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Original Article

The Value of Climate Services in Agriculture and Water Sector: Impact Evidences from Smallholder Survey and Stakeholder Engagement in Kenya and Uganda

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Abstract: *Climate change has become a new normal and both a cause and consequence to under development, escalating poverty and vulnerability for developing countries and the IGAD region in particular. Climate variability, especially erratic, severe, and occasionally extreme weather events like droughts, floods, and landslides, is already endangering ecosystems and means of subsistence in the IGAD region. In light of these unfolding challenges from climate extremes, many adaptation scholars now have recognized the importance of scaling up the generation, dissemination and utilization of climate services among end-users more especially the smallholder farmers, as part of climate change adaptation responses. The provision of climate-related services has historically been associated with improved decision-making in the production and weather-sensitive economic sectors, as well as raised safety and efficiency in the land use, sea, aviation, and transportation sectors. It has also assisted communities in anticipating and responding to severe weather situations. The National Meteorological Services (NMS) have done much to provide climate services. However, the benefits of their efforts related to the provision of such services have not been widely demonstrated at the smallholder level in adaptation literature, making answering value for money to continued investments remain questionable at a time when budget priorities across sectors and funding sustainability, remains a big concern in development cooperation and government programmes in general. In line with this concern, between May- July, IGAD/ICPAC commissioned a household survey in the districts of Taveta, Voi and Mwatate (drought prone) areas of Kenya, covering 188 households. While in Uganda, Bugishu (Mbale and Bulambuli districts, and Teso sub-regions (Soroti district) in Eastern Uganda were selected, historically known hotspots to flooding (land/mudslides) and droughts respectively and suffering recurrent hunger and starvation. A total of 197 households were reached, besides wider consultation with CS providers and end-users in water and agricultural sectors across the two countries. This was aimed at providing evidence on the social economic value of climate services in the ClimSA pilot countries (Kenya and Uganda) and, where possible, applying the results broadly across the region. More specifically, the study aimed to address two objectives: (1) to estimate the economic value of climate services supported by ICPAC through the Intra ACP ClimSA project and (2) to identify the specific effects of climate change, such as those on the water and agriculture sectors.*

The study adopted computer-aided software (Kobo Data Collect), administered to 385 households in the two countries using Android smartphones and tablets. Data was analyzed using STATA and MS Excel to determine the CS-use and development impacts related to food security outcomes proxy by household Food Consumption Scores (FCS), Dietary Diversity and Resilience Capacity Index (RCI) estimated through Shiny-Resilience Index Measurement Analysis (RIMA-II) methodology developed by Food and Agriculture Organization of the United Nations (FAO); which provides quantitatively, why some individuals/ households cope easily with shocks and stresses; while others not. Results show that the greatest proportion of the study participants had knowledge of climate services as reported by 183 (97.3%) in Kenya and 167 (84.8%) in Uganda, with higher concentration among women compared to men with Kenya women 131 (71.6%) against men 52 (28.4%); while Uganda women 107 (61.5%) against men 67 (38.5%), explained by greater role of agricultural activities being left to females in smallholder farming system. Future rural development programmes will need to engage more men in agricultural transformation across the two countries. Another notable contrast was that awareness of CIS tended to be more in male-headed households than female-headed households, reported by 124 (67.8%) for male-headed households compared to 59 (32.2%) in female-headed households in Kenya, while in Uganda, reported by 142 (81.6%) for male-headed households against 32 (18.4%) in female-headed households. Education also matters when it comes to awareness of the existing climate services, with more awareness among people with low educational attainment, explaining that their livelihoods depend mainly on the agricultural sector. The stated average years of experience in CIS use was 3 years in Kenya and Uganda 7 years; and CS impact increases with years in use. A sizeable proportion reported experiencing better /improvement in farming decisions as a result of CIS use. The food security scoring outcome showed about 84 (44.7%) of Kenyans surveyed are living in a "poor food consumption level"; those in "borderline consumption" 44 (23.4%); and "acceptable consumption" level, 60 (31.9%). In

Uganda, 34 (17.3%) are in "poor food consumption", 68 (34.5%) in the "Borderline" and 95 (48.2%) in "acceptable food consumption". There was a slight reduction in those living in poor food consumption in households which are aware of climate services available and using them in their production decisions. This trend was equally true for CS long-term users compared to recent users revealed in the survey. There was a higher Resilience Capacity Index (RCI) observed among the CS users compared to non-users (users 21.4 versus 6.15). This is more than thrice relative to CS non-users. Therefore, it's valid to conclude that CS use improves livelihood resilience among smallholder farmers as the survey tools were applied in fairly the same community location, in samples with similar cultures across the two countries piloted. Evidently, the CS users were found to be more likely to have access to /use improved seeds and their animals vaccinated, partly explained by their relatively higher wealth status, e.g. accumulating more livestock and receiving more transfers compared to their counterparts, the non-CS users. The years of CS use in production decisions are also correlated with increased resilience capacity among smallholder farmers. In addition, more years of CS use are also associated with increased household resilience.

In the water sector, CS also showed enormous positive outcomes, especially in regulating water level flows in stabilizing hydro-power generation and supply for of electricity for the wider economy. It helps in scheduling and balancing the water levels in the dam to avoid unstable supply, avoids defaulting supply contracts, reduces overreliance on dirty fossil fuel as alternative energy, and reduces power rationing, destabilizing economic activities. In addition, countries are better prepared to avoid flooding associated with heavy rains, therefore reducing the incidences of water borne diseases such as malaria, cholera, dysentery and loss of lives and properties. Despite the challenges CS continues to face at both national, sub-national, institutional and farmer levels, therefore overcoming these bottlenecks calls for more rigorous investment, strengthening public-private-donor partnerships, building the capacity of National Meteorological Services (NMS), investing in agricultural extension services for improved communication with farmers, efficient farmer organizations, and social networks. This would significantly improve climate change adaptation and poverty reduction steps in line with Agenda 2030 Sustainable Development Goal and Agenda 2063 of the African Union, "a prosperous Africa, based on inclusive growth and sustainable development" through modernizing agriculture for increased productivity and production.

Keywords: *Adaptation, Climate Services, Resilience and Smallholders.*

I. INTRODUCTION

The Horn of Africa (HoA) region has an extended record of being vulnerable to extreme weather events, such as hurricanes and droughts, which worsen the region's food and water shortages and occasionally spark cross-border conflicts. The rain-fed agriculture that sustains the economies and way of life in the HoA (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda) is extremely vulnerable to weather variations and climatic shifts. Rainfall has a significant impact on agricultural output and is also associated with the social and economic health of the rural populations in the area. It appears that climate change in the area may increase both the severity and frequency of extreme weather events, which could result in more intense flash floods, more frequent droughts, and a shortage of water. Resource-based conflicts in nations like Kenya, Somalia, Ethiopia, Uganda, Sudan, and South Sudan are also increasingly linked to climate risks that affect the livelihoods and food security situations of pastoralists and agro-pastoralists. These developments could worsen the precariousness of the populations impacted in the region.

In order to support IGAD/ICPAC in developing climate information services, the Intra-ACP Climate Services and Related Applications (ClimSA) project was started under the 11th European Development Fund (EDF) multi-year funding. In order to improve widespread access to and use of climate data, as well as to facilitate and promote the creation and utilization of climate applications and services for decision-making procedures across all stages, part of the initiative includes providing IGAD with the infrastructure as well as capacity establishing, financial and technical assistance, and the infrastructure and training. In order to fund and implement the Global Framework for Climate Information Services (GFCIS) at all levels, ClimSA offers substances that connect individuals in climate-relevant industries to stakeholders in climate services.

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In the end, the Action supports ICPAC's Strategic Plan 2016-2020, which aims to improve regional lives in order to reduce risks and disasters associated with climate change. Five outcome chains are the focus of the ClimSA portfolio: (1) Ensure enhanced communication between users, researchers, and climate service providers in the IGAD region by strengthening and organizing User Interface Platforms (UIPs); (2) Ensure that climate services are provided at both national and regional levels; (3) Increase access to climate information; (4) Boost the ability to produce and use climate products and information; and (5) Integrate climate support into national and regional planning processes.

A. Objectives of the Study

The study's primary goal is to offer technical assistance on the social and economic value of climate services in the IGAD region, with a focus on Kenya and Uganda. Whenever feasible, the findings will be applied regionally.

B. Specific Objectives

The consultant will primarily focus on two goals: (1) calculating the economic value of climate services financed by ICPAC through the Intra ACP ClimSA project and (2) identifying particular climate change impacts, such as those in the water and agriculture sectors. Outputs 1 & 2, which focused on the wider macro-level analyses, have now been completed, and the sector report at the household (macro-level) is expected to provide evidences to supplement the earlier studies.

C. The Organization of the Report

The structure of the report is as follows. The introductory section and literature review chapter, Section I, provides an overview of climate change and its effects on the global economy and the Horn of Africa. It also discusses how the scenario is changing and how much it has impacted rural livelihoods, as well as how climate services may be able to help with adaptation efforts. Here, the project's goals and description (ClimSA) are also covered. The study area, data, and technique are then presented in section 3. Section 3 presents the research findings, while Section 4 provides a summary, recommendations, and a discussion. At the conclusion of the study project, supporting annexures (appendices) and references are provided.

II. LITERATURE REVIEW

It's now very clear climate change inform of weather variability and extreme events (e.g. droughts and floods), is increasingly threatening livelihoods of the different segments of the population differently, with the smallholder farmers mostly impacted (Altieri and Koohafkan, 2008; Hertel and Rosch, 2010; Harvey et al., 2014; and Rakotobe et al., 2016) Climate variability, particularly erratic, severe, and occasionally extreme weather events like droughts, floods, and landslides, is already endangering ecosystems and means of subsistence in the IGAD region. In the past few decades, the frequency and severity of droughts and floods in the area have increased.

In light of these unfolding challenges from extreme climate events, many adaptation scholars have recognized the importance of scaling up the generation, dissemination, and utilization of climate services among end-users, more especially smallholder farmers, as part of climate change adaptation responses. The delivery of climate services has historically been associated with enhanced decision-making for the manufacturing and weather-sensitive economic sectors, as well as increased security and effectiveness in the land use, sea, aviation, and transportation sectors. It has also assisted communities in anticipating and responding to extreme weather events. However, the benefits related to the provision of such services have not been widely demonstrated at the smallholder level in adaptation literature, making answering value for money in investments questionable at a time when budget priorities across sectors and funding sustainability remain big concerns in development cooperation and government programmes in general.

The value chain of producing, translating, transferring, and using climate knowledge and information for climate-informed decision-making is known as "climate services." In order to minimize climate-related losses and maximize benefits—such as the preservation of lives, livelihoods, and property—climate services seek to give people and organizations timely, customized information and expertise on climate change (Vaughan and Dessai, 2014). Climate services, which address all sectors impacted by climate at the international, regional, and local levels, can assist societies in adapting to climate variability and change by developing and providing science-based and user-specific data relating to recent, current, and potential future climate (WMO 2016). The practicality of these services depends on a range of factors: the availability of and access to timely, understandable, and useful climate information (Hansen et al., 2013; and Coulier et al., 2018). Where quality, timeliness and use are guaranteed, climate services could empower the smallholder farmers whose livelihoods depend on climate-sensitive agricultural sectors, especially in Africa, to allow them to reduce vulnerabilities and exposure to climate-related shocks and stresses associated with climate change (Tesfaye et al., 2018).

In amplifying adaptation efforts in the wave of climate change in its member states, the Intergovernmental Authority on Development (IGAD) under the IGAD Climate Prediction and Applications Centre (ICPAC), an entity accredited by the World Meteorological Organization (WMO), has intensified efforts to tackle the effects of climate change through providing a number of climate services (CS)/ instruments to users ranging from climate forecasting, dissemination of climate information dissemination, technical assistance to disaster risk reduction management, environmental monitoring, agriculture and food security monitoring, water resources monitoring, and capacity building in the 11 East African countries under its mandate, aimed at creating resilience in a region deeply affected by climate change and weather extreme events (Owani, 2023).

In the agricultural industry, for instance, the provision of high-quality climate services enables disaster-risk managers to better prepare for prolonged rainfall and droughts while also enabling vulnerable agricultural producers and communities to optimize their planting and marketing strategies, boost farm productivity, improve livelihood and food security, and reduce risk (Patt et al., 2005, CARE, 2014; Snow et al., 2016; WMO, 2016). Research indicates that farmers' decisions are influenced by climate information even in situations where their choices are limited by resource constraints (Ngugi et al., 2011; Phillips et al., 2001; Mudombi and Nhamo, 2014; Rasmussen et al., 2014; Wood et al., 2014; Bryan et al., 2009, 2013, Gebrehiwot and van der Veen, 2013). It has been shown that investing in climate services can reduce the risk of crop losses due to extreme weather, drought, flood, hail, and frost; help schedule crop protection, planning, and harvesting; boost farm sales and productivity; better schedule the use of agricultural machinery; and minimize the need for drought relief services.

III. DATA AND METHODOLOGY

A) Sampling Technique

Study Areas Profile. The study focused on selected regions of the two ClimSA pilot countries (Kenya and Uganda), which are prone to droughts and floods. In Uganda, Eastern Uganda (Bugishu) and Teso sub-regions were selected as these are known hotspots for flooding (land/mudslides) and droughts, respectively. Equally in Kenya, Taita Taveta was selected in consultation with the ICPAC (Monitoring and Evaluation) team for historically known as prone to droughts, and ICPAC also works directly with these communities.

Sampling. These were purposively selected based on their level of knowledge of Climate Services, their accessibility and their ability to use climate information. It also focused on households in areas prone to droughts and floods in the two countries studied. The households were selected from the farmer groups /field schools in selected villages for enumeration. It was envisaged that the entire sample size from the selected districts would constitute 384 respondents guided by statistical methods, i.e. this sample size has been statistically determined.

The statistical equation used was:

$$n = \frac{Z^2 P q}{d^2}$$

Where;

n = refers to the desired sample size when the entire survey population is greater than 10,000.

Z = the standard normal deviate usually set at 1.96, which correspondents to the 95% confidence level.

p = Population of the target population estimated to have a particular characteristic, 50%, is normally used because it is the recommended measure if there is a lack of reasonable estimate.

q = 1.0 – p and

d = degree of accuracy desired in this context set at 0.05.

The final sample will be 384 respondents.
Substituting in the figures;

$$\frac{1.96x1.96x0.5\ (1.0-0.5)}{0.05x0.05}$$

=384 Respondents.

A total of 385 samples were enumerated in the survey, with 188 respondents from Kenya and 197 in Uganda, table 1 below.

Table 1: Households interviewed by the country of residence

	Distribution by District		**Total Number**
Kenya	N	%	188
1. Mwatate	27	14.4	27
2. Taveta	73	38.8	73
3. Voi	88	46.8	88
Uganda			197
1. Bulambuli	62	31.5	62
2. Mbale	94	47.7	94
3. Soroti	41	20.8	41

Source: *Household survey, ClimSA, 2023*

The differences in sample size by each district were due to differences in the number of members, and sometimes, the turn-up for interviews was high in some cases and low in others.

B) Data Collection and Research Instruments

a. Quantitative Data

Data collection was done in May 2023 in Kenya, while in Uganda during July 2023. In Kenya, the selection of sample households was facilitated by ICPAC in collaboration with the FAO sub-office in Taita Taveta in order to identify the Farmer Field Schools established in the area. In Uganda, the Local Government were used to identify community SACCOS implementing the government programme under the Parish Development Model (PDM). Household information was collected using computer-aided software (Kobo Data Collect) and administered to households by trained research assistants (enumerators) through mobile smartphones or tablets. The interviews were conducted with persons regarding access and the use of Climate Services for various purposes in farming activities and production decision-making processes in the farming systems. They comprised smallholder farmers, both men and women aged eighteen years (18) and above.

b. Qualitative data

Information was also collected from both key informants and the Focus Group Discussion for triangulation of information from the desk reviews and the household interviews. The Key informants comprised of persons who are knowledgeable about the climate situation of the area. They included Environmental Officers, village heads in the area, and agricultural officers/ extension workers. In the water sector, information was collected from the Ministry of Water and Environment in Uganda, UNMA, and big water users (Pespsi Cola and Coco-cola beverages company, while in Kenya, KEN Gen, the energy generation company, was selected to provide evidential information to assess the value of climate services in the water sector.

c. Data Processing and Editing

Using digital tablets and Kobo Collect software, computer-assisted personal interviewing (CAPI) was used to gather the data. The use of electronic gadgets shortens interview times, minimizes errors in data entry and interview processes, and permits the gathering of household-level geographic information system (GIS) data. It also lowers the risk of physical damage related to paper-based methods, which are common during the rainy season. Kobo Toolbox, a software suite for data gathering in difficult circumstances that enables the use of remote data control protocols, was used to transfer the data on a regular basis.

C) Estimation of impacts of climate services on development outcome(s)

In this study, the value of climate services at the household level was measured in terms of resilience and food security outcomes attributed to ‘users’ versus ‘non-users’ and years in CS use (i.e. recent versus long-term use) of CS in production decisions. The study used a mixed method to measure development impacts, e.g. household resilience, among which were 1) the Food Consumption Score (FCS) and the household Dietary Diversity (DD) as a measure of food security outcome in households who use climate services in their routine production decisions compared to the non-users. Another common approach of resilience measurement to climate adaptation has been developed by the Food and Agricultural Organization (FAO), termed Resilience Index Measurement and Analysis (RIMA-II), which provides quantitatively why some individuals/ households cope easily with shocks and stresses while others do not.

Therefore, the household survey data was used to provide this estimation. Attempts have also been made to measure CS outcomes on lifting households from poverty through a generic measure of multi-dimensional poverty outcomes for CS user versus non-users in their production decisions. The details of the findings are presented in the subsequent sections. The household survey was conducted in the districts of Voi, Mwatate and Tataveta on the Kenya side. In contrast, in Uganda, the districts of Mbale, Bulambuli and Soroti were enumerated where both qualitative and quantitative methodologies were applied.

a. Estimation of the CS impact on household Food Consumption Score

The FCS is a composite indicator that, using a seven-day recall of the foods ingested at the family level, assesses dietary diversity, food frequency, and the corresponding nutritional value of food groups. A more thorough measure that takes into account meal frequency, dietary diversity, and comparative nutritional value is the meal Consumption Score (FCS). To determine how many days in the last seven days the desired household has eaten a pre-defined food type clustered along the eighth cluster, individual interviews took place with delegates of the target household, following the instructions established by the World Food Programme (WFP) on the Food Consumption Score (FCS). The interview questions were as follows: "I would like to ask you about all the different foods that your household members have eaten in the last seven days." How many days in the last seven days has your household dined during this time? [mention all eight food categories that are included in the WFP's FCS criteria one by one. Table 2 below provides a detailed reference for the FCS estimating methodologies based on the WFP methodology.

