foodstuffs which are mainly sold in the shift/village markets (WFP, 2009).

***Research design***

The study employed a cross-sectional survey research design as described by Lyberg et al. (1997), to capture a representative sample of the population. This design allowed the study to

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derive insights into the opinions, attitudes, perceptions, and knowledge regarding climate change and variability, coping and adaptation mechanisms, and the role of institutions in community adaptation to climate change. The elements of the research design, including the target population, sample size and sampling procedures are described as follows.

***Target population and unit of analysis***

The main target population of the study constituted farmers in the study area as the study issues were focused on climate change and variability, coping and adaptation mechanisms, and institutional roles in community coping and adaptation. Farmers also predominated the study area since agriculture was the major livelihood activity that employed over 90% of the people (WFP, 2009). The unit of analysis for the study was the household since it enabled to capture and implicate a range of socioeconomic characteristics at that level.

***Sample size and sample selection***

The sample size was determined on the basis of household population. To capture an appropriate sample, there was a need to obtain the current household population data. Although population data for the previous census of 2002 was readily available, this was deemed outdated. Thus, a reconnaissance was undertaken in Paicho sub-county headquarters to obtain recent population data. The reconnaissance yielded population and household data for each parish for the year 2011. Although the data was based on estimated projections, it was certainly more realistic than the UBOS census data of 2002. The total sample size of the study was 147 households obtained from two parishes; Kalumu parish (87 households) and Kal-ali Parish (60 households). Although, Paicho Sub County was constituted of four parishes covering Kalumu, Kal-ali, Pagik, and Omel, only two parishes deemed to be representative of the entire population were selected taking into consideration accessibility, population characteristics and cost implications. The sample size for the study was statistically determined using the equation (1) given by Allyn and Bacon (2010).

$$n = \frac{pqN}{(SE)^2 N+pq}$$

……Equation 1

n = sample size,

SE = standard error of the proportion,

p = proportion of households engaged in farming

q = 1-p and

N = total population of households.

$SE = \frac{0.10}{2.58}$ at 99% confidence level=0.04, N=2470, p=0.5, q=1-0.5=0.5

$$n = \frac{0.5x0.5x2470}{(0.04)^2 x\ 2470 + 0.5\ x\ 0.5}$$

Therefore n=147

The household-based data and the determined sample size collapsed for the two parishes are given in Table 1.

**Table 1: Sample size for the study**

| Parish | Number of households | Sampled households |
|---|---|---|
| Kalumu | 1456 | 87 |
| Kal-ali | 1014 | 60 |
| Total | 2470 | 147 |

***Selection of respondents***

The selection of households was based on random sampling procedures as described by Dillman et al. (2001). Random sampling was deemed appropriate due to the rural setup of Paicho Sub County where over 90% of the households are engaged in agriculture (WFP, 2009) and assumed to be uniform, and selecting any household would be representative of the total population.

 

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***Data collection***

Self-administered questionnaires were used to collect data on the perceptions of households on changes and variations in climate, the coping and adaptation mechanisms to climate change and variability, and the role of institutions in community coping and adaptation to climate stressors. Structured household interviews were administered to the target respondents using a questionnaire instrument. This was done after requesting for their consent to involve in the interview process. Each interview with the respondent took approximately one hour.