Table 2: A template used for estimating Food Consumption Score

	Food Item/Category	Food Group	Weight (Score)
1.	Maize /posho, rice, sorghum, millet, bread and other cereals; cassava, potatoes and sweet potatoes	Cereals, tubers and root crops	2
2.	Beans, peas, groundnuts and cashew nuts	Pulses	3
3.	Vegetables, relish and leaves	Vegetables	1
4.	Fruits	Fruit	1
5.	Beef, goat, poultry, pork, eggs and fish	Meat and fish	4
6.	Mil, yoghurts, and other dairy products	Milk	4
7.	Sugar and sugar products	Sugar	0.5
8.	Oils, fats and butter	Oil	0.5
9.	Any other foods, such as condiments, coffee, tea, including milk in tea?	Condiments	0

Source: *WFP FCS Technical Guidance sheet*

For instance, the weighting of beans, peas, groundnuts, and cashew nuts is three, indicating the high protein and high-fat content of the respective foods. Given its lack of micronutrients and the fact that it is often consumed in modest amounts, sugar is assigned a weight of 0.5. Every food team's frequency is multiplied by its weight to determine the household food consumption score for each home. The values are then added together to create a single composite score.

A maximum score of 112 for the household indicates that all food categories were consumed daily over the previous seven days. In order to compare the household score between CS users and non-users, thresholds indicating the state of the food intake in the home were developed. The following thresholds, according to WFP, are appropriate in a variety of scenarios:

Table 3: Established threshold for household food consumption

	Consumption level	Scores
1.	Poor food consumption	0 to 21
2.	Borderline food consumption	21.5 to 35
3.	Acceptable food consumption	> 35

Source: *WFP FCS Technical Guidance sheet*

b. Estimation of the CS impacts on household Dietary Diversity

Dietary diversity in households is the quantity of various food types ingested during a specified time frame. Because a more broadened diet is a significant result and correlates with factors like income in the household, the proportion of protein derived from foods sourced from livestock, and calorie and protein adequacy, the Household Dietary Diversity Score (HDDS) or Individual Dietary Diversity Score (IDDS) is an appealing proxy for food security (Hoddinot and Yohannes, 2002).

The Household nutritional Diversity Score and the Individual Dietary Diversity Score (IDDS) can be used to determine the nutritional diversity of a household or individual members of the household. In this study, FCS was based on household level dietary diversity and compared across CS users compared to non-users. Only food eaten within the home should be included in the 24-hour recall, which is used to gather food consumption data from household members who prepare meals. Foods eaten outside the house that weren't cooked there (such as food from hotels) shouldn't be counted since they seldom ever reflect food security at the household level.

The HDDS is calculated by dividing the total number of homes by the sum of all food categories consumed by the household during the previous 24 hours. It would be nice to calculate the dietary variety score for each member of the household individually. This implies that the queries ought to be directed specifically at each member of the household. However, they were applied to one adult participant in this study who served as a respondent by determining "whether any household members have consumed items from 12 different food groups in the past 24 hours" due to time and financial constraints. The resulting HDDS for the home is the number of food types out of 12 that are ingested (by at least one member of the household). The findings are compared with CS users and non-users to determine the effects of climate services on production choices.

The analysis and interpretation of the HDD are then based on the following processes.

1) Answers concerning the consumption of each food group are recorded (no =0, yes = 1)
2) Values for all food groups are summed up, and the resulting score can be anything from 0 (none of the food groups were consumed in the previous 24 hours) to 12 (all food groups were consumed in the previous 24 hours).

3) For IPC purposes, the households with different scores should be divided into the following three categories: 5-12 (Phases 1-2), 3-4 (Phase 3), and 0-2 (Phases 4 and 5).

The IPC Acute Malnutrition is a five-phase scale of increasing severity: Phase 1: Acceptable Phase; Phase 2: Alert; Phase 3: Serious; Phase 4: Critical; Phase 5: Extremely Critical (IPC, 2021). Each phase is characterized by a certain prevalence of acute malnutrition.

c. Estimation of the CS impacts on household Resilience Capacity Index

The resilience capacity index (RCI), which incorporates shock/stressors (like climate change) and is built around four pillars, is connected to a particular outcome (like food insecurity) and is measured using the Shiny-RIMA (Resilience Index Measurement Analysis) method created by the FAO. The precise result, however, must take into account the goals and parameters of the study, which, in this instance, compares the production choices of households that use climate services (treatment group) to those that do not (control group). Table 4 below lists the four conventional pillars.

Table 4: The Main Pillars of Resilience Capacity Index (RCI) Measurement

	Resilience Pillar	**Descriptions**
1	Access to basic Services (ABS)	Demonstrates a household's capacity to provide for its fundamental necessities and to make efficient use of the resources that are available to them, such as marketplaces, infrastructures, health facilities, and educational and learning centers.
2.	Assets (AST)	Includes household and societal assets, including productive and non-productive. Land, cattle, and durable goods are a few examples of indicators; other tangible assets, including a home, car, and home comforts, show the standard of living and household wealth.
.3.	Social Safety Nets (SSN)	Evaluates a household's capacity to receive aid from friends, family, and foreign organizations as well as charities and NGOs.
4.	Adaptive Capacity (AC)	It is the ability of a household to adapt to a new situation and develop new livelihood strategies. The adaptive capacity in social systems is strictly connected to the existence of institutions and networks that represent learning and store knowledge and experience, creating flexibility in problems.

Source: *FAO (2016)*

IV. RESULTS AND DISCUSSION

A) Socio-economics/ demographics characteristics of study samples

28. The majority of respondents who participated in the survey were females, i.e. 262 (68.1%) against 123 (32%) males. In Kenya, 136 (72.3%) were females versus 52 (27.7%) males, and in Uganda, 126 (64%) versus 71 (36%) males. The more turn-up trend of females explains the greater role of women in the agriculture value chain, especially among smallholder farming systems in Sub-Saharan countries and therefore, more climate adaptation responses, including access to climate services, need to place emphasis on greater livelihood impacts. About 59 (26.6%) of the respondents in Kenya came from households considered ‘‘poor” by multidimensional poverty indicators, a proxy measuring household deprivation based on set indicators applied in the survey against 138 (73.4%) as “rich” while 95 (48.2%) considered as ‘poor’ against ‘rich’ 102 (51.8%%) in Uganda, Figure 1, below.

The majority of the study participants came from male-headed households, i.e. 284 (73.8%) across the two ClimSA pilot countries (Kenya 126 (67.0%) versus 158 (80.2%), Uganda). A total of 101 (26.2%) of the participants interviewed were from female-headed households, with Kenya 62 (33%) versus 39 (19.8%) Uganda), figure 2 below.

A total of 385 respondents aged 18 to 84 years actively participated in the survey in the two countries. The mean age was 50.3 years in Kenya (males, 49.3 years against females, 50.7 years), while in Uganda, it was 41.9 years (males, 46.6 years against females, 39.2 years). A greater proportion of the respondents studied had upper primary education, i.e. attained an average of 5 to 7 years of completed education, with Kenya 94 (50%) and Uganda 91 (46.2%), followed by lower secondary education (1-4) (Kenya 51 (27.1%) against 37 (18.8%), Uganda) (Figure 3 & 4, below). Slightly more females had no education compared to their male counterparts. For example, of the 19 (10.1%) with no education in Kenya, all were women; and in Uganda, of the 20 (10.2%) respondents who lacked education, 15(11.9%) were women compared to 5(7%) men.

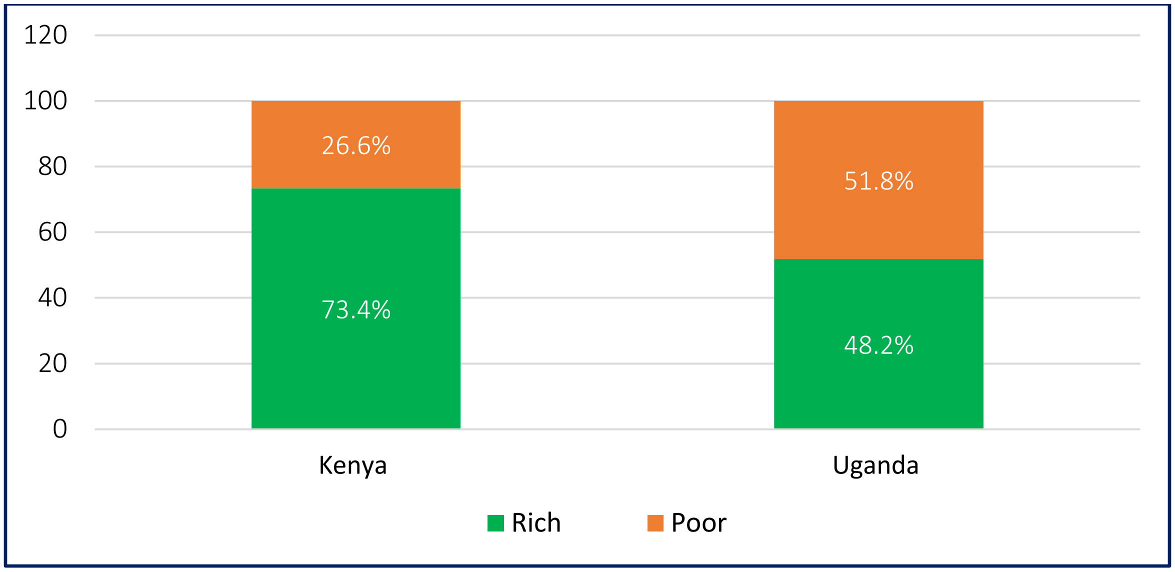

Figure 1: Household Deprivation by Multidimensional Poverty Indicators (%)

Source: *ICPAC Survey, 2023*

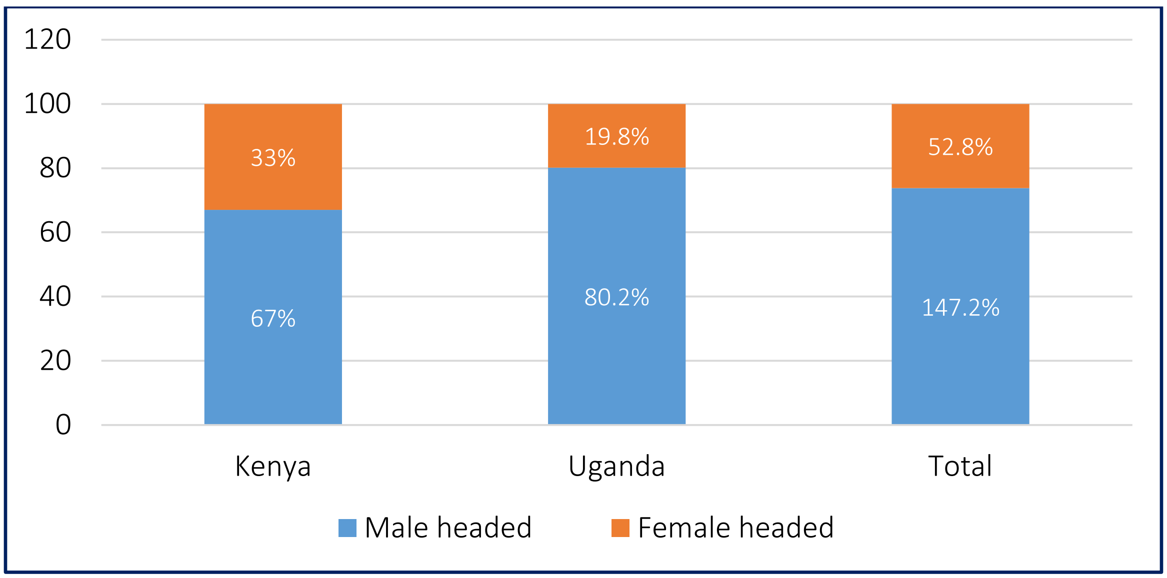

Figure 2: Heads of the Respondents' Households (%)

Source: *ICPAC Survey, 2023*

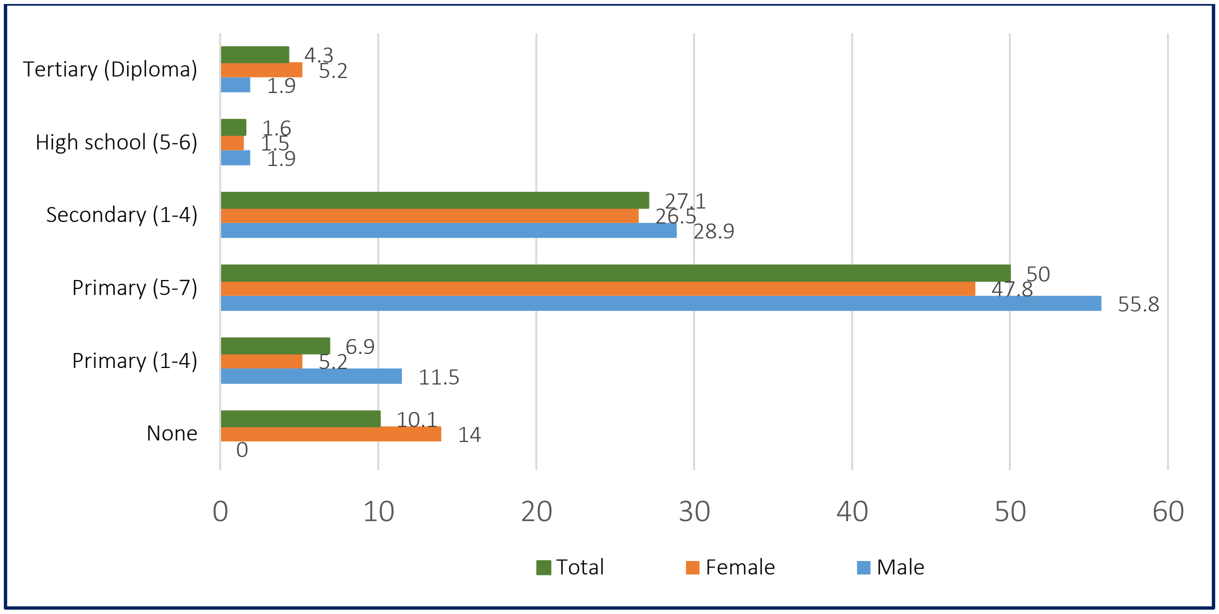

Figure 3: Highest level of education attained in Kenya (%)

Source: *ICPAC Survey, 2023*

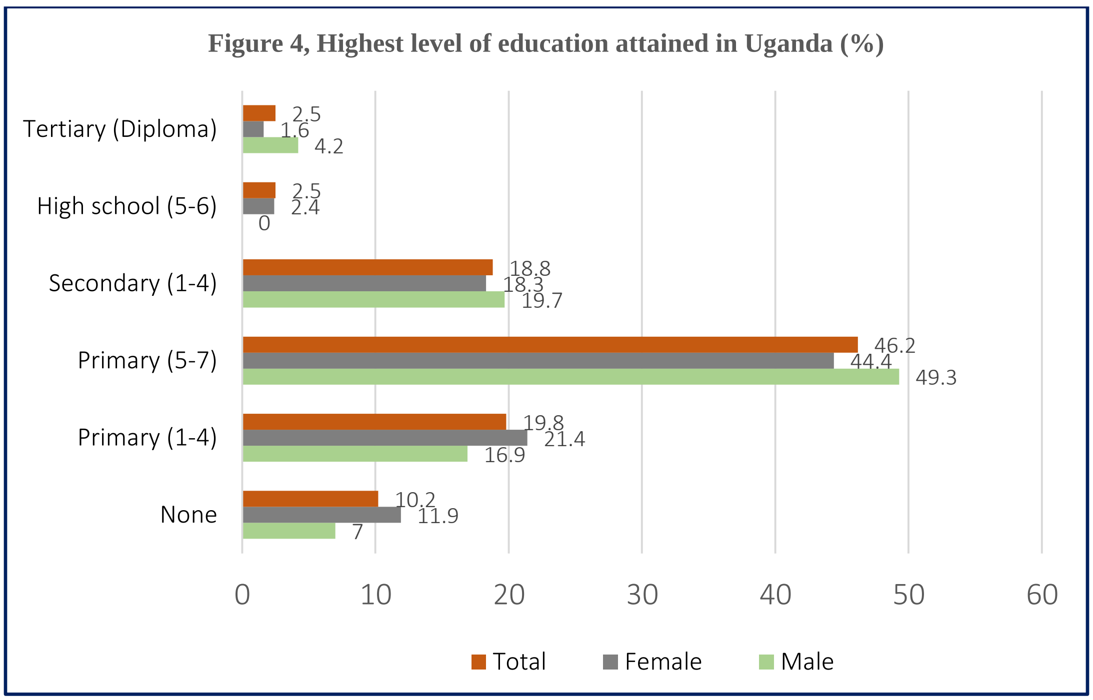

Figure 4: Highest level of education attained in Uganda (%)

Source: *ICPAC Survey, 2023*

The greatest majority were married, as reported by 290 (75.3%) of the respondents, followed by widowers/ widows, 46 (12%), single 31 (8.1%), and separated/divorced 18 (4.7.1%). (Figure 5, below).

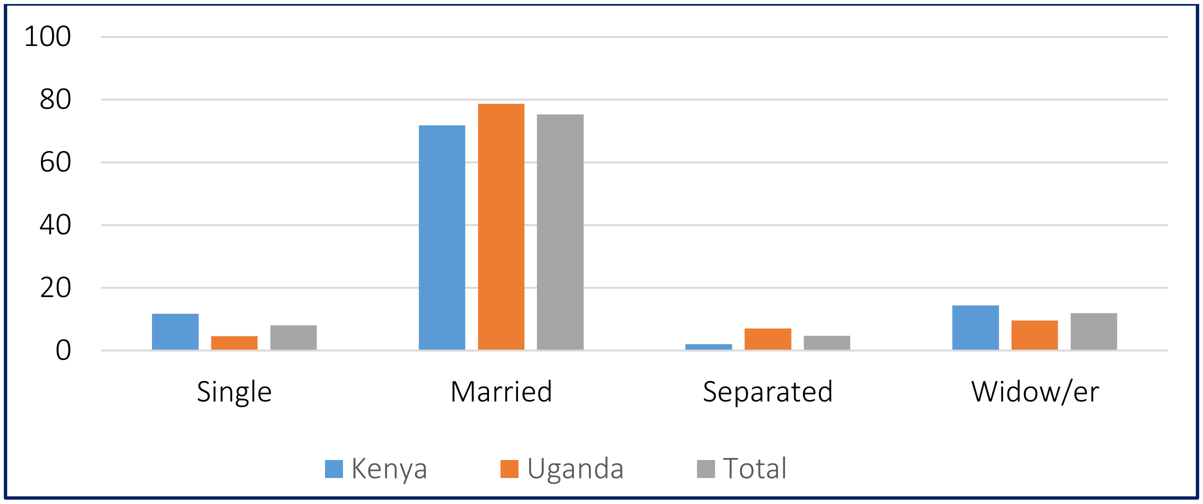

Figure 5: Marital Status of the Study Participants (%)

Source: *ICPAC Survey, 2023*

B) Primary Sources of Household Livelihoods

In both countries, crop farming dominated the main sources of livelihoods across the households participating in the survey (Kenya, 132 (70.2%); against 164 (83.3%), Uganda). This is followed by causal work to supplement their income in Kenya, with non-agricultural causal labour contributing 10.1%, and agricultural causal laborer (in other agricultural farms) contributing about 9%; while in Uganda, farm households generate income from small businesses (6.7%), figure 6 & 7, below. This is a clear indicator of the continued importance of agriculture in the livelihoods of smallholder farmers in both countries, yet more vulnerable to climate-related shocks and stresses such as flooding and droughts.