***Data analysis***

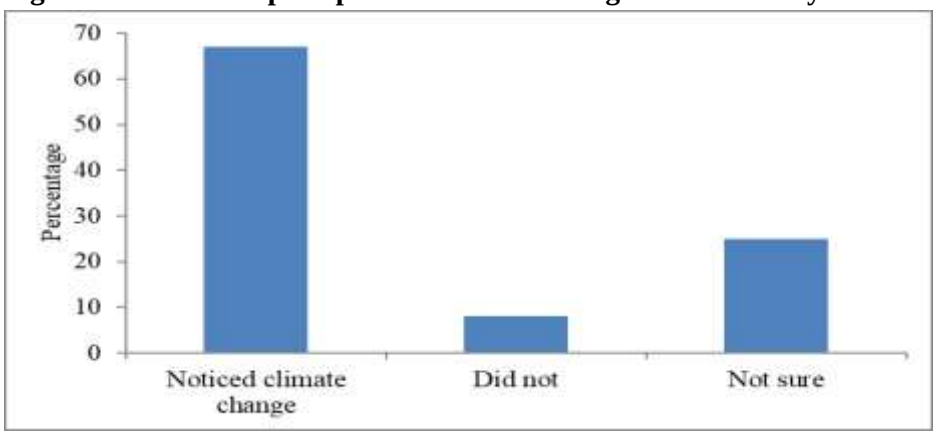
To analyze the questionnaire data, the following analytical tools were employed: (a) Regression model to determine the factors that influence adaptation mechanisms to climate variability and change. The independent variables included: age of household head, household income, household type, gender, education level of household head, household access to credit, size of land, and access to extension service. While adaptation strategies to climate variability and change formed the dependent variables. Significance in relationships was determined at $P<0.05$. (b) Descriptive statistics involving (i) Cross tabulation to establish the relationship between institutions, their roles in community adaptation to climate change and variability, and their distribution in terms of parishes where they exist. (ii) Percentages were also used to quantify household perceptions on the changes and variations climate.

**Results**

***Perception of households on climate change and variability***

Findings on household perceptions on climate change (Figure 3) revealed that most respondents (67%) perceived that there is climate change taking place. The perceived change in climate is likely to be driven by information disseminated on media. This perception agrees with the general notion that climate is changing (Orindi & Eriksen, 2005; IPCC, 2007; Lobell et al., 2013; Alexander, 2013). However, this study finding contrasts with statistically analyzed meteorology data which indicates more of variability in climate than change (Oriangi et al., 2024).

**Figure 3: Household perception on climate change in the last 15 years**




Household's perceptions on climate parameters that have changed (Figure 4) revealed that rainfall had changed most (26%), followed by temperature (25%), and wind speed and direction represented by 21% of the household's responses. These perceptions could be driven by the delays in rainfall in the previous seasons, and media information on global warming. The perception that rainfall has changed contrasts with statistically analyzed meteorology data which shows that rainfall has not changed significantly over the period 1980-2010 in the area (Oriangi et al., 2024). While the perception that temperature has changed confirms with a report by Oriangi et al. (2024) that both maximum and minimum temperatures had changed significantly for the period 1990-2009.

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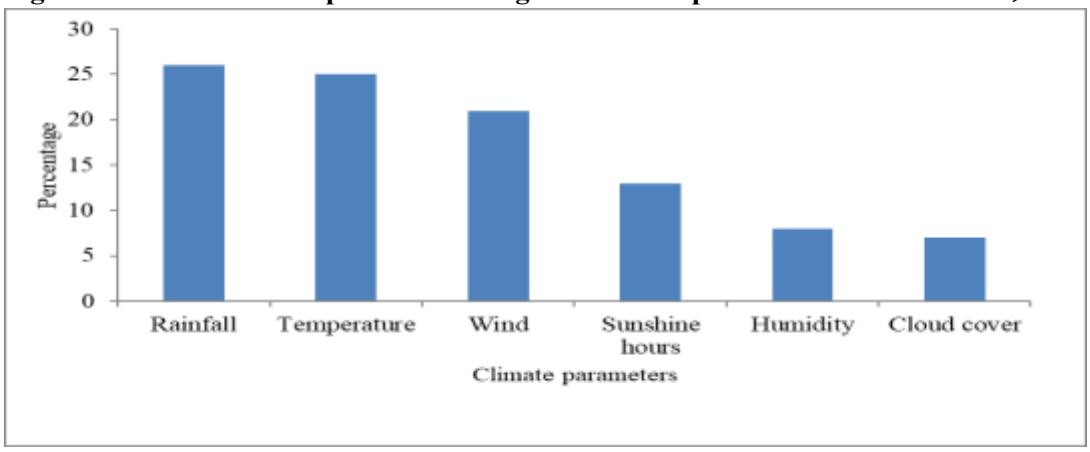
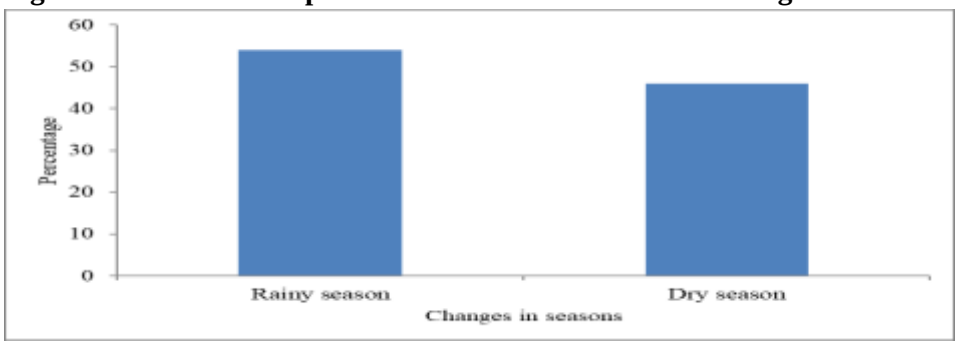
**Figure 4: Household's responses on changes in climate parameters in Paicho S/C, Gulu district**