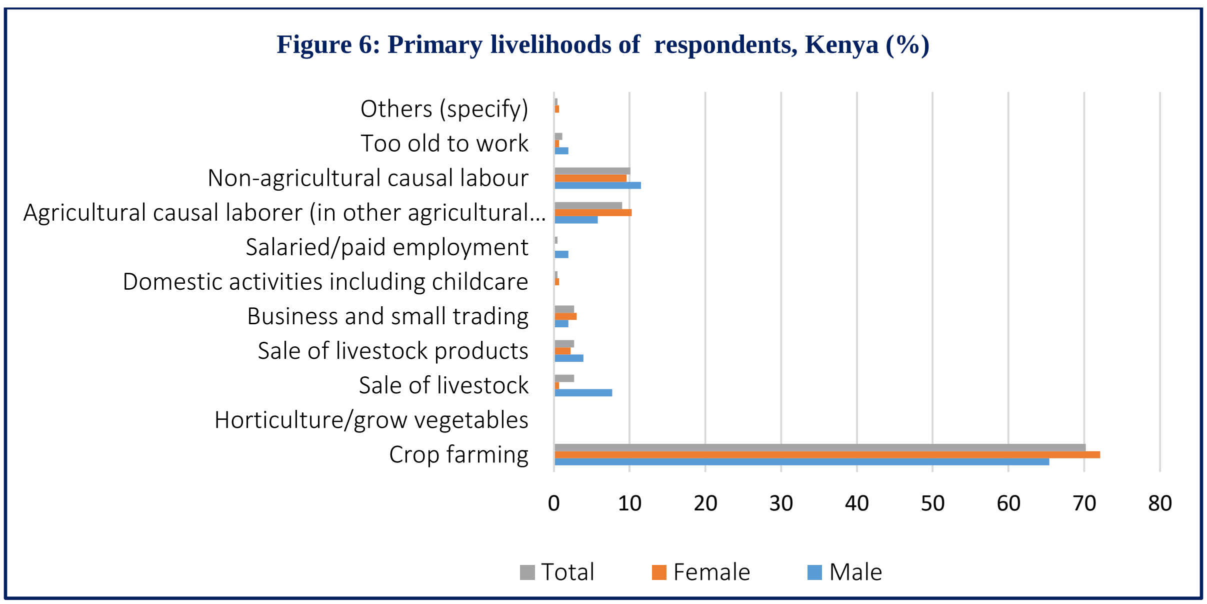

Figure 6: Primary Livelihoods of Respondents, Kenya (%)

Source: *ICPAC Survey, 2023*

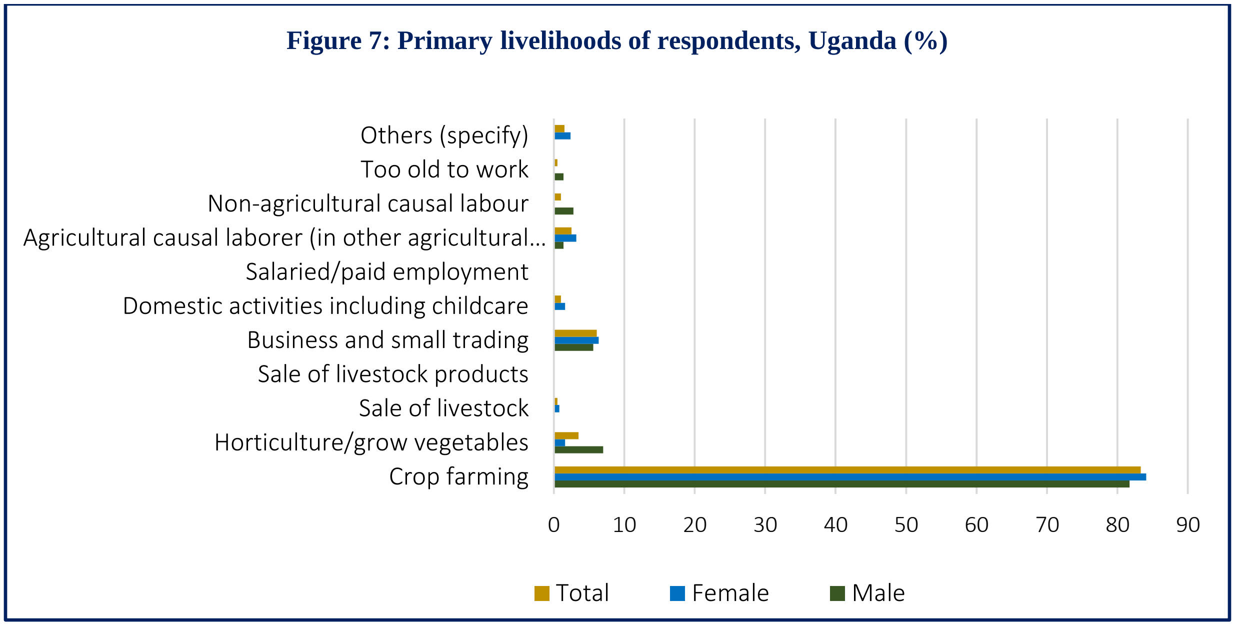

Figure 7: Primary Livelihoods of Respondents, Uganda (%)

Source: *ICPAC Survey, 2023*

C) Impacts of Climate Services on Food Security and Agriculture

a. Smallholder knowledge and Experience in the use of Climate Services

Awareness of the existence of climate services in the area: Asked as to whether the respondents are aware of any form of climate information services available to farmers in the area, the greatest proportion of the study participants had knowledge, as reported by 183 (97.3%) in Kenya and 167 (84.8%) in Uganda. However, this awareness of CIS existence was higher among women compared to men, with Kenya women 131 (71.6%) against men 52 (28.4%), and Uganda women 107 (61.5%) against men 67 (38.5%), figure 8, below. The major cause of variation could be the major involvement of women in the farming system as more men opt to take other non-agricultural activities in urban centers, leaving women behind. Future rural development programmes will need to engage more men in agricultural transformation across the two countries. Farmers get CS from radio, phones, TV and extension workers in the area.

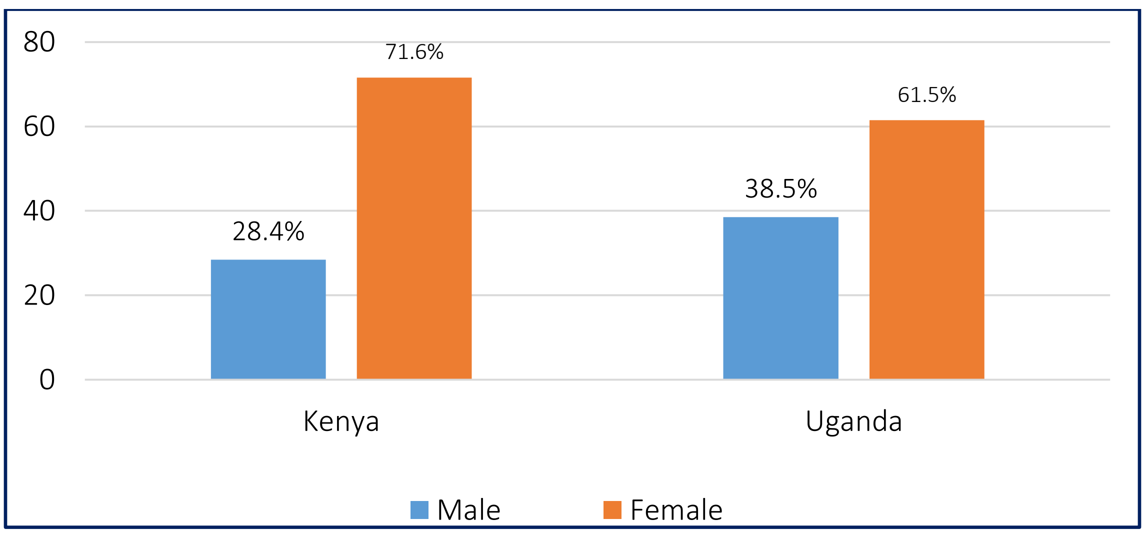

Figure 8: CIS Awareness by Gender of Respondents (%)

Source: *ICPAC Survey, 2023*

Another notable contrast was that awareness of CIS tended to be higher in male-headed households compared to female-headed households, as discovered in the survey. For example, in Kenya, this was reported in 124 (67.8%) male-headed households compared to 59 (32.2%) female-headed households as being aware of the available climate services in the area. The trend was similarly true in Uganda, where in male-headed households, a total of 142 (81.6%) against 32 (18.4%) female-headed households had knowledge of existing CIS in the area (Figure 9, below). Female-headed households remain a vulnerable section of the population and are more likely to be left behind in development activities, including knowledge products needed for farming innovations. Institutions must work towards bringing them on board to ensure no one is left behind, as spelt in Agenda 2030 Sustainable Development Goals (SDGs).

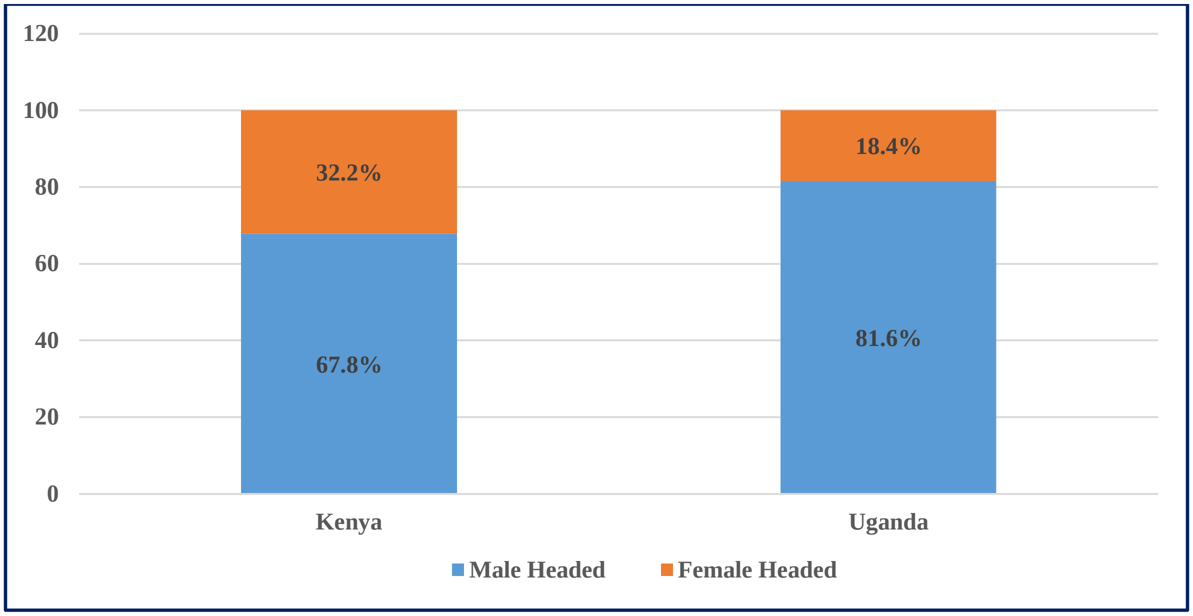

Figure 9: CIS awareness by Gender of Household heads (%)

Source: *ICPAC Survey, 2023*

Education level also matters when it comes to awareness of the existing climate services in agricultural production decisions. The majority of the farmers are those with low levels of education, and thus, their livelihoods depend majorly on the agricultural sector. It's not surprising that awareness of CIS was more among those with lower educational levels, i.e., no education at all than those who ended up in lower secondary schools. Those with higher levels, e.g. higher secondary to tertiary, had less knowledge of CIS existence in farming as more prefer white collar jobs with less attachment to agriculture.

Table 5: Awareness of Climate Services in the Area by Educational Level

Educational level	Kenya		Uganda	
	N	%	N	%
None	18	9.8	18	10.3
Primary (1-4)	13	7.1	35	20.1
Primary (5-7)	91	49.7	82	47.1
Secondary (1-4)	51	27.9	31	17.8
High school (5-6)	3	1.6	4	2.3
Tertiary (Diploma)	7	3.8	4	2.3

Source: *ICPAC Survey, 2023*

b. Household Use of Climate Services in Farming Systems

Whereas awareness of the existence of CIS was reported by the majority of the respondents, as discussed in the previous section, their actual application in the decision-making in the farming system is almost in equal proportion with awareness. However, a few of the study participants, despite being aware of CIS existence, don't apply in the actual agricultural production decisions, as reported by 1.6% of respondents in Kenya and 9.6% in Uganda (Figure 11 below).

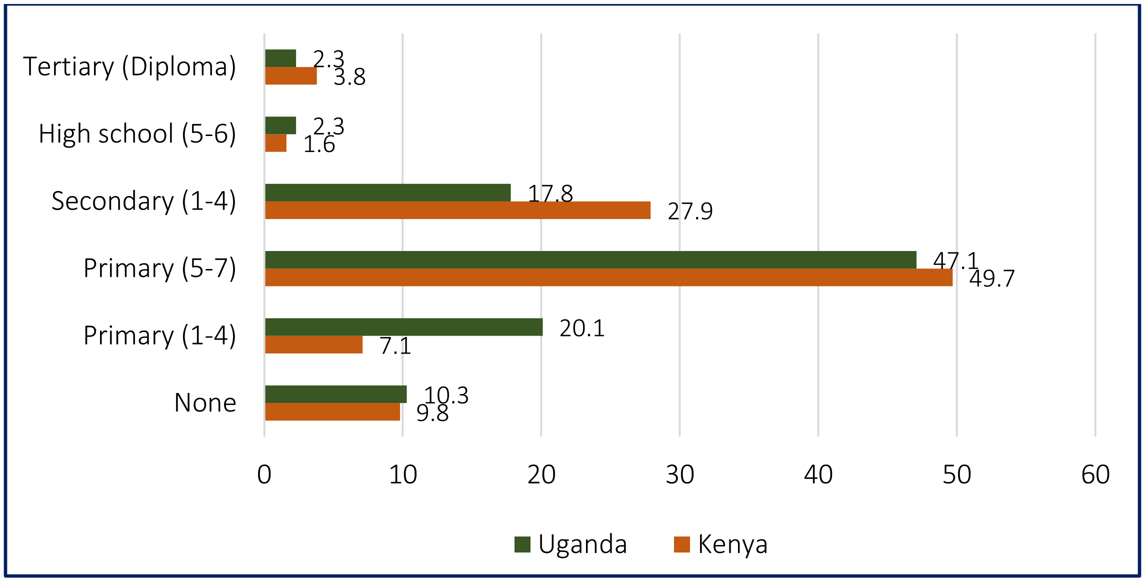

Figure 10: Knowledge on CIS by Educational Attainment (%)

Source: *ICPAC Survey, 2023*

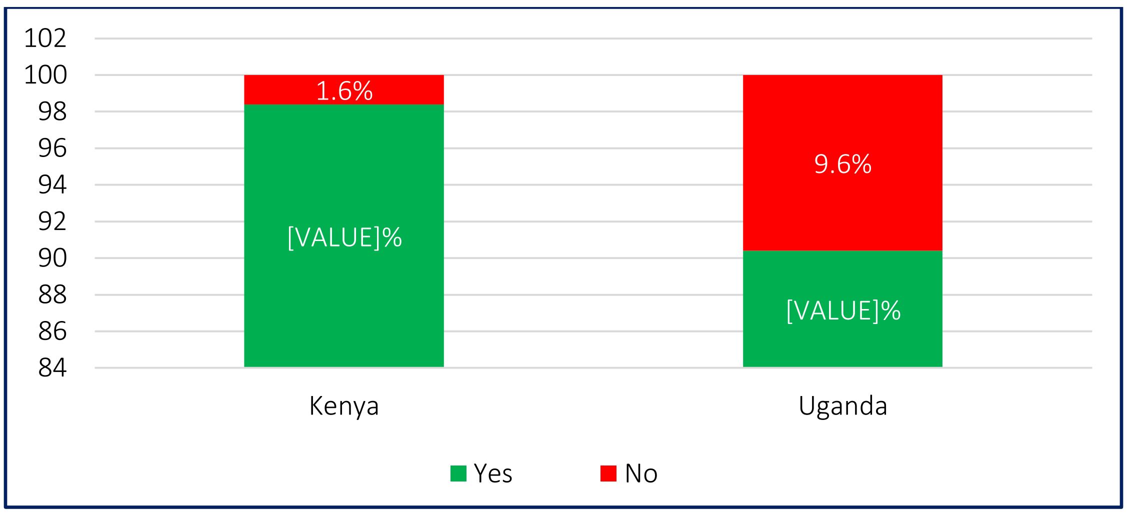

Figure 11: Use of CIS in Agricultural Production Decisions (%)

Source: *ICPAC Survey, 2023*

The majority of CIS users can be classified as "long-term users" as they have applied this in agricultural production decisions for more than 3 years, as detailed in Table 6 below.

Table 6: Years of CIS use in Agricultural Decision-Making by Study Participants

Years of using CIS	**Kenya N (%)**			**Uganda N (%)**		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
Recent users (0 to 2 yrs)	20 (38.5)	47 (34.6)	67 (35.6)	15 (21.1)	38 (30.2)	53 (26.9)
Long Term Users (3 yrs+)	32 (61.5)	89 (65.4)	121 (64.4)	56 (78.9)	88 (69.8)	144 (73.1)

Source: *ICPAC Survey, 2023*

The stated average years of experience in CIS used was 3 years in Kenya and 7 years in Uganda. As to whether they have received CIS in the last 12 months, a greater proportion of respondents reported having received in the form of crop selection to march expected rains, planting time, selection of varieties, and the start of rains, among others, to guide their production decisions; as details in table 7 below.

Table 7: Climate services received in the last 12 months in Agricultural decisions

CIS Received	Kenya N (%)	Uganda N (%)
Crop selection	184 (97.9)	160 (81.2)
Planting time	182 (96.8)	161 (81.7)
Variety selection	174 (92.6)	102 (51.8)
Field selection	128 (68.1)	108 (54.8))
Weed management	131 (69.7)	140 (71.1)
predicting rainfall	178 (94.7)	150 (76.1)
Start of the rain /Onset	179 (95.2)	125 (63.5)
Expected rainfall amount	180 (95.7)	138 (70.1)
predicting drought	178 (94.7)	140 (71.1)
cropping calendar	140 (74.5)	130 (66.0)
Fertilizer application	111 (59.0)	121 (61.4)
Pest and disease management	125 (66.5)	134 (68.0)
Pest and disease outbreak	126 (67.0)	134 (68.0)
Soil management	150 (79.8)	116 (58.9)
Water management	158 (84.0)	136 (69.0)
Insurance	96 (51.1)	27 (13.7)
Others (specify…)	30 (16.0)	15 (7.6)

Source: *ICPAC Survey, 2023*

Table 8 below provides detailed information on whether farmers applied the CIS information received to guide their agricultural production decision-making in different activities.

Table 8: Did You Use CIS to Make Agricultural Production Decisions in the Last 12 Months?

	Kenya N (%)		Uganda N (%)	
	Yes	No	Yes	No
Crop selection	183 (99.5)	1 (0.5)	150 (93.7)	10 (6.3)
Planting time	182 (100.0)	0	153 (95.0)	8 (5.0)
Variety selection	172 (98.9)	2 (1.1)	92.2 (94)	7.8 (8)
Field selection	121 (94.5)	7 (5.5)	93 (86.1)	15 (13.9)
Weed management	128 (97.7)	3 (2.3)	136 (97.1)	4 (2.9)
predicting rainfall	176 (98.9)	2 (1.1)	137 (91.3)	13 (8.7)
Start of the rain /Onset	178 (99.4)	1 (0.6)	121 (96.8)	4 (3.2)
Expected rainfall amount	177 (98.3)	3 (1.7)	128 (92.8)	10 (7.5)
predicting drought	177 (99.4)	1 (0.6)	119 (85.0)	21 (15.0)
cropping calendar	139 (99.3)	1 (0.7)	125 (96.2)	9 (3.9)
Fertilizer application	103 (92.8)	8 (7.2)	92 (76.0)	29 (23.8)
Pest and disease outbreak	124 (99.2)	1 (0.8)	122 (91.0)	12 (8.9)
Pest and disease management	125 (99.2)	1 (0.8)	127 (94.8)	7 (5.2)
Soil management	149 (99.3)	1 (0.7)	110 (94.8)	6 (5.2)
Water management	152 (96.2)	6 (3.8)	118 (86.7)	18 (13.2)
Insurance	83 (86.5)	13 (13.5)	8 (29.6)	19 (70.4)
Others (specify…)	28 (93.3)	2 (6.7)	14 (93.3)	1 (6.7)

Source: *ICPAC Survey, 2023*

The frequencies of CIS use vary among households. However, the greatest proportion of respondents stated using it always regardless of weather expectations, as reported by (241 (62.6%) across the two countries. Some, however, use Only when expecting good weather conditions58 (15.1%); Only when expecting normal weather conditions 43 (11.2%); only when expecting bad weather conditions (18 (4.7%); and those never using 25 (6.5%) (Figure 12, below).

c. Perceptions of Changes in Production Activities Following the CIS Use

Asked in which ways the following have changed after using climate service (s) in their household, a great number of respondents attached positive outcomes attributed to CIS use in their livelihoods and farming activities. A sizeable proportion reported experiencing better /improvement in farming decisions as a result of CIS use. For example, the use of CIS has been linked to better selection of appropriate crop varieties to match the weather pattern, increased knowledge on the amount, when and which fertilizers/pesticides to apply, and guided the time of planting and harvesting, resulting in increased yield and increased income and better savings, among CIS users. The details of these perceptions are provided in Tables 9 and 10 for Kenya and Uganda, respectively.

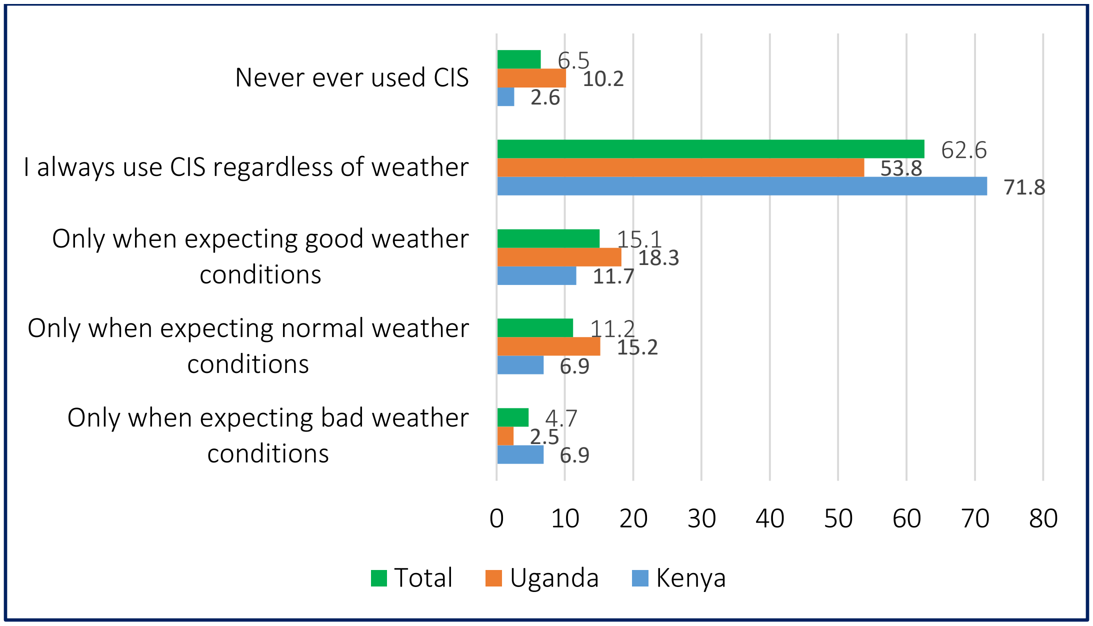

Figure 12: Decisions to use CIS in Farm Production (%)

Source: *ICPAC Survey, 2023*

d. Perceptions of changes in production activities following the CIS use

Asked in which ways the following have changed after using climate service (s) in their household, a great number of respondents attached positive outcomes attributed to CIS use in their livelihoods and farming activities. A sizeable proportion reported experiencing better /improvement in farming decisions as a result of CIS use. For example, the use of CIS has been linked to better selection of appropriate crop varieties to match the weather pattern, increased knowledge on the amount, when and which fertilizers/pesticides to apply, and guided the time of planting and harvesting, resulting in increased yield and increased income and better savings, among CIS users. The details of these perceptions are provided in Tables 9 and 10 for Kenya and Uganda, respectively.

Table 9: Perception of Changes In Production Activities Due to CIS Use in Kenya

Areas of change	**Direction of change N (%)**					
	Much better	**Better**	**Same (No Change)**	**Worse**	**Much worse**	**Didn't Use**
The yield of most crop harvests	9 (5.0)	139 (76.4)	16 (8.8)	18 (9.9)	0	0
The use of pesticides	8 (4.4)	107 (58.8)	15 (8.2)	2 (1.1)	0	50 (27.5)
The use of fertilizers	6 (3.3)	83 (45.6)	14 (7.7)	0	0	79 (43.4)
Farm income or savings	6 (3.3)	133 (73.1)	29 (15.9)	14 (7.7)	0	0
Labour needs	5 (2.8)	82 (45.1)	33 (18.1)	0	0	62 (34.1)
The timing of harvests	7 (3.8)	115 (63.2)	30 (16.5)	2 (1.1)	0	28 (15.4)
The timing of planting	9 (5.0)	152 (83.5)	16 (8.8)	1 (0.6)	0	4 (2.2)
Can choose appropriate crop species/varieties	9 (5.0)	156 (85.7)	13 (7.1)	0	---	4 (2.2)
Communication and/or knowledge sharing in the community after the Participatory Scenario Planning	7 (3.9)	137 (75.3)	34 (18.7)	1 (0.6)	0	3 (1.7)
Women farmers' participation in farm decision-making	9 (5.0)	116 (63.7)	35 (19.2)	0	0	22 (12.1)
Men farmers' participation in farm decision-making	6 (3.3)	96 (52.8)	57 (31.3)	1 (0.6)	0	22 (12.1)
Something else in farming that has changed?	5 (17.2)	23 (79.3)	1 (3.5)	0	0	0

Source: *ICPAC Survey (Kenya, 2023)*

Table 10: Perception of Changes in Production Activities due to CIS use in Uganda

Areas of change	Direction of change N (%)					
	Much better	Better	Same (No Change)	Worse	Much worse	Didn't Use
The yield of most crop harvests	55 (32.7)	86 (51.2)	15 (8.9)	5 (3.0)	6 (3.5)	1 (0.6)
The use of pesticides	44 (26.2)	94 (56.0)	13 (7.7)	2 (1.2)	3 (1.8)	12 (7.2)
The use of fertilizers	41 (24.4)	57 (33.9)	12 (7.1)	2 (1.2)	3 (1.8)	53 (31.6)
Farm income or savings	49 (29.2)	83 (49.4)	15 (8.9)	4 (2.4)	1 (0.6)	16 (9.5)
Labour needs	43 (25.6)	51 (30.4)	40 (23.8)	4 (2.3)	1 (0.6)	29 (17.3)
The timing of harvests	42 (25.0)	92 (54.8)	19 (11.3)	4 (2.4)	1 (0.6)	10 (6.0)
The timing of planting	50 (29.8)	94 (56.0)	18 (10.7)	2 (1.2)	1 (0.6)	3 (1.8)
Can choose appropriate crop species/varieties	65 (38.7)	75 (44.6)	17 (10.1)	2 (1.2)	---	9 (5.4)
Communication and/or knowledge sharing in the community after the Participatory Scenario Planning	68 (40.5)	59 (35.1)	23 (13.7)	1 (0.6)	2 (1.2)	15 (8.9)
Women farmers' participation in farm decision-making	37 (22.0)	79 (47.0)	17 (10.1)	1 (0.6)	1 (0.6)	33 (19.6)
Men farmers' participation in farm decision-making	45 (26.8)	69 (41.1)	15 (8.9)	3 (1.8)	2 (1.2)	34 (20.2)
Something else in farming that has changed?	19 (33.3)	34 (59.7)	1 (1.8)	1 (1.8)	1 (1.8)	1 (1.8)

Source: *ICPAC Survey (Uganda, 2023)*

The open-ended question on how they used climate information in their farming systems, a result of Focus Group Discussion, is provided in Box 1 below:

Box 1: Climate services in farmers' production decisions and their impacts?

a) Helps in variety selection, especially drought-resistant crop varieties. In Kenya, when expecting droughts, farmers choose green peas, sunflower, cowpeas, millet, sorghum and groundnuts, while maize, beans, green grams and cassava are grown when the forecast shows more rain.
b) Guide farmers when to relocate to safer places to avoid flooding and mudslides
c) When expecting drought, farmers store grass for livestock fodder
d) Drying and processing vegetables for next season
e) Impacted women in better planning to store 'harvesting water during the rainy season
f) Preparation of houses to avoid leakage and timely purchasing of seed.
g) Making silage for livestock feeds
h) Land preparation planning and early planting
i) In Kenya, farmers are better positioned to sell off livestock to reduce the number to match the dry weather. They can use the money to buy poultry, which doesn't need a lot of water, unlike other animals/
j) If expecting much rain, farmers increase the acreages to put under food production, and the number of crops for that season also increases.
k) When expecting less rain, CS help them prepare terraces and basins in the gardens to store water and avoid run off.
l) Water harvesting has improved micro-irrigation among CS users
m) Depending on the forecast received, farmers are guided to save money to buy inputs such as seeds, fertilizers and pesticides
n) It has guided youth to take other livelihood activities in expectation of droughts and failing weather.
o) Psychologically, farmers are prepared to plan for both negative and positive eventualities to match the weather forecast.

e. Challenges Limiting Farmers' Access and Use of Climate Services

The results from the Focus Group Discussions showed that access to climate services is faced with a number of challenges limiting farmers from adequate and timely utilization. These include:

- The accuracy of the information forecast is sometimes not reliable and thus misguiding farmers. Guided by the forecast, farmers open large pieces of land, spend money to buy inputs, prepare gardens, and sometimes take loans in expectation of the rains, but the rain fails, leading to losses. For example, in Voi, Kenya, farmers were told in

March the rain would resume in April-May, and there was no rain in the whole of May; therefore, farmers had planted crops and just dried them in the field due to misinformation.

- The rain forecast is not uniform and varies across different locations, but the forecast gives a general view of a very wide area. Future improvement is needed to give sub-areas coverage tailored to specific small areas.
- Repeated failed weather pattern also limits farmers from using the weather forecast. Farmers receive the CS as useful but are unable to use it as the weather remains unconducive to plant any crop.
- Lack of money to access farm inputs, e.g. seeds, pesticides and fertilizers, limiting farmers from using CS despite awareness of what weather to expect in the planting season.
- Information is sent through smartphones, but many farmers don't have them and know how to use them.

Asked "To what extent do you agree with the following statements? The study participants expressed how well they related the used of the CIS in their farming systems, and Figures 13 & and 14 below were the excerpts of their responses from the two countries studied.

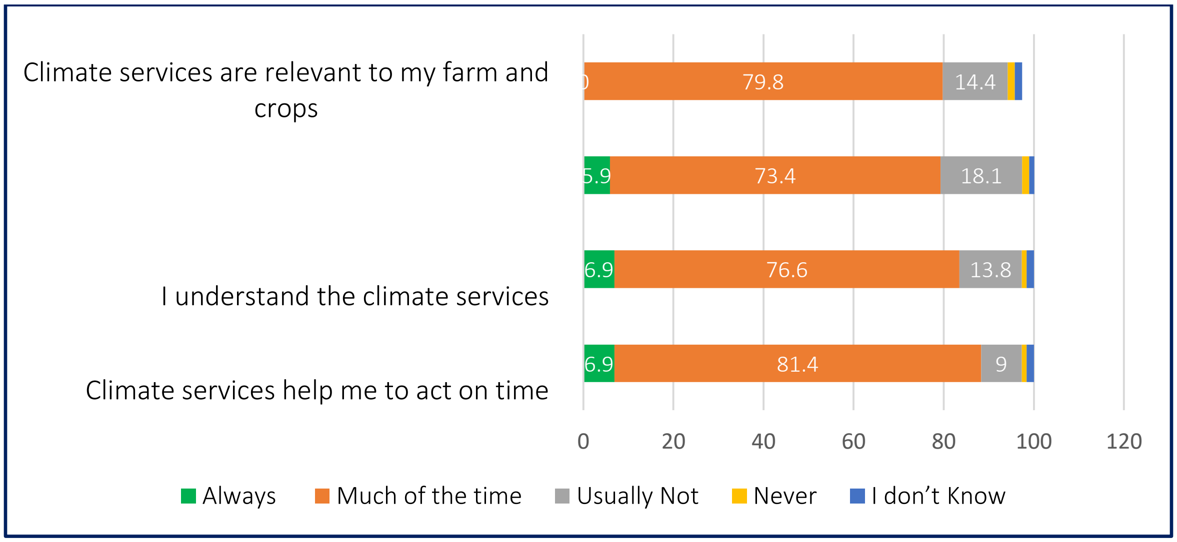

Figure 13: Smallholder Attachment to the Value to Climate Services, Kenya (%)

Source: *ICPAC Survey (Kenya, 2023)*

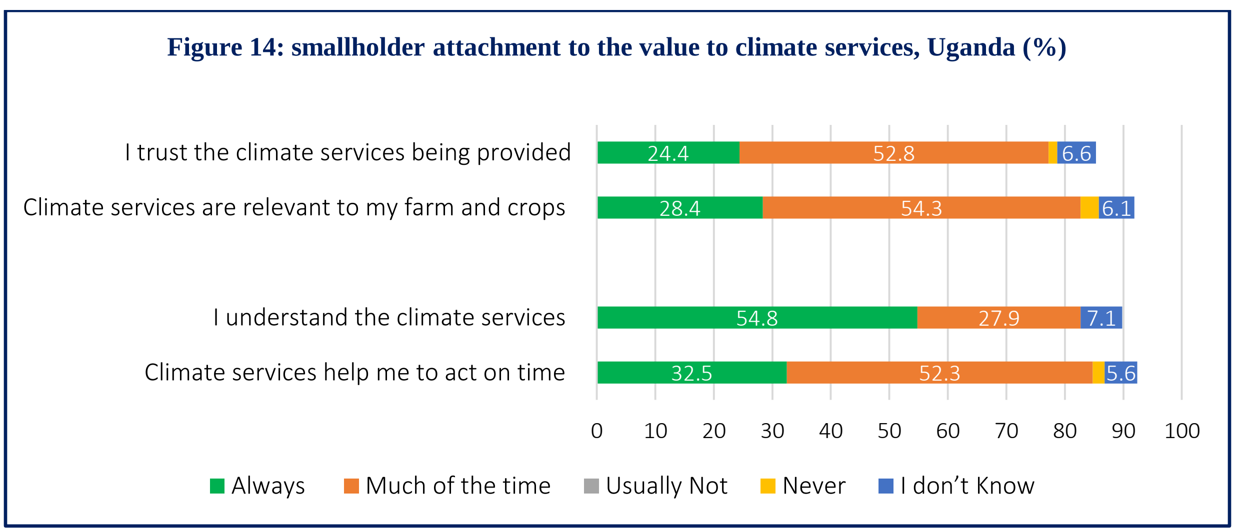

Figure 14: Smallholder Attachment to the Value to Climate Services, Uganda (%)

Source: *ICPAC Survey (Uganda, 2023)*

Asked how they feel about the climate services in your area, Figure, 15 below gives their opinions and level of satisfaction on the quality being provided.