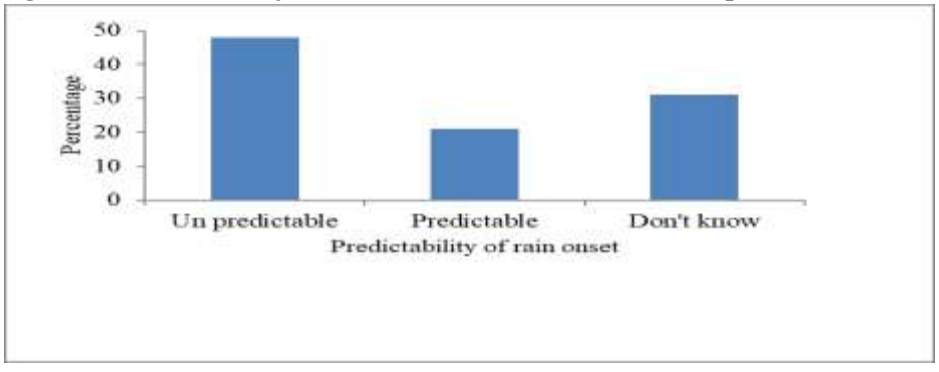

Perceptions on changes in seasons (Figure 5) revealed that 54% of the households perceived that the rainy season had changed most and 46% responded that it is the dry season that had changed most. Thus, the most changed season was the rainy season. This finding is likely to be a result of the onset of the rainy season which is becoming almost unpredictable, variation in rainfall distribution and amounts in the region.

**Figure 5: Household responses on the season which have changed most**




Perceptions on the predictability of the onset of rains (Figure 6) revealed that the onset of rainfall was largely unpredictable (48%) as compared to the last 15 years. The perception that rainfall was largely unpredictable equates with analyzed meteorology data which indicates that the occurrence of the onset of rain for the period 1980-2012 ranges from the first week of March to the second week of April hence difficult to predict because of the wide variation (Oriangi et al., 2024).