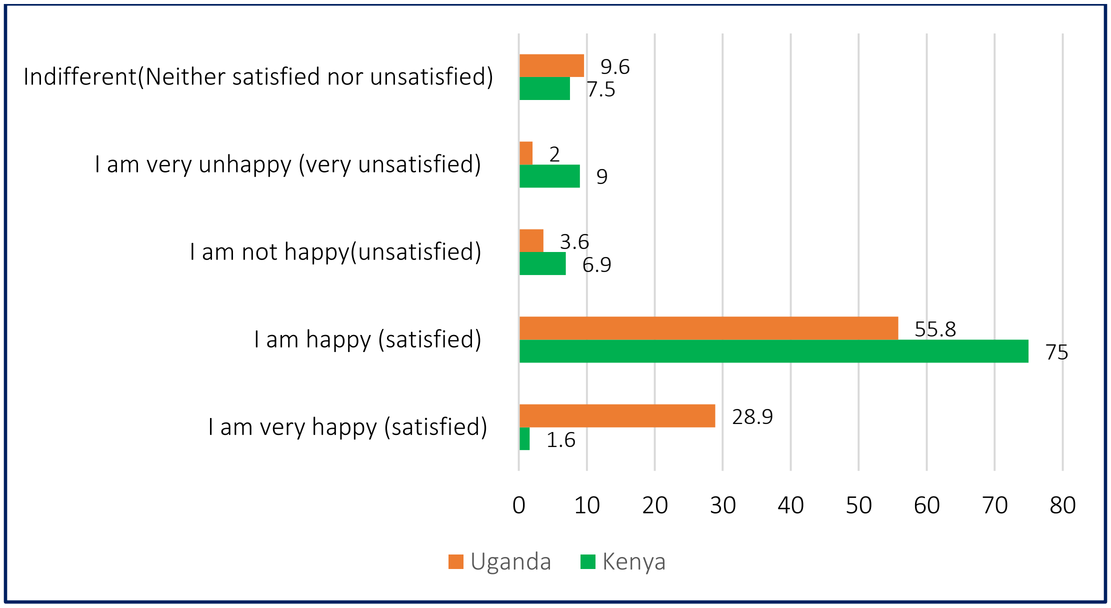

Figure 15: Satisfaction on the Quality of CS Provided in the Area (%)

Source: *ICPAC Survey (Uganda, 2023)*

D) Impacts of Climate Services on Food Security and Development Outcomes

The types of food consumed matter as a good indicator of food security, especially in smallholder households. For example, a high protein diet is most often eaten when a household is considered affluent and food secured in rural areas, while a starchy diet and vegetables are predominantly in periods of food insecurity, i.e. households facing hunger and starvation. Below are the different food groups consumed in the last 1 week at the time of the survey. The mean shows the average number of days the different food groups were eaten during the week.

Table 11: Food Groups Consumed in the Households by Country

Food Item	**Kenya**			**Uganda**		
	%	**Mean**	**SD**	**%**	**Mean**	**SD**
#.1 – Maize	53.0	5.8	1.697	47.0	4.0	2.01
#.2 – Rice	42.9	1.6	0.82	57.1	2.8	1.78
#.3 – Sorghum	30.6	3.9	2.62	69.4	5.1	2.36
#.4 – Millet	16.5	3.6	2.90	83.5	3.2	1.91
#.6 – Bread/wheat (paster, chapati)	35.2	1.9	1.57	64.8	2.9	1.85
#.7 – Tubers (cassava/yams/ potatoes)	18.4	1.6	0.97	81.6	3.6	2.30
#.8 – Groundnuts, beans, peas (Pulses)	36.0	2.2	1.20	64.0	4.3	1.96
#.9 – Fish (eaten as a main food)	31.2	1.7	1.01	68.8	1.8	1.26
#.10 – Fish powder (used for flavor only)	3.7	2.9	2.34	0	---	---
#.11 – Red meat (sheep/goat/beef/Pork)	27.7	1.6	0.68	72.3	2.02	1.18
#.12 – White meat (poultry)	46.2	1.2	0.43	53.9	1.4	0.69
#.13 – Vegetable oil, fats	58.9	6.3	1.45	41.1	4.6	2.02
#.14 – Eggs	36.3	2.2	1.59	63.7	2.1	1.31
#.15 – Milk and dairy products (main food)	41.2	5.5	2.34	58.8	3.4	2.13
#.16 – Milk in tea in small amounts	66.2	6.2	1.82	33.8	4.7	2.14
#.17 – Vegetables (including leaves)	49.2	6.3	1.37	50.8	4.1	1.87
#.18 – Fruits	31.8	2.7	1.85	68.2	3.3	1.90
#.19 – Sweets, sugar	51.8	4.8	2.09	48.2	4.79	2.09

Source: *ICPAC Survey (Uganda, 2023)*

E) Household Coping Strategies to Meet Stressing Food Demand

The farmers were also asked in the last 7 days about the different strategies they deployed in times the household did not have enough food or money to buy food and how often this happened. Table 12 below shows their responses.

Table 12: Household Coping Strategies to Food Stress by Country (Days)

Strategy	Kenya		Uganda	
	Mean	SD	Mean	SD
#1. Rely on less preferred and less expensive foods?	4.2	2.596	2.2	2.159
#2. Borrow food or rely on help from a friend or relative?	1.3	1.938	1.3	1.361
#3. Purchase food on credit?	2.1	1.977	1.0	1.414
#4. Gather wild food, hunt, or harvest immature crops?	0.7	1.673	0.8	1.245
#5. Consume seed stock held for the next cropping season?	0.6	1.404	0.6	0.891
#6. Send household member(s) to eat elsewhere?	0.5	1.317	0.2	0.853
#7. Send household member(s) to beg?	0.3	1.110	0.2	0.814
#8. Limit portion size at meal times?	3.4	3.426	2.0	1.667
#9. Restrict consumption by adults in order for small children to eat?	1.0	2.051	0.9	1.366
#10. Feed working members at the expense of non-working members?	0.1	0.766	0.1	0.531
#11. Reduce the number of meals eaten in a day?	3.6	3.042	1.9	1.685
#12. Skip entire day(s) without eating	1.3	2.074	0.5	0.753

Source: *ICPAC Survey (Uganda, 2023)*

Table 13: Household Coping Strategies to Food Stress by Years in CS Use (Days).

Coping strategy	Kenya				Uganda			
	Recent Users		Long term user		Recent Users		Long term user	
	N	Mean	N	Mean	N	Mean	N	Mean
Rely on less preferred and less expensive foods?	61	4.9	97	5.0	27	3.7	106	3.1**
Borrow food or rely on help from a friend or relative?	31	2.9	44	3.5	31	2.3	90	2.1**
Purchase food on credit?	52	3.6	82	2.6**	32	2.7	46	2.3**
Gather wild food, hunt, or harvest immature crops?	11	3.9	22	3.8**	20	2.3	54	2.1**
Consume seed stock held for the next cropping season?	18	2.8	27	2.4**	23	1.9	62	1.2**
Send household member(s) to eat elsewhere?	16	3.4	19	2.6**	8	2.5	12	2.1**
Send household member(s) to beg?	9	3.9	13	2.3**	11	2.1	10	2.4
Limit portion size at meal times?	41	5.6	75	5.5**	38	2.9	105	2.6**
Restrict consumption by adults in order for small children to eat?	18	4.6	27	3.9**	29	2.6	43	2.3**
Feed working members at the expense of non-working members?	4	3.3	5	3.0**	3	3.3	2	1.0**
Reduce the number of meals eaten in a day?	50	5.0	74	5.7	39	3.1	105	2.4**
Skip entire day(s) without eating	34	3.1	46	2.9**	22	1.5	58	1.2**

Source: *ICPAC Survey (Uganda, 2023);*

***Indicates cases where the long-term CS users performed better than recent users.*

F) Impacts of Climate Services and Food Consumption Scores

The results from food security scoring showed about 84 (44.7%) of Kenyans surveyed are living in a "poor food consumption level"; those in "borderline consumption" 44 (23.4%); and "acceptable consumption" level, 60 (31.9%). In Uganda, 34 (17.3%) in "poor food consumption", 68 (34.5%) in the "Borderline", and 95 (48.2%) in "acceptable food consumption" level, table 16 below. There was a slight reduction in those living in poor food consumption in households aware of climate services and using climate services, as revealed in the survey, table 16, below. The trend was equally true for CS long-term users compared to recent users of CS services, as found in the survey. However, the study did not decompose these differences whether statistically significant.

Table 14: Household Food Consumption Score with Knowledge and CS use

Score	Kenya (N=188) N (%)			Uganda (N=197) N (%)		
	Total	CS Awareness	CS Users	Total	CS Awareness	CS Users
Poor Food Consumption	84 (44.7)	81 (44.3)	82 (44.3)	34 (17.3)	28 (16.1)	29 (16.3)
Boarderline Food Consumption	44 (23.4)	44 (24.0)	44 (23.8)	68 (34.5)	58 (33.3)	60 (33.7)
Acceptable Food Consumption	60 (31.9)	58 (31.7)	59 (31.9)	95 (48.2)	88 (50.6)	89 (50.0)

Source: *ICPAC Survey, 2023)*

There is a clear indication that the more years a farmer adopts Climate Services in their farm decision making, the more likelihood of being more food secured. For example, in Kenya, about 46.3% of the respondents falling under recent CS users were living in poor food consumption compared to 43.8% for long-term CS users; in the borderline consumption level, there were fewer recent users compared to long-term users (20.9% for recent users versus 24.8% for long term CS users as discovered in the survey. This explains the greater role CS should be integrated into climate adaptation and rural development for better food security outcomes.

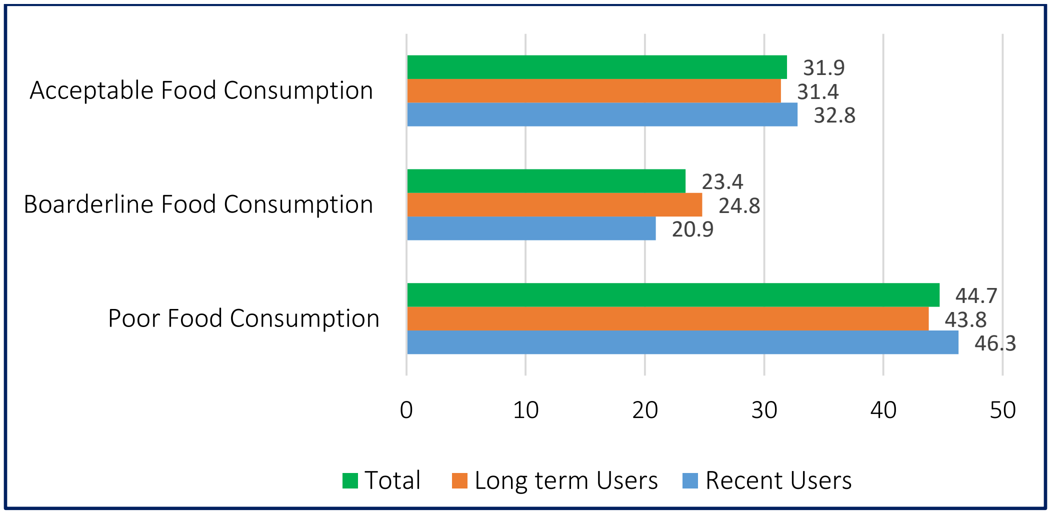

Figure 16: Food comsumption scores with years in CS use, Kenya (%)
Source: *ICPAC Survey (Kenya, 2023)*

Similarly, in Uganda, a greater proportion of households who are recent CS users are more likely to be food insecure compared to long-term users, as discovered in the survey. For instance, 26.4% using CS more recently were found to be living in poor food consumption relative to their counterpart, the long-term CS users (13.9%). They were exceptionally few when it came to living in acceptable food consumption, depicted by 37.7% (recent CS users) compared to 51.2% among long-term CS users (Figure 17, below).

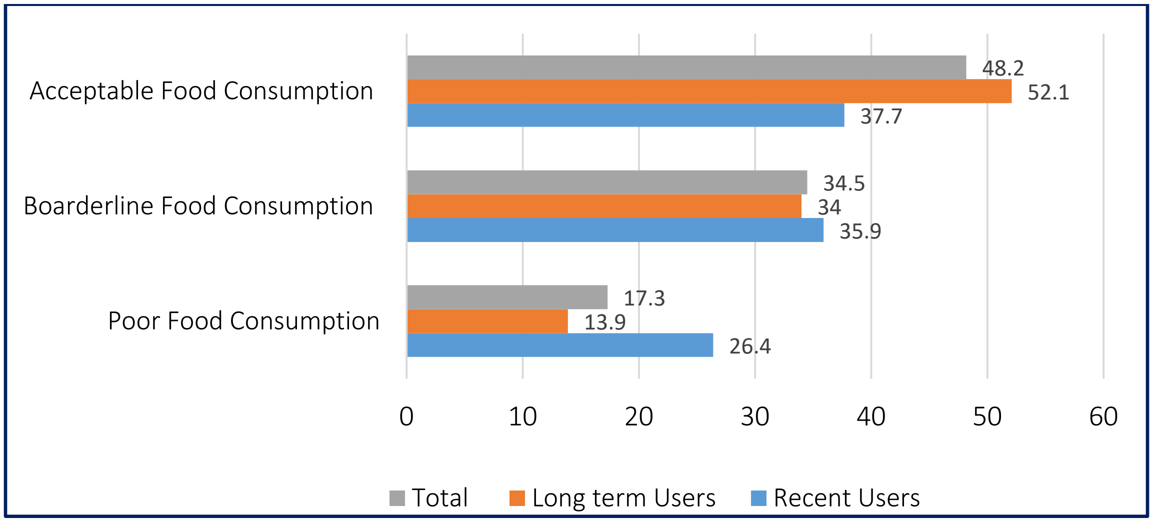

Figure 17: Food Comsumption Scores with Years in CS use, Uganda (%)
Source: *ICPAC Survey (Uganda, 2023)*

In both countries, results showed more cases in households living with poor food consumption levels among recent users compared to recent CS users, as demonstrated by the food consumption scores (Kenya, 46.3% for recent users versus 43.8% for long-term users) and Uganda (26.4% in recent users versus 13.9% in long term users) (Figure 16 & 17, above). This is a clear indicator that more years of CS use is likely to lower the incidences of a household being in unacceptable food consumption, as revealed in the survey. The analyses didn't attempt to show whether the differential impacts are statistically significant.

G) Impacts of Climate Services on Smallholder Resilience to Shocks

a. CS Impacts on Smallholder Resilience to Shocks and Stressors

Building more resilient livelihoods is increasingly recognized as one of the most powerful means to mitigate and prevent food security crises. The Resilience Capacity Index, expressed in the range of 0-100 percent, measures the household's capacity to recover or withstand shocks and stressors that affect their livelihoods. In this section highlights, we bring you the RCI results using the Shiny-RIMA-II methodology developed from the Food and Agriculture Organization of the United Nations to explain whether CS use and experience in used matters in shaping household resilience outcomes. Figure 18 below illustrates RCI variations in Kenya and Uganda in households surveyed.

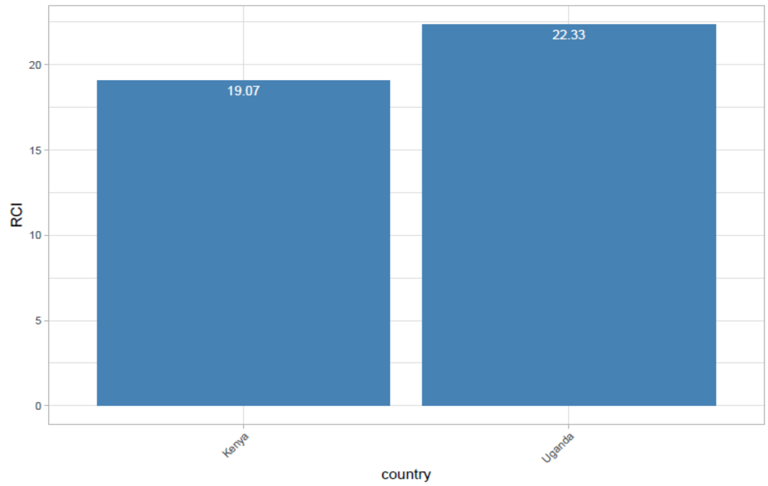

Figure 18: Average Resilience Capacity Index (RCI) by country

There was slightly more RCI observed in Uganda compared to Kenya (22.33 in Uganda versus 19.07), and therefore, locational influence matters for smallholder farmers to build resilience livelihoods resulting from the survey data.

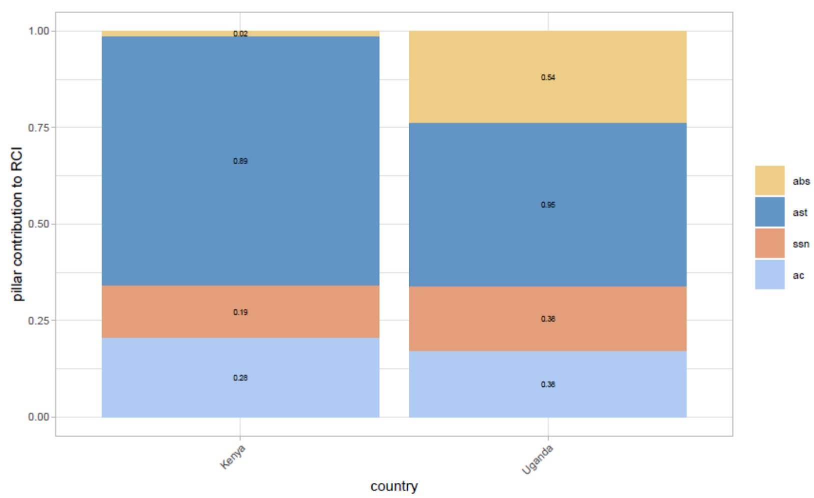

Figure 19: Resilience Structure Matrix (RSM) by country

When it comes to which factor matters most to resilience livelihoods, accumulated household assets denoted (AS), e.g. both productive and non-productive assets of households and community assets, play the main role in both countries to determine their resilience capacity (Figure 19, above). This is followed in Kenya by adaptive capacity (AC), which quantifies a household's capacity to adjust to changing circumstances and create new means of subsistence as a result of being linked to networks and institutions that serve as learning centers and repositories of information, thereby fostering flexibility. The social safety nets (SSN), or the family's access to aid from NGOs, international organizations, and families, as well as support from friends and family, come after the AC. The ABS component comes last.

In Uganda, AST importance is followed by ABS, which measures shows the ability of a household to meet basic needs and access effective use of basic services, e.g., access to schools/learning centers, health facilities, infrastructures, and markets, then SSN and AC in equal proportions (Figure 19, above). The details on the contributions of the different parameters to each resilience pillar across the study countries are provided in Figures 20- 22 below.