**Figure 6: Predictability of the onset of rainfall now as compared to 15 or 30 years ago**



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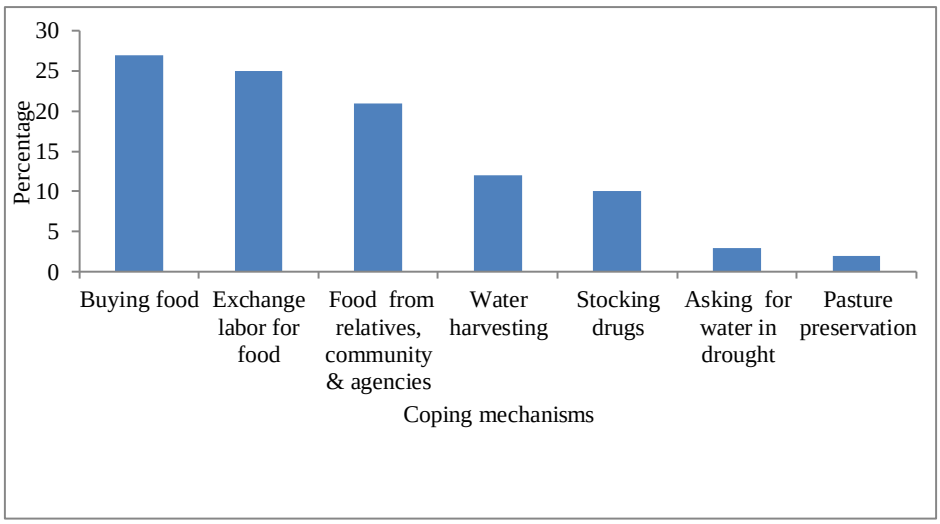
***Household coping mechanisms to climate stressors***

Results on the coping mechanisms to climate stressors adopted by households in Paicho Sub County are given in figure 7. The major coping mechanisms undertaken include; buying food from the market (27%), exchange of labor for food (25%), getting food help from relatives (21%), community and food agencies (21%). The probable reasons for this nature of coping mechanisms are likely to be the prevalence of high poverty rates and the effect of the civil war that dominated the region for two decades (1986-2006). Paicho Sub County had a low social economic status with 62% of the population living below the poverty line (UNDP, 2012). Studies on coping mechanisms by Quay (2008) and Kyekyeku (2012) in Ghana; Fana and Snake (2012) in Ethiopia; and Bardege et al. (2013) obtained various diversified coping mechanisms in response to climate stressors, some of which relate to the coping mechanisms found in this study and they include; collection of wild foods, purchasing food from the market, migration and wage labor in exchange for food, support from relatives and friends, sales from livestock and household valuables, reduction in the number of meals served each day, reduction in the portions/sizes of meals and consumption of less preferred foods.

**Figure 7: Household coping mechanisms to climate stressors**




***Households' adaptation mechanisms to climate stressors***

Results on adaptation strategies to climatic stressors undertaken by households in Paicho S/C are given in figure 8. The adaptation mechanisms include; getting other jobs outside agriculture (20%), adjustment of planting dates and diversification of production (19%), carrying out mixed cropping (15%), growing improved crop varieties (11%), rearing improved animal breeds (10%), and growing first season crops in second season and second season crops in first season (10%). Households in Paicho S/C have carried out several adaptation strategies in response to the effects of climate change and variability. This implies that climate change and variability is not a new phenomenon to the people of Paicho S/C in Gulu district. The adoption of these adaptation mechanisms is likely to be due to limited institutional capacity, low financial capability of the households and limited farm technology. These adaptation strategies are not new but have a close relationship to those carried out elsewhere. A study by Nhemachena (2008) in 11 African countries found diversified adaptation mechanisms to climate change e.g. diversifying production, using different improved varieties, changing planting dates, increased irrigation, use of insurance, water conservation, prayers, soil conservation etc. Similarly, Kathleen et al. (2008) reported that in Ethiopia and South Africa,