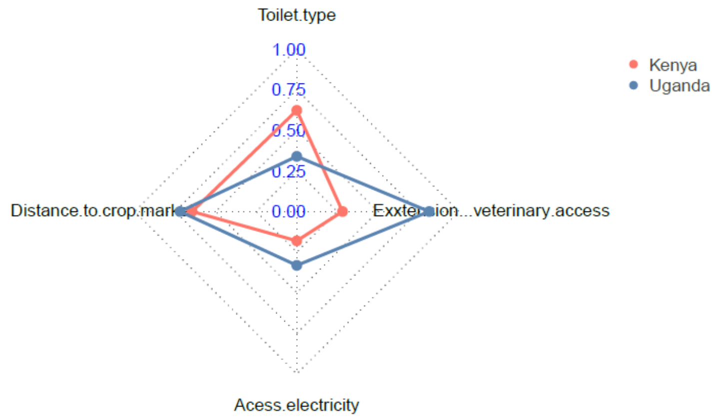

Figure 20: Correlations of Sub-Variables with the ABS Pillar by Country

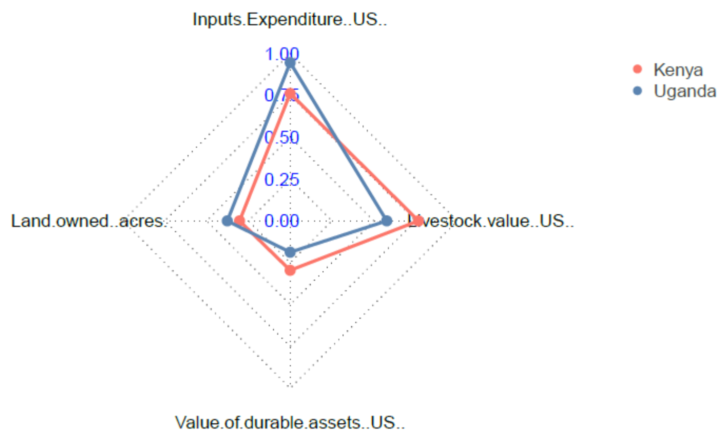

Figure 21: Correlations of sub−variables with the AST pillar by country

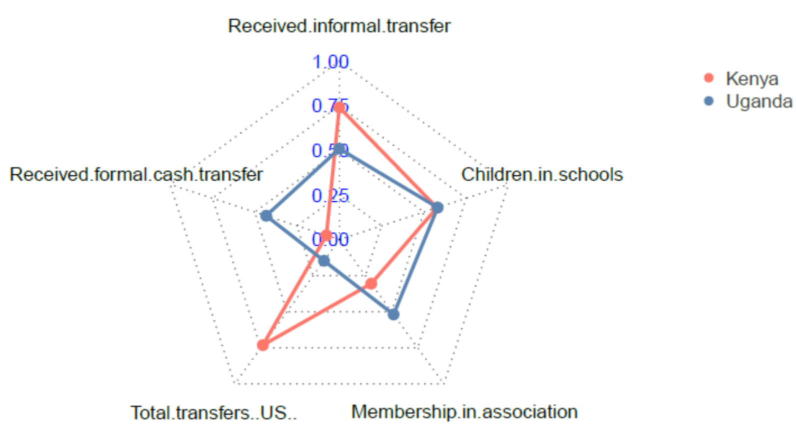

Figure 22: Correlations of sub−variables with the SSN pillar by country

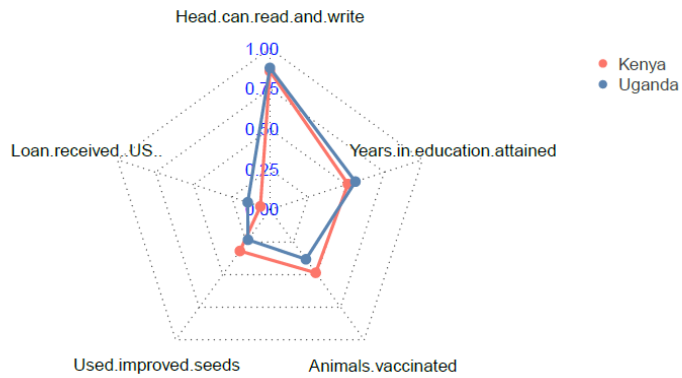

Figure 23: Correlations of sub−variables with the AC pillar by country

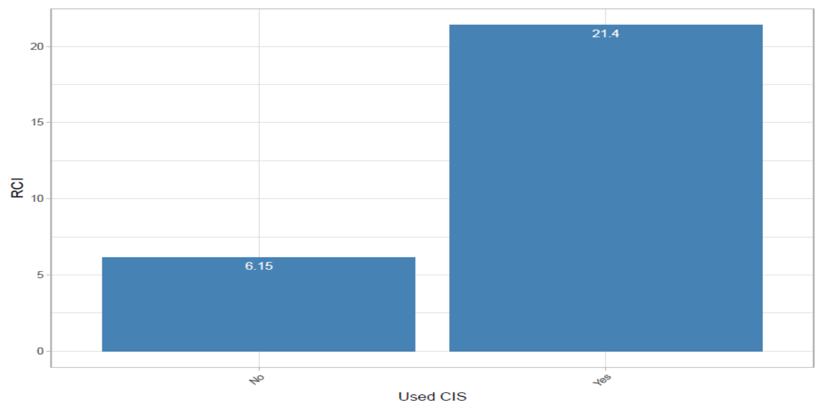

Figure 24: Average RCI by whether household uses CIS

There was a higher RCI observed in users of CS compared to non-users (users 21.4 versus 6.15). This is more than thrice relative to non-users of CS services (Figure 24, above). Therefore, it's valid to conclude that CS use improves resilience livelihoods among smallholder farmers as the survey tools were applied in fairly the same community location among samples with similar cultures in countries piloted.

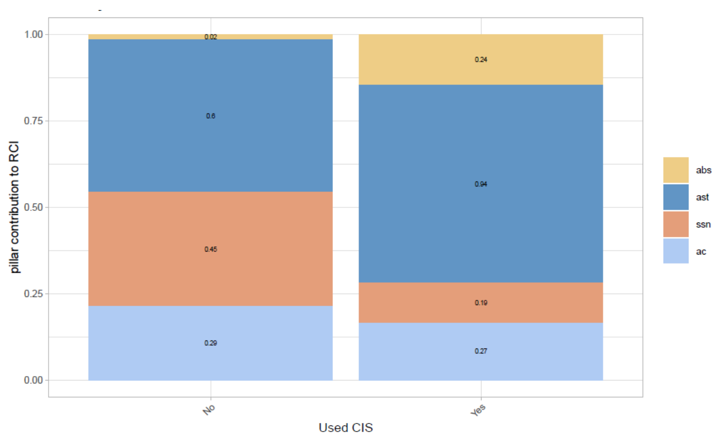

Figure 25: Resilience Structure Matrix (RSM) by CS use

Assets play the biggest role in determining resilient livelihoods to shocks and stressors for both CS users and non-users alike (Figure 25 above). Among non-users, the social safety net (SSN) follows, then adaptive capacity (AC), and lastly, access to basic services (ABS). Among CS users, after AST, it is followed by AC, then ABS, and lastly, SSN to determine resilience to shocks and stresses to livelihoods (Figure 25 above). For a more detailed breakdown of parameters by resilience pillar among CS users and non-users, please make reference to Figures 26-29 below.

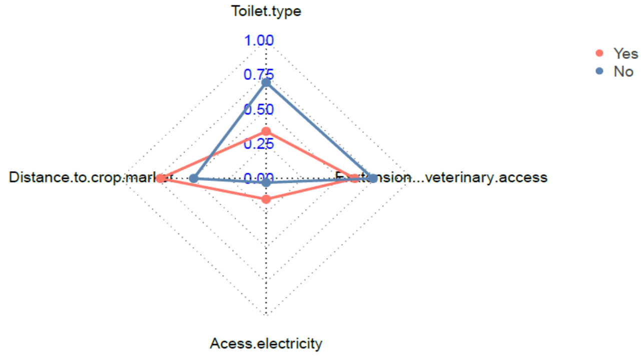

Figure 26: Correlations of sub−variables with the ABS pillar by CS use

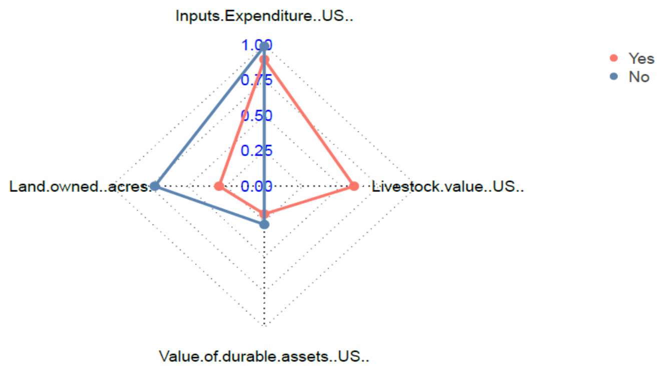

Figure 27: Correlations of sub−variables with the AST pillar by CS use

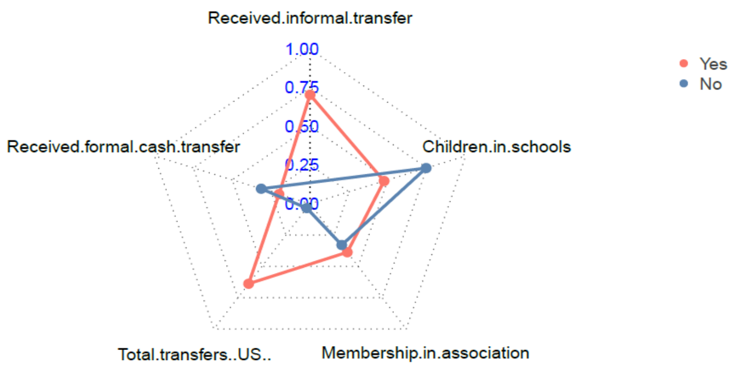

Figure 28: Correlations of sub−variables with the SSN pillar by CS use

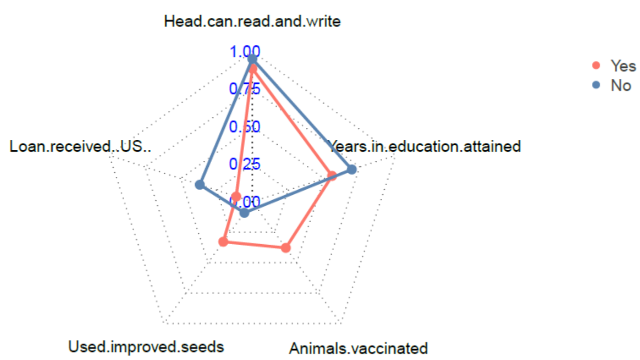

Figure 29: Correlations of sub−variables with the AC pillar by CS use

The CS users are more likely to have access to improved seeds and their animals vaccinated, partly explained by their relatively higher wealth status, e.g. accumulating more livestock and receiving more transfers compared to their counterparts, the non-CS users.

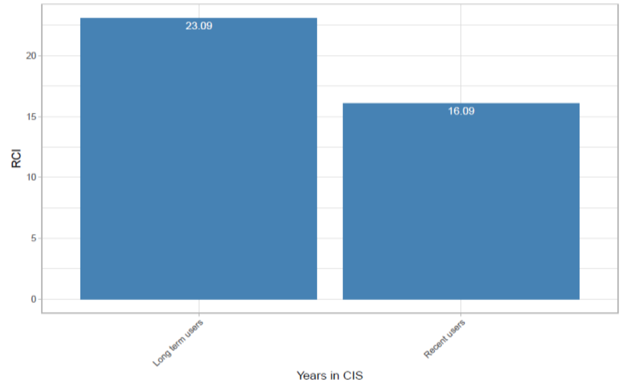

Figure 30: Average Resilience Capacity Index (RCI) by Years in CIS use

The years of CS use in production decisions also matter in determining resilience capacity among smallholder farmers, as discovered from the survey data. The more years in CS use are associated with increased household resilience. For example, we found RCI reported at 23.09 for long-term users (3++ years) compared to the recent users at 16.09 for recent CS users (0-3 years) (Figure 30, above).

The role of assets accumulated (AST) plays the most important role in determining household resilience to shocks and stresses in both long term and recent CS users alike. Among the long terms users, AST (0.95) is followed by ABS (0.31), then AC (0.28), and lastly, SSN (0.13). In the recent CS users, AST (0.85) is followed by SSN (0.45), the AC (0.34); and lastly, ABS (0.17) (Figure 31, below). For a more detailed breakdown of parameters by resilience pillar for years in CS use in farming systems, please make reference to Figures 31-34 below.

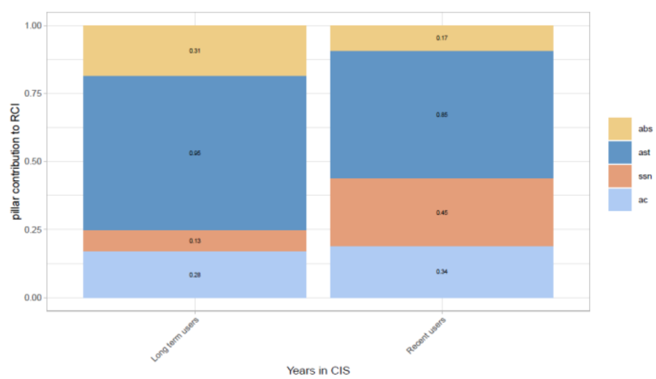

Figure 31: Resilience Structure Matrix (RSM) by Years in CIS Use

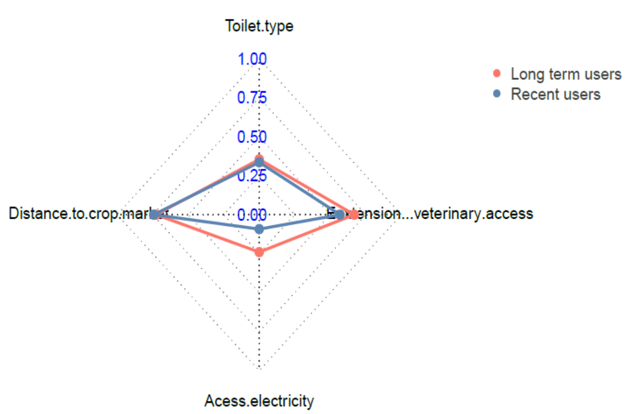

Figure 32: Correlations of sub−variables with the ABS pillar by years in CIS use

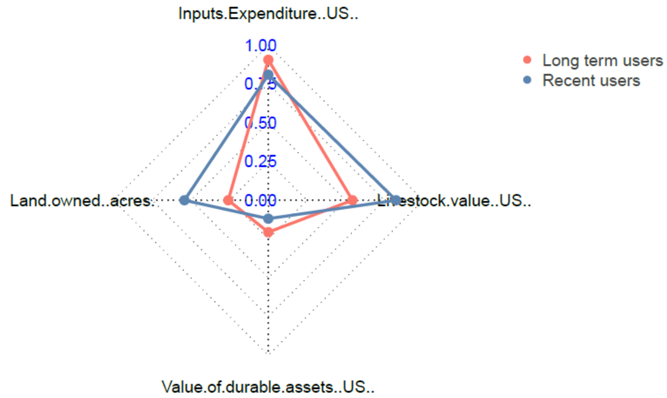

Figure 33: Correlations of sub−variables with the AST pillar by years in CIS use

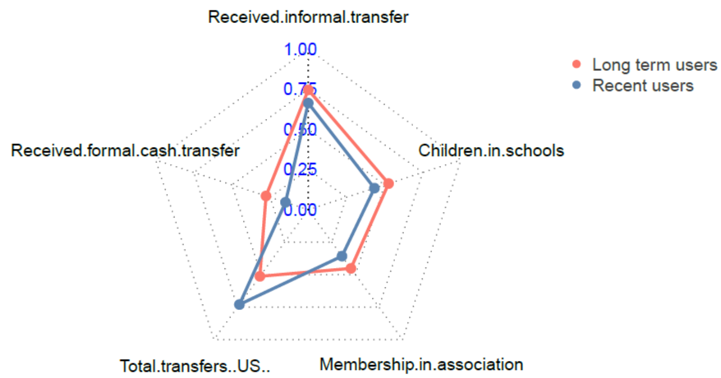

Figure 34: Correlations of sub−variables with the SSN pillar by years in CIS use

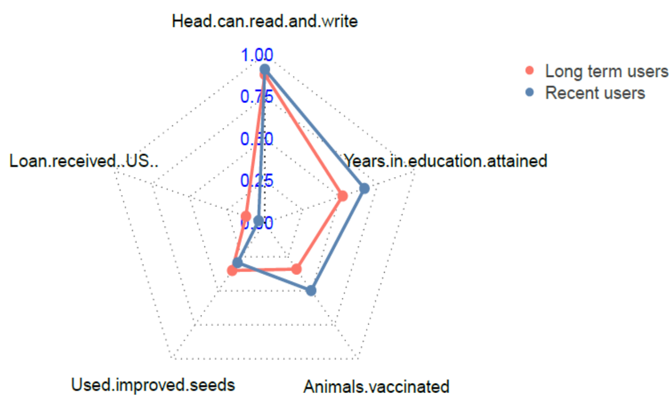

Figure 35: Correlations of sub−variables with the AC pillar by years in CIS use

The more years of CS use in smallholder farming systems, the more household resilience to shocks and stress that affect their livelihoods. For example, they are more likely to have better access to extension/ veterinary services, use improved seeds, access electricity, spend more to access agricultural inputs, accumulate more durable assets, receive both formal and informal cash transfers more, have their children in schools; and belonging to more community associations than their counterparts; partly explaining their more resilience outcome, depicted in the survey.

H) Impacts of Climate Services on the Water Sector

The stakeholders interviewed among big water users in the two countries, e.g. the Ministry of Energies, Ministry of Water and Environment (MoWE), Coco-Cola and Pepsi Beverages companies in Uganda, and KEN Gen, an electrical generation company in Kenya, all agreed that the use of climate services produces enormous benefits. Without giving quantitative pieces of evidence due to lack of data being collected, for example, the MoWE routinely received seasonal weather forecasts, temperature trends, onset dates, Standard Precipitation Index (SPI) from IGAD Climate Prediction & Applications Centre (ICPAC) on regional trends, and nationally from the Uganda Meteorological Authority (UNMA), which updates them on seasonal and monthly forecasts and the performance from the previous season, which guides MoWE on scenario planning and decision makings. The UNMA issues alerts and forecasts in the form of report advisories and maps, and the Ministry uses the downscale forecast from the UNMA to invite stakeholders and issue bulletins and reports.

I) Major challenges in the forecasts facing MoWE

- The monthly forecast and performance from the previous season provided from UNMA and equally from ICPAC are not consistently issued to the Water Ministry. As a Ministry, their main interest from climate services is in performance and forecasts.
- Information on historical forecasts, which would be very useful for monitoring the overall trend for decision-making, is not archived and /or available on ICPAC websites for stakeholders.
- The format in which Climate information is being mapped, i.e. reported as "below and above normal", is qualitative in nature and not so direct in hydrological work. For example, the forecast does not give the likely volume of water expected to rise or drop in the lake, thus unable to guide which volume of water to release or maintain.
- Human resources constraints. The UNMA is understaffed, and the majority of them are on contract. Thus limiting their ability to deliver their mandates in delivering quality climate services.

J) Climate Services in the Water Sector and Evidential Impacts From Uganda

***a) Water Resources Management Unit**:* The use of CS has guided the management of the Lake Victoria basin very successfully. Lake Victoria is a transboundary water body, having many rivers feeding but with only one outlet. By nature, water is expected to exit on its own out of the lake. However, the construction of a hydroelectric dam in Jinja (Uganda) has altered this natural flow. Therefore, Climate Services is playing a key role in regulating the water volume in the lake to avoid flooding in the surrounding areas and neighboring countries as well. In addition, incorporating CS has helped the country have enough stable electricity in the country. The climate services are in the form of forecasts to help the Ministry regulate water volumes in Lake Kyoga and Albert through Lake Victoria.

b) The CS is being used to understand what is going on in the water drainage basins in the country, e.g. Kidepo, Aswa, Lake Kyoga, Albert Nile, Victoria Nile, Lake Edward and Lake George. The stream floor forecast is generated from climate information services to guide decisions around these major water basins in the country.