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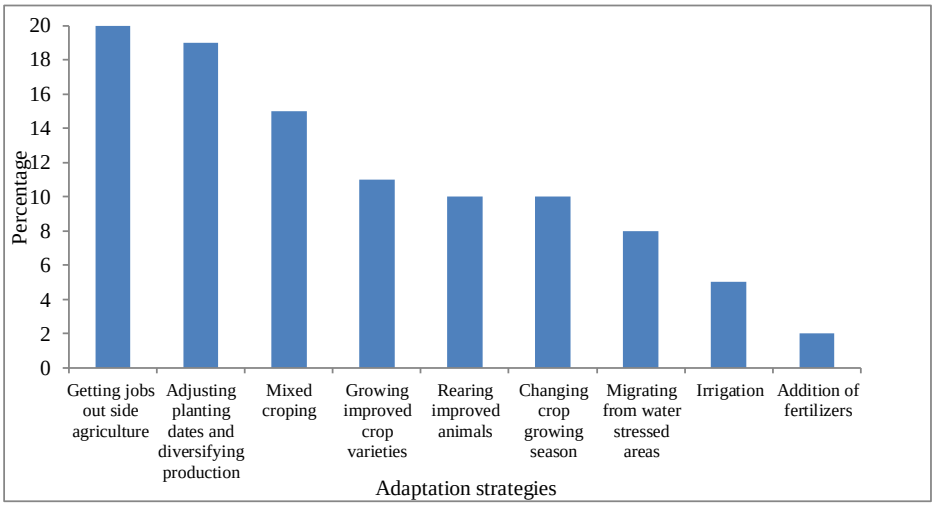
common adaptation strategies included use of different crop varieties, planting trees, soil conservation, changing planting dates and irrigation. However, Burton et al. (2002) reported quite different adaptation strategies being carried out in Bangladesh, the Netherlands and USA including; changing the topography of the land, changing farming practices, changing timing of farm operations, using different crop varieties, research into new technologies and change of government and institutional programs. The adaptation strategies adopted by communities in different regions seem to be dependent on their level of economic development, technology, financial capacity, institutional support and traditions. However, most of the adaptation strategies adopted by communities in various regions tend to be similar.

**Figure 8: Household adaptation strategies to climate stressors**




Household characteristics that influence adaptation to climatic stressors (Table 2) revealed that the gender ($P<0.05$), and the age of the household head ($P<0.05$) had a significant influence on household adaptation mechanisms in Paicho S/C. The influence of gender on adaptation strategies could be because the male gender is more likely to adapt than their female counterparts since in many African traditions, the females have less access to land, and other socioeconomic resources which constrains their adaptive capacity to climatic stressors. Similar to this study finding, gender studies by IFPRI (2001) and Meinzen-Dick et al. (2010) reported unequal distribution of assets between male and female in rural households which was in favor of male. This study finding also conforms with a report by Tenge and Hella (2004) in West Usambara highlands in Tanzania, and Nabikolo et al. (2012) in Eastern Uganda, who found out a significant influence of gender on adaptation to climate stressors.

Furthermore, the age of the household head significantly influenced adaptation mechanisms. This is likely to be because young adults have a higher level of motivation to act on perceived changes in order to adapt. They are energetic and able to get other jobs outside agriculture, can diversify agricultural production which can enable them get more income to adopt other adaptation mechanisms such as buying improved crop varieties, livestock varieties, and fertilizers. A study by Bandura (1977) and Hines et al. (1987) reported that the ability to adapt depends on an individual's motivation to act. The elderly do not perceive themselves as able to act on perceived threats and therefore their adaptation ability is lower than that of the young adults. A study carried out by Wolf et al. (2009) on elderly people's perceptions on wave risks in the United Kingdom suggested that old people do not perceive well their vulnerability and therefore do little to adapt.

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**Table 2**: **Factors influencing adaptation mechanisms to climate change in Paicho Sub County in Gulu District**

| Independent variables | Estimated coefficient | SE of the coefficient | P value |
|---|---|---|---|
| Age of household head | -0.393 | 0.271 | **0.05** |
| Education level of household head | -0.289 | 0.406 | 0.479 |
| Household type | -0.565 | 0.806 | 0.485 |
| Gender | 1.902 | 0.809 | **0.021** |
| Average weekly income | -0.121 | 0.294 | 0.681 |
| Size of land in acres | 0.007 | 0.005 | 0.07 |
| Household access to extension service | -0.491 | 0.618 | 0.428 |
| Household access to credit | 0.36 | 0.692 | 0.959 |
| Constant | 5.265 | 1.981 | 0.09 |
| R Square | 0.093 | | |
| Standard error of the estimate | 2.605 | | |
| Regression significant | 0.285 | | |