- Depending on the forecast, the Ministry is better positioned to advise the National Water and Sewerages Corporation (NWSC) on how much water intake is needed from the lakes and rivers to match the advisory.
- In addition, hydropower can benefit from regulating their power reservoirs, making rehabilitation works on their future power releases, and stabilizing the supply in the country.
- Lake Kyoga is very shallow, and in case a forecast above normal rainfall is not issued and used timely, or the information is not accurate to guide the management of water volume in the lakes, this would cause serious flooding around the Kyoga zone and other countries like South Sudan.
- In the absence of a forecast or an inaccurate forecast, there may be an over-release of water at the hydro-power dam, causing the water level in Lake Victoria to affect the docking of ships (s). With the forecast, the Ministry is able to understand periods of droughts and thus advice the hydropower to minimize the release of water from the lake to stabilize electricity supply as well as shipping activities. In case of above normal expected, the Ministry advises on releasing water in a timely manner to avoid flooding. The Ministry makes use of both weather forecasts and stream flow to correct advisories for stakeholders.
- The Ministry also uses this information to guide irrigation users. For example, where the forecast is reading below normal, they are advised to scale down their investments to avoid incurring serious losses.
- Meanwhile, beverages such as Coca-Cola and Pepsi companies have entered formal contracts with the National Water and Sewerage Corporation to ensure that water is given priority to supply to the two plants, irrespective of the volume of the forecast. For example, both Katosi and Gaba water supply lines are serving the factories to avoid outrages. However, in cases where serious droughts are expected and likely to destabilize the water supply, the company is advised and they are able to restructure their production lines. The companies are better positioned to prioritize which lines to maintain in expectation of water shortages to avoid entering losses. This also helps them allocate time towards maintenance works on inactive lines.

K) Climate Services in the Water Sector and Evidential Impacts From Kenya

The results from consultation with KEN GEN, an energy distribution company, showed that hydropower contributes about 30% of the energy mix in the country. Unlike other sources of power, e.g. wind, solar, and geothermal, among others, which are very difficult to control the generation and match with the market forces, hydro is a very good stabilizer of the energy mix as its generation and supply depend on the market demand from consumers. The CS play a very important role in guiding this decision.

The hydro depends on MUM and OND operational guidelines. The guide places emphasis on the dam levels to be kept low to allow the reception of rain to avoid flooding. At the end of the dry season, the dam level should be kept as high as possible to generate enough electricity. The Met services guide them on the weather forecast in order to maintain the recommended dam level to avoid interrupted energy supply. As KEN Gen, it received probability forecasts in order to develop Scenario planning. The probability forecasts and regional outlooks are issued from ICPAC, and KMD also provides a national forecast.

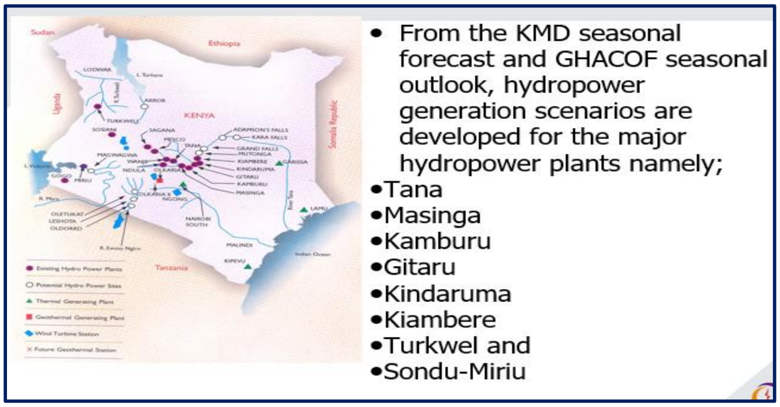

Figure 36: Climate Services and Hydropower Projections, Kenya

Source: *Ken Gen, 2023*

- The regional forecast helps KEN Gen to know the weather conditions in the neighborhoods, especially in countries where Kenya imports electricity, to plan accordingly.
- The climate regional outlook from ICPAC helps KEN GEN to plan for the season, e.g. dry or wet expectations in order to schedule and balance the water levels in the dam.
- The monthly forecast helps to provide the Memo for energy/ power distributors in line with the alerts.
- The 7-day and 5 day updates help to monitor the performance of the rainfall, as it's a more accurate indicator than the monthly or seasonal forecasts. For example, sometimes the monthly forecast may read below/above normal, but the 7 and 5-day forecasts will give the most accurate information to base adjustments in energy planning and decision-making.
- The forecast helps KEN GEN maintain and avoid breaching contracts with Kenya Power. It helps regulate the amount of power supplied to Kenya Power in line with the contract requirements. Failure to follow the forecast leads to the failure of this contract, exposing both parties to heavy losses.
- A while ago (before 2016), the forecasts were issued when the season was already ongoing, and KEN GEN had no control over scenario planning and decision-making for regulating the energy distribution. However, a new approach was adopted where the forecasts are issued at least a month before the start of the season. This has helped a lot in decision planning for stabilizing energy supply. In the earlier approach, there was no close collaboration between KMD and end-users. Leading to frequent hydro-dam/ water reservoirs for almost 6 months, especially the Masinga dam. This lead to serious rationing of electricity, and the worst experience was in 2009, when the dam was closed for nearly 6 months, leading to energy emergencies. Energy consumers resorted to diesel generators, which are expensive to run, leading to price rises in energy, including fossil fuel prices, loss of revenue to both KEN Gen as the contract has defaulted, and the general public incurring heavy losses due to interrupted power supply.

Box 2: Impacts of not using guided forecasts in hydropower

When the dam was closed for 6 months, we had to bring emergency diesel generators, which were expensive to run, caused carbon pollution, and led to fuel price rises. The revenue lost was enormous to the company, the government, and the private sector as a whole. Consumers pay more when using emergency generators. KEN GEN lost money due to a failing contract. Diesel prices also go up when these dams are shut down. I could not imagine the economy-wide impacts of the 5 consecutive seasons of failed weather in the absence of collaborations with ICPAC and KMD since 2016.

Source: *"Voices from a Key Informant (KEN GEN, 2023)*

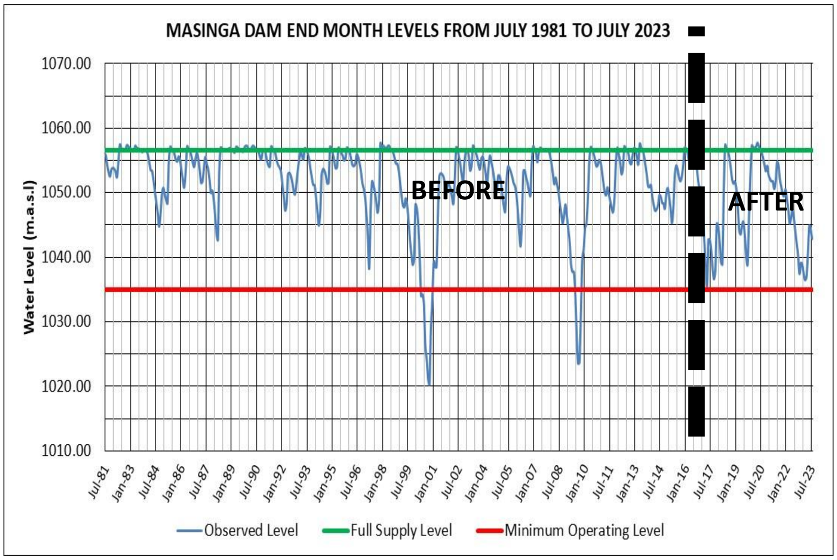

Figure 37: Masinga Dam End Months Levels from July 1981 to July 2023

Source: *Ken Gen, 2023*

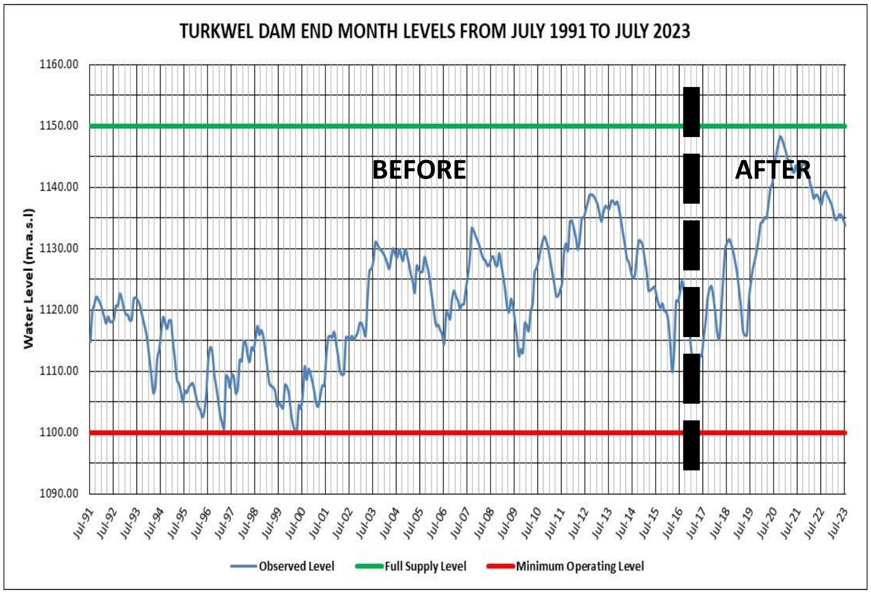

Figure 38: Turkwel Dam End Months Levels from July 1981 to July 2023

Source: *Ken Gen, 2023*

Since 2016 onwards, with the collaboration between KMD, ICPAC and KEN GEN, there has been marked improvement in regulating the dam volumes guided by the forecast. For example, in 2017, there was another serious drought, but the reservoir was only closed for 3 months due to a guided forecast. In addition, despite the country experiencing failed rainfall for 5 consecutive seasons, the reservoirs have never been shut down, and the consumers have never experienced energy shutdown due to guided collaboration with ICPAC and KMD to KEN GEN. The company is now working to extend the forecast to support other renewable sources (solar, wind and geothermal) besides hydro sources.

L) The use of Climate Services in Hydropower in Kenya

The hydropower generation planning is usually based on the KMD's forecasts and the GHACOF outlook to guide hydropower reservoir water management. The seasonal forecasts are usually updated monthly based on the ICPAC's and KMD's monthly forecasts for the purpose of monthly hydropower generation dispatch planning. The 7-day and 5-day updates are used to monitor and make necessary adjustments. The forecasts are applied together with operational rule curves for hydropower reservoirs.

Box 3: Scenario Planning for Hydropower

Step 1: Climate outlook forums at Regional and National levels
Step 2: Understanding the forecast/outlook probabilities
Step 3: Creating Planning scenarios based on the best and the worst-case
Step 4: Prepare projected scenarios and recommend the one with the highest probability
Step 5: Evaluate the performance
Step 6: Update projections as necessary.

Impact of Scenario Planning based on weather and climate information

Sustainable management of water resources in the hydropower reservoirs during flooding and droughts; Minimizing hydropower dams' overflows (spillage) and avoiding power outages during droughts; and Providing early warnings for floods to the people downstream of the dams to minimize losses

Source: *Dr. Willis Ochieng (KEN GEN, 2023).*

M) Major Challenges in Climate Services in the Water Sector in Kenya

The Kenya Meteorological Department (KMD), mandated to generate and distribute weather forecasts, had been slow to reach stakeholders. Where stakeholder consultations are needed, the department would focus only on high-level meetings with people on policy development, missing out on the end users of CS on the ground, and yet getting tailored feedback from policy actors may be low. We recommend that water/energy-related forecasts should tailored at the basin level instead of the general level to give a tailored estimate of water level to guide planning and decision making.

V. CONCLUSION

The provision of climate services to smallholder farmers in developing countries could help make vulnerable communities more resilient to climate-related shocks and stresses affecting their livelihoods. The agricultural sector remains the main driver of livelihoods for smallholder farmers and poverty reduction efforts in developing countries and the IGAD region alike but is highly exposed to the impacts of climate change. The agriculture in the region is rain-fed and vulnerable to extreme weather events such as floods and floods, leading to severe losses in crops and livestock productivity; threatening the livelihoods of smallholder farmers majorly.

In the absence of climate services, farmers are left helpless and unable to plan and take actions needed to match the cropping seasons, diversify livelihoods and spread risks to other livelihood opportunities, exposing them to more negative impacts of climate change. Climate services have the potential to guide farmers in making informed decisions, a way for better adaptation to climate change.

For example, farmers surveyed have linked climate services to better yield and income results due to timely planning for agronomic activities, e.g. timely planting, selection of crop varieties, and fertilizer application selling off their livestock when expecting droughts, when and how much to invest in farm inputs, preparing fodders for livestock, among others in line with the weather forecasts, leading to better farm outputs and food security outcomes. It is now clear that the more years a farmer adopts Climate Services in their farm decision-making, the more likely they are to be more resilient to climate shocks and stress and also more food secure compared to non-users. Farmers are psychologically more prepared to plan for both negative and positive eventualities to match the weather forecast. Therefore, climate services in the context of climate change place farmers into seasoned decision-making, forming an important step towards climate adaptation.

In addition, not only does it impact the smallholder agricultural sector alone, but it is capable of impacting the water sector enormously, especially in regulating water level flows in stabilizing hydro-power generation and supply for of electricity for the wider economy. The regional outlooks, monthly and weekly forecasts, help hydro-power companies plan for the season, e.g. dry or wet expectation, in order to schedule and balance the water levels in the dam to avoid unstable supply defaulting supply contracts, reduce overreliance on dirty fossil fuel as alternative energy, reduced power rationing destabilizing the economic activities. In addition, countries are better prepared to avoid flooding associated with heavy rains, therefore reducing the incidences of waterborne diseases such as malaria, cholera, dysentery and loss of lives and properties.

The CS provision faces numerous challenges, ranging from insufficient funding, the NMS's slow reach to end-users, especially for the agricultural sector, and historical forecasts not being adequately archived and easily useable to stakeholders. The format in which Climate information is mapped and reported, e.g. as “below and above normal”, is qualitative in nature and not so direct in hydrological work. In Uganda, UNMA is understaffed, and the majority of the staff are under contract; the accuracy of the information forecast is sometimes not reliable, thus misguiding decisions.

In addition, the weather forecast is not uniform and varies across different locations, but the NMS gives the state of the weather a general view over a very wide area. The farmers also lack the needed financial resources to access farm inputs, e.g. seeds, pesticides and fertilizers, thus limiting their ability to use climate services despite awareness. The weather information is sent through smartphones, but the majority of the farmers do not have them and do not know how to use them. Climate change is increasing at alarming rates; take, for instance, consecutive failed rain seasons, which limit the farmers from using climate information despite receiving it successfully. Access to CS was skewed to more women than men across the two countries, explained by the greater role of agricultural activities being left to females in smallholder farming systems. Future rural development programmes will need to engage more men in agricultural transformation across the two countries.

Overcoming challenges that face CS provisions at both national, sub-national, institutional and farmer levels call for rigorous investment, strengthening public-private-donor partnerships, building capacity of National Meteorological Services (NMS), investing in agricultural extension services for improved communication with farmers, efficient farmer organizations, and social networks. This would significantly improve climate change adaptation and poverty reduction steps in line with Agenda 2030 Sustainable Development Goal and Agenda 2063 of the African Union, “ a prosperous Africa, based on inclusive growth and Sustainable Development” through modernizing agriculture for increased productivity and production.

A. Appendix 1: Households' Exposures to Shocks and Stress in the Last 12 Months

Table 14: How many times over the last 5 years has your household experienced [the shock] by country?

	Kenya				Uganda			
Climatic shocks	**N**	**Mean**	**Min**	**Max**	**N**	**Mean**	**Min**	**Max**
a. Excessive rains/flooding	10	1.3	1	2	162	2.3	1	5
b. Variable rain/drought	174	5.1	1	10	167	2.11	1	10
c. Hail/frost	5	2.8	1	5	73	1.93	1	5
d. Landslides/erosion	10	2.6	1	5	95	2.05	1	5
Biological shocks								
e. Crop diseases(rust on wheat, sorghum)	33	3.70	1	5	84	3.29	1	10
f. Crop pests (locusts)	92	3.3	1	8	71	1.4	1	10
g. Weeds(e.g. associated with striga)	23	4.7	2	5	68	4.4	1	20
h. Livestock disease	68	3.5	1	5	85	3.6	1	30
i. Human disease outbreaks(from contaminated water)	20	2.4	1	5	8	4.6	1	60
Conflict shocks								
j. Theft or destruction of assets	50	2.7	1	5	103	2.3	1	30
k. Theft of livestock(raids)	48	3.0	1	7	60	2.5	1	30
Economic shocks								
l. Delay in PSNP food assistance	48	1.8	1	6	66	2.2	1	60
m. Increasing food prices	176	5.0	1	10	184	44.4	1	1000
n. Increased prices of agricultural or livestock inputs	169	5.3	1	95	111	27.0	1	1000
o. Decreased prices for agricultural or livestock products	71	2.9	1	5	87	3.9	1	50
p. Loss of land/rental property	13	1	1	1	42	1.5	1	5
q. Unemployment for youths	109	4.2	1	10	51	15.2	1	150
r. Death of the household member	41	1.2	1	3	89	2.1	1	9

Table 15: How Many Times Over the Last 5 Years has your Household Experienced [The Shock] by Years in CS use?

	Kenya				Uganda			
	Recent Users		Long term user		Recent Users		Long term user	
Climatic shocks	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
Excessive rains/flooding	3	1	7	1.4	42	2.2	120	2.4
b. Variable rain/drought	62	5.4	112	5.1	39	14.1	128	7.2
c. Hail/frost	1	5	4	2.3	24	2	49	2.1
d. Landslides/erosion	4	2.5	6	2.7	19	2.1	76	2.2
Biological shocks								
e. Crop disease(rust on wheat, sorghum)	13	3.9	20	3.6	76	3.4	8	2.5
f. Crop pests (locusts)	32	3.1	60	3.3	3	1.3	68	1.3
g. Weeds(e.g. associated with striga)	7	5	16	4.5	3	5	65	4.3
h. Livestock disease	21	3.7	47	3.4	10	5.6	75	3.4

i. Human disease outbreaks (from contaminated water)	7	2.3	13	2.5	15	7.7	66	3.8
Conflict shocks								
j. Theft or destruction of assets	17	2.9	33	2.6	25	2.5	78	3.4
k. Theft of livestock(raids)	16	3	32	3.0	10	3.7	50	2.2
Economic shocks								
l. Delay in PSNP food assistance	16	1.9	32	1.8	13	5.9	53	1.3
m. Increasing food prices	62	4.8	114	5.1	46	88.0	138	29.9
n. Increased prices of agricultural or livestock inputs	62	6.2	107	4.8	17	69.9	94	19.3
o. Decreased prices for agricultural or livestock products	23	2.7	48	3.0	28	3.9	59	3.9
p. Loss of land/rental property	2	1	11	1	13	1.8	29	1.3
q. Unemployment for youths	42	4.4	67	4.1	17	14.7	34	15.4
r. Death of household member	10	1.2	31	1.2	11	2.3	78	2.1

Table 16: Did Your Household Experience [The Shock] Within The Last Years (12 Months) By Country?