***The role of institutions in community adaptation to climate variability and change***

The institutions that exist in Kalamu and Kalali Parishes in Paicho S/C and their roles in community adaptation to climate stressors are illustrated in table 3. Institutions that exist in Kalamu and Kalali include; local councils, farmer's groups, NGOs/CBO's, clan/elder networks, family networks, and religious institutions. The roles of these institutions in the two Parishes are related i.e. Local council's advice on avoiding tree cutting, avoiding bush burning and providing access to information relevant to coping and adaptation. Farmers groups also advise on avoiding bush burning, making decisions on planting time and provide access to information. NGO's provide access to credit and access to information relevant to adaptation and capacity building. Clan/elders networks make decision on when farmers should plant crops, and govern entitlements to key natural resources. Family networks give access to information and also govern entitlements to key resources while religious institutions also give access to information relevant to climate change adaptation and capacity building. These findings revealed that there exist institutions that enhance community adaptation to climate stressors in Paicho S/C in Gulu district. This study findings on institutional roles in community adaptation revealed similar institutional roles as those reported by African Climate Change Resilience Alliance (ACCRA), (2012) in the districts of Bundibujyo, Gulu and Kitgum who found out that institutions dictate when farmers should plant crops, stop people from deviating from common practices and determine entitlements to key assets needed to cope and respond to climate change stressors. Agrawal (2008) found out that local government in the Philippines involved in tree planting and reforestation, better implementation of forest laws, soil and water conservation, construction of drainage, controlled burning, logging ban, information sharing, research and capacity building, provision of relief goods, creation of task forces, and infrastructure construction and repair. Neil and Adger (2001) assert that the role of institutions is much more eminent in post-socialist countries where the ideology of social bonding is still strong. Institutions play diversified roles in enhancing community adaptation to climate stressors in various communities and the roles become rigorous when government institutions are involved in enforcement.

 

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**Table 3: Institutional roles in community adaptation to climate stressors**

| | | Institutional roles in community adaptation to climate stressors | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parish | Institution | Avoiding tree cutting | Avoiding bush burning | Governing key resources | Deciding when to plant | Access to credit | Access to information | Capacity building |
| Kalamu | Local councils | 26 | 26 | 0 | 0 | 0 | 48 | 0 |
| | Farmers groups | 0 | 14 | 0 | 33 | 0 | 53 | 0 |
| | NGO's/CBO's | 0 | 0 | 0 | 0 | 21 | 48 | 31 |
| | Clan/Elders network | 6 | 3 | 45 | 36 | 0 | 10 | 0 |
| | Family networks | 0 | 0 | 29 | 27 | 0 | 44 | 0 |
| | Religious institutions | 0 | 0 | 0 | 0 | 0 | 88 | 12 |
| Kal-ali | Local councils | 23 | 30 | 0 | 0 | 0 | 46 | 0 |
| | NGO's/CBO's | 0 | 0 | 0 | 0 | 24 | 42 | 34 |
| | Clan/Elders network | 0 | 0 | 39 | 35 | 0 | 26 | 0 |
| | Religious_ institutions | 0 | 0 | 0 | 0 | 0 | 88 | 12 |

## Conclusions

A range of coping and adaptation mechanisms are in place to counter act perceived changes and variations in climate in Paicho S/C. The most prominent being buying food from the market, exchange of labor for food, getting food help from relatives, community and food agencies while major adaptation strategies were adjusting of planting dates, diversification of production, mixed cropping, getting other jobs outside agriculture, growing improved crop varieties and changing crop growing seasons. These coping and adaptation mechanisms depict the low level of socioeconomic development in the region and consequently high levels of vulnerability to changes and variations in climate. Thus, a need by government and other stakeholders to provide technologically enhanced adaptation mechanisms, strengthen institutions to improve household resilience to changes and variations in climate.

Gender and age of household head were found to be the most significant factors influencing adaptation mechanisms thus, policies still need to continue being gender sensitive vis-à-vis continuing to support social security for the elderly.

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