	Kenya				Uganda			
	Yes		No		Yes		No	
Climatic Shocks	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**
Excessive rains/flooding	8	4.3	180	95.7	135	68.5	62	31.5
b. Variable rain/drought	176	93.6	12	6.4	114	57.9	83	42.1
c. Hail/frost	8	4.3	180	95.7	54	27.4	143	72.6
d. Landslides/erosion	14	7.5	174	92.6	80	40.6	117	59.4
Biological Shocks								
e. Crop disease(rust on wheat, sorghum)	20	10.6	168	89.4	70	35.5	127	64.5
f. Crop pests (locusts)	77	41.0	111	59.0	9	4.6	188	95.4
g. Weeds(e.g. associated with striga)	24	12.8	164	87.2	64	32.5	133	67.5
h. Livestock disease	50	26.6	138	73.4	65	33.0	132	67.0
i. Human disease outbreaks(from contaminated water)	15	8.0	173	92.0	71	36.0	126	64.0
Conflict Shocks								
j. Theft or destruction of assets	38	20.2	150	79.8	75	38.1	122	61.9
k. Theft of livestock(raids)	32	17.0	156	83.0	33	16.8	164	83.3
Economic Shocks								
l. Delay in PSNP food assistance	26	13.8	162	86.2	45	22.8	152	77.2
m. Increasing food prices	180	95.7	8	4.3	181	91.9	16	8.1
n. Increased prices of agricultural or livestock inputs	170	90.4	18	9.6	106	53.8	91	46.2
o. Decreased prices for agricultural or livestock products	41	21.8	147	78.2	60	30.5	137	69.5
p. Loss of land/rental property	4	2.1	184	97.9	36	18.3	161	81.7
q. Unemployment for youths	98	52.1	90	47.9	45	22.8	152	77.2
r. Death of household member	30	16.0	158	84.0	52	26.4	145	73.6

Table 17: Did your household experience [the shock] within the last 12 months by years in CS use?

	Kenya				Uganda			
	Recent Users		Long term user		Recent Users		Long term user	
Climatic shocks	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**
Excessive rains/flooding	4	50.0	4	50.0	38	28.2	97	71.8
b. Variable rain/drought	63	35.8	113	64.2	38	33.3	76	66.7
c. Hail/frost	2	25.6	6	75.0	24	44.4	30	55.6
d. Landslides/erosion	6	42.9	8	57.1	16	20.0	64	80.0
Biological Shocks								
e. Crop disease(rust on wheat, sorghum)	4	20.0	16	80.0	5	7.1	65	92.9
f. Crop pests (locusts)	30	39.0	47	61.0	1	11.1	8	88.9
g. Weeds(e.g. associated with striga)	8	33.3	16	66.7	3	4.7	61	95.3
h. Livestock disease	32	64.0	18	36.0	56	86.2	9	13.8
Human disease outbreaks(from contaminated water)	8	53.3	7	46.7	58	81.7	13	18.3

Conflict Shocks								
j. Theft or destruction of assets	13	34.2	25	65.8	27	36.0	48	64.0
k. Theft of livestock(raids)	12	37.5	20	62.5	8	24.2	25	75.8
Economic Shocks								
l. Delay in PSNP food assistance	6	23.1	20	76.9	11	24.4	34	75.6
m. Increasing food prices	63	35.0	117	65.0	49	27.1	132	72.9
n. Increased prices of agricultural or livestock inputs	60	35.3	110	64.7	21	19.8	85	80.2
o. Decreased prices for agricultural or livestock products	13	31.7	28	68.3	20	33.3	40	66.8
p. Loss of land/rental property	1	25.0	3	75.0	12	33.3	24	66.7
q. Unemployment for youths	36	36.7	62	63.3	16	35.6	29	64.4
r. Death of household member	9	30.0	21	70.0	9	17.3	43	82.7

B. Appendix II: Impacts of Shocks and Stress on Households in the Last 12 Months

Table 18: Did your household experience [the shock] within the last year (12 months) country?

	Kenya				Uganda			
Climatic shocks	**No Impact**	**Slight Decrease**	**Sever Decrease**	**Worst Ever Happened**	**No Impact**	**Slight Decrease**	**Sever Decrease**	**Worst Ever Happened**
Excessive rains/flooding	3 (37.5)	2 (25.0)	3 (37.5)	---	7 (5.2)	13 (9.6)	21 (15.6)	94 (69.6)
b. Variable rain/drought	---	6 (3.4)	42 (23.9)	128 (72.7)	10 (8.8)	34 (29.8)	30 (26.3)	40 (35.1)
c. Hail/frost	2 (25.0)	2 (25.0)	3 (37.5)	1 (12.5)	8 (14.8)	21 (38.9)	6 (11.1)	19 (35.2)
d. Landslides/erosion	4 (28.6)	5 (35.7)	4 (28.6)	1 (7.1)	1 (1.3)	13 (16.3)	7 (8.8)	59 (73.8)
Biological Shocks								
e. Crop disease(rust on wheat, sorghum)	1 (5.0)	5 (25.0)	8 (40.0)	6 (30.0)	---	35 (50.0)	10 (14.3)	25 (35.7)
f. Crop pests (locusts)	2 (2.6)	11 (14.3)	36 (46.8)	28 (36.4)	1 (11.1)	4 (44.4)	2 (22.2)	2 (22.2)
g. Weeds(e.g. associated with striga)	2 (2.6)	11 (14.3)	36 (46.8)	28 (36.4)	1 (11.1)	4 (44.4)	2 (22.2)	2 (22.2)
h. Livestock disease	2 (4.0)	21 (42.0)	18 (36.0)	9 (18.0)	2 (3.1)	23 (35.4)	9 (13.9)	1 (1.5)
Human disease outbreaks(from contaminated water)	1 (6.7)	4 (26.7)	6 (40.0)	4 (26.7)	1 (1.4)	20 (28.2)	7 (9.9)	43 (60.6)
Conflict Shocks								
j. Theft or destruction of assets	1 (2.6)	12 (31.6)	11 (29.0)	14 (36.8)	2 (2.7)	9 (12.0)	15 (20.0)	49 (65.3)
k. Theft of livestock(raids)	1 (3.1)	3 (9.4)	12 (37.5)	16 (50.0)	1 (3.0)	3 (9.1)	5 (15.2)	24 (72.7)
Economic Shocks								
l. Delay in PSNP food assistance	10 (34.6)	12 (46.2)	2 (7.7)	3 (11.5)	19 (42.2)	11 (24.4)	12 (26.7)	3 (6.7)
m. Increasing food prices	---	7 (3.9)	38 (21.2)	135 (75.0)	2 (1.1)	24 (13.3)	55 (30.4)	100 (55.3)
n. Increased prices of agricultural or livestock inputs	4 (2.4)	34 (20.0)	46 (27.1)	86 (50.6)	---	30 (28.3)	20 (18.9)	56 (52.8)
o. Decreased prices for agricultural or livestock products	3 (7.0)	8 (19.5)	13 (31.7)	17 (41.5)	14 (23.3)	10 (16.7)	24 (40.0)	12 (20.0)
p. Loss of land/rental property	1 (25.0)	1 (25.0)	1 (25.0)	1 (25.0)	1 (2.8)	1 (2.8)	1 (2.8)	33 (91.7)
q. Unemployment for youths	3 (3.1)	14 (14.3)	43 (43.9)	38 (38.8)	3 (6.7)	9 (20.0)	6 (13.3)	27 (60.0)
r. Death of household member	---	5 (16.7)	15 (50.0)	10 (33.3)	6 (11.5)	4 (7.7)	2 (3.9)	40 (76.9)

Table 19: How severe was the impact on your household's income over the last 12 months by country?

	Kenya				Uganda			
Climatic shocks	**No Impact**	**Slight Decrease**	**Sever Decrease**	**Worst Ever Happened**	**No Impact**	**Slight Decrease**	**Sever Decrease**	**Worst Ever Happened**
Excessive rains/flooding	3 (37.5)	2 (25.0)	3 (37.5)	---	6 (4.4)	51 (37.8)	34 (25.2)	44 (32.6)
b. Variable rain/drought	---	7 (4.0)	48 (27.3)	121 (68.8)	11 (8.8)	46 (40.4)	32 (28.1)	25 (21.9)
c. Hail/frost	1 (5.0)	6 (30.0)	7 (35.0)	6 (30.0)	1 (1.4)	37 (52.9)	31 (44.3)	1 (1.4)
d. Landslides/erosion	4 (28.6)	6 (42.9)	3 (21.4)	1 (7.1)	2 (2.5)	41 (51.3)	14 (17.5)	23 (28.8)
Biological Shocks								
e. Crop disease(rust on wheat,	1 (5.0)	6 (30.0)	7 (35.0)	6 (30.0)	1 (1.4)	37 (52.9)	31 (44.3)	1 (1.4)

sorghum)								
f. Crop pests (locusts)	2 (2.6)	13 (16.9)	35 (45.4)	27 (35.1)	---	5 (55.6)	4 (44.4)	---
g. Weeds(e.g. associated with striga)	---	11 (45.8)	8 (33.3)	5 (20.8)	4 (6.3)	12 (18.8)	48 (75.0)	---
h. Livestock disease	3 (6.0)	21 (42.0)	16 (32.0)	10 (20.0)	5 (7.7)	31 (47.7)	17 (26.2)	12 (18.5)
Human disease outbreaks(from contaminated water)	1 (6.7)	4 (26.7)	6 (40.0)	4 (26.7)	1 (1.4)	40 (56.3)	21 (29.6)	9 (12.7)
Conflict Shocks								
j. Theft or destruction of assets	1 (2.6)	13 (34.2)	10 (26.3)	14 (36.8)	---	28 (37.3)	12 (16.0)	35 (46.7)
k. Theft of livestock(raids)	2 (6.3)	2 (6.3)	11 (43.4)	17 (53.1)	---	5 (15.2)	5 (15.2)	23 (69.7)
Economic Shocks								
l. Delay in PSNP food assistance	8 (30.8)	13 (50.0)	2 (7.7)	3 (11.5)	20 (44.4)	7 (15.6)	15 (33.3)	3 (6.7)
m. Increasing food prices	2 (1.1)	8 (4.4)	38 (21.1)	132 (73.3)	3 (1.7)	63 (34.8)	57 (31.5)	58 (32.0)
n. Increased prices of agricultural or livestock inputs	5 (2.9)	34 (20.0)	45 (26.5)	86 (50.6)	11 (10.4)	45 (42.5)	26 (24.5)	24 (22.6)
o. Decreased prices for agricultural or livestock products	2 (4.9)	9 (22.0)	13 (31.7)	17 (41.5)	19 (31.7)	17 (28.3)	18 (30.0)	6 (10.0)
p. Loss of land/rental property	3 (75.0)	1 (25.0)	---	---	1 (2.8)	4 (11.1)	3 (8.3)	28 (77.8)
q. Unemployment for youths	2 (2.0)	14 (14.3)	44 (44.9)	38 (38.8)	6 (13.3)	9 (20.0)	8 (17.8)	22 (48.9)
r. Death of household member	---	5 (16.7)	16 (53.3)	9 (30.0)	7 (13.5)	5 (9.6)	1 (1.9)	39 (75.0)

Table 20: How severe was the impact on your household's food consumption over the last 12 months by country?

	Kenya					Uganda				
Climatic Shocks	**Did not recover**	**Fully recovered, same as before the shock**	**Fully recovered and better than before the shock**	**Partially recovered**	**Not affected by [event]**	**Did not recover**	**Fully recovered, same as before the shock**	**Fully recovered and better than before the shock**	**Partially recovered**	**Not affected by [event]**
Excessive rains/flooding	3 (37.5)	1 (12.5)	1 (12.5)	1 (12.5)	2 (25.0)	32 (23.7)	61 (45.2)	3 (2.2)	32 (23.7)	7 (5.2)
b. Variable rain/drought	121 (68.8)	1 (0.6)	---	54 (30.7)	---	15 (13.2)	51 (44.7)	6 (5.3)	37 (32.5)	5 (4.4)
c. Hail/frost	3 (37.5)	---	---	3 (37.5)	2 (25.0)	15 (27.8)	17 (31.5)	3 (5.6)	16 (29.6)	3 (5.6)
d. Landslides/erosion	4 (28.6)	2 (14.3)	---	4 (28.6)	4 (28.6)	15 (18.8)	46 (57.5)	4 (5.0)	15 (18.8)	---
Biological Shocks										
e. Crop disease(rust on wheat, sorghum)	12 (60.0)	1 (5.0)	---	6 (30.0)	1 (5.0)	4 (5.7)	58 (83.9)	1 (1.4)	7 (10.0)	---
f. Crop pests (locusts)	34 (44.2)	3 (3.9)	1 (1.3)	37 (48.1)	2 (2.6)	1 (11.1)	6 (66.7)	1 (11.1)	1 (11.1)	---
g. Weeds(e.g. associated with striga)	14 (58.3)	4 (16.7)	---	6 (25.0)	---	1 (1.6)	57 (89.1)	1 (1.6)	2 (3.1)	3 (4.7)
h. Livestock disease	15 (30.0)	14 (28.0)	2 (4.0)	17 (34.0)	2 (4.0)	11 (16.9)	39 (60.0)	4 (6.2)	9 (13.9)	2 (2.1)
Human disease outbreaks(from contaminated water)	7 (46.7)	2 (13.3)	1 (6.7)	5 (33.3)	----	----	61 (85.9)	5 (7.0)	5 (7.0)	---
Conflict Shocks										
j. Theft or destruction of assets	11 (29.0)	10 (26.3)	---	11 (29.0)	6 (15.8)	21 (28.0)	26 (34.7)	4 (5.3)	24 (32.0)	---
k. Theft of livestock(raids)	10 (31.3)	3 (9.4)	---	11 (34.4)	8 (25.0)	17 (51.5)	6 (18.2)	1 (3.0)	9 (27.3)	----
Economic Shocks										
l. Delay in PSNP food assistance	12 (46.2)	2 (7.7)	1 (3.9)	6 (23.1)	5 (19.2)	----	22 (48.9)	4 (8.9)	9 (20.0)	10 (22.2)

m. Increasing food prices	140 (77.8)	1 (0.6)	----	39 (21.7)	---	81 (44.8)	61 (33.7)	2 (1.1)	35 (19.3)	2 (1.1)
n. Increased prices of agricultural or livestock inputs	99 (58.2)	5 (2.9)	---	63 (37.1)	3 (1.8)	22 (20.7)	61 (57.6)	4 (3.8)	16 (15.1)	3 (2.8)
o. Decreased prices for agricultural or livestock products	23 (56.1)	1 (2.4)	----	15 (36.6)	2 (4.9)	7 (11.7)	12 (20.0)	3 (5.0)	23 (38.3)	15 (25.0)
p. Loss of land/rental property	3 (75.0)	---	---	--	1 (25.0)	23 (63.9)	5 (13.9)	3 (8.3)	5 (13.9)	---
q. Unemployment for youths	47 (48.0)	1 (1.0)	---	49 (50.0)	1 (1.0)	28 (62.2)	3 (6.7)	2 (4.4)	11 (24.4)	1 (2.2)
r. Death of household member	19 (63.3)	---	---	11 (36.7)	---	43 (82.7)	3 (5.8)	---	6 (11.5)	--

C. Appendix III: Study Design Matrix

Table 21: Operational Methodology for Understanding the Beneficial Impacts of Access and use of CS

Study issue	Information required	Information sources	Data collection method	Data analysis methods	Limitations	What will the analysis allow us to say
A. What are the factors that influence demand drivers /willingness to pay for CS?	Characteristics of people who use/are willing to pay for CS Distribution of CS access and use in the study areas	Key informants Household members Documents	Interviewing Document review	Thematic analysis Content analysis	Limited success in creating CS users	Establishing demand drivers that determine use and Willingness to pay for CS.
B. What is the main use of CS (Look out for socio-economic configuration of the household)	The main source of income to households Plausible economic opportunities available The main reason for using CS	Documents Key informants Observation Household interviews	Interviewing Observation	Thematic analysis Multivariate analysis.	Limited critical value of development indicators Assumption of blanket indicative profiles	Establishing and understanding the level of access and use of CS in households
C. What is the existing knowledge base regarding: CS	Community knowledge and awareness as regards CS.	Ethnographic profiles of the study area FGDs Household interviews	Observation of both individual and household practices	Thematic analysis	Plausible apathy on the role of CS.	How knowledge influences the adoption of CS. How the knowledge of CS can be translated into productive activities.
D. What are the attitudes and perceptions of the local people toward CS (is there a relationship between attitudes held and the type of use CS are put).	Support of CS Opposition to CS.	Local community members FGDs	In-depth personal interviews with selected KI s FGD moderation.	Content analysis Thematic analysis	Understanding the role of CS and opinions on CS.	How attitudes toward CS influence CS adoption and subsequent application.
E). What is the level of CS in the study area? a) Types of CS being accessed/ applied.	No. of CS users Sources of CS to farmers	Key informants. Households Focus Groups	Interviewing selected KIs, Individuals	Content analysis of responses from Key informants, Thematic analysis of in-depth interviews	Total lack of CS in some areas Availability of accurate records of registered CS activities	Explain the determinants for CS distribution. Determine factors that influence CS use.

g) What are the existing gaps in the local population as regards CS as a tool for poverty reduction? Gaps among Local leaders Gaps among Local community Gaps among providers of ICT services.	Perceptions toward CS. Areas of CS that need strengthening Aspects of CS that need collaboration Aspects of CS that need change Content of CSs Role of CS in poverty reduction.	Key Informant Interviews FGDs Household	Interview guide for FGDs, KIs & Individuals	Thematic analysis Content analysis	Credibility of use of CS Clarity on the role of CS in the development process.	Ascertain the existing gaps regarding; Value systems Community ideology Implementation techniques Propose viable options for the sustainable use of CSs for welfare inputs. Ascertain the viability of CS as a tool for poverty reduction in communities.
h) To what extent has CS impacted household resilience?	Household resilience to key food economic development indicators (Food Consumption Scores, Coping strategy index scores, dietary diversity….)	Household interviews	Interview Guide for Individuals	Thematic analysis Content analysis	Limited to subjective assessment	Ascertain the differences in resilience among users and non-users of CS.

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While significant efforts have been made to ensure the accuracy of the data, the reliance on mixed sources and methods may justify a level of caution and verification in the use of statistics cited in the text or tables, facts and figures from this research in further analysis. References should be made directly to the underlying datasets and sources for specific details.

The boundaries, colours, denominations, and other information depicted on any map in this publication do not imply any judgment on the part of the ICPAC concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

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