Foresight4Food
International Collaborative Initiative

Background policy paper

Improving climate resilience in the Ugandan food system

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Key Messages

01 Uganda's rain-fed agriculture, on which most of its population relies, is highly vulnerable to climate change impacts like droughts, floods, and erratic rainfall. These climate impacts could cost Uganda up to USD 332 billion over 40 years.

02 Climate-smart agriculture practices, efficient water management, and early warning systems are vital for enhancing food system resilience. For instance, climate-smart practices could have mitigated the USD 470 million losses caused by the 2010/11 drought.

03 NARO-developed seed varieties have increased maize and bean yields by 22% and 19% respectively. Techniques like no-tillage also improve water use and soil health, enhancing climate adaptation.

04 Climate changes, particularly in the cattle corridor, lead to reduced water availability and the spread of diseases like ticks, causing up to a 50% rise in livestock illnesses during droughts.

05 Stronger implementation of programs like the Parish Development Model is needed to provide agricultural inputs, climate-smart training, and better access to climate information for farmers.

06 Strategic foresight and collaboration between government, NGOs, and local communities are essential for effective climate adaptation, ensuring policies are not only designed but also implemented at scale.

07 To build a resilient food system, key uncertainties – such as rising temperatures and unpredictable rainfall – require flexible policies that integrate local knowledge and promote agro-ecological practices.

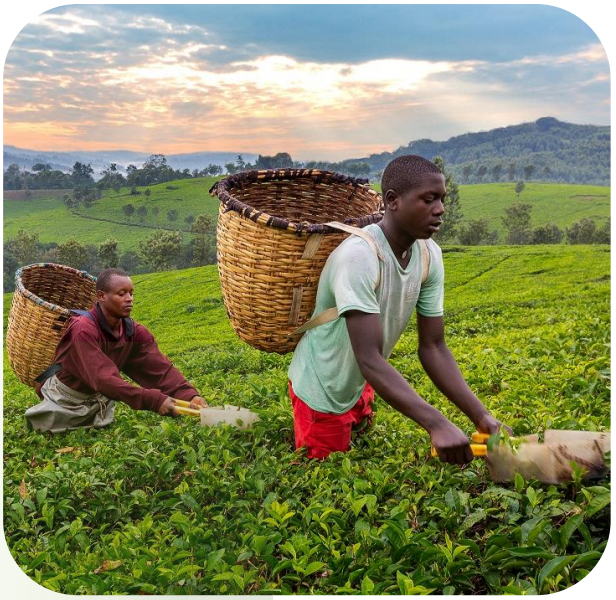
Introduction

This paper explores the opportunities for strengthening climate resilience to achieve desired food system outcomes in Uganda, using a foresight approach. Foresight and scenario analysis promote societal understanding, learning, and innovation essential for transforming food systems (Foresight4food, 2024). The paper first examines the impact of climate change on food production and its effects on achieving desired food system outcomes. Secondly, coping mechanisms are explored used by farmers and communities to address climate challenges, as well as the existence and implementation of national and local climate adaptation strategies. Next, the authors adopt a future-oriented perspective, analysing trends and key uncertainties to explore potential future scenarios and assess their implications for stakeholders. Drawing on these insights, the paper offers policy recommendations aimed at enhancing climate resilience and promote initiatives that lead to more sustainable and desirable futures.

1 Impact of climate on food production

Often referred to as the "Pearl of Africa", Uganda is known for its lush landscapes and diverse ecosystems (Lubogo, 2024). The major food crops grown in Uganda include maize, East African highland banana (matooke), common beans, rice, sorghum, cassava, sweet potato, and horticultural crops. From 2015 to 2020, these crops contributed to an agricultural sector growth rate of 3.4% per annum with food crops (maize, cassava, and bananas), showing notable growth of 3.7%. However, in recent decades, its agriculture sector has grappled with the adverse effects of climate change and weather variability, threatening agricultural production and household food, nutrition, and income security (MAAIF, 2019).

One of the most significant impacts of climate change in Uganda is the shift in rainfall patterns. Traditionally, the country experiences two rainy seasons: the long rains from March to May, and short rains from September to November. However, climate change has made rainfall unpredictable and inconsistent, causing prolonged droughts or intense rainfall and flooding with devastating effects (MAAIF, 2019). The increased frequency, intensity, and duration of heatwaves, and associated reduced water availability, directly impact food production (OPM, 2016). Irregular rainfall has disrupted planting and harvesting seasons, reducing crop yields and altering the agricultural calendar. Farmers who once relied on predictable seasons now face uncertainty, making it challenging to plan and optimize production (MoWE, 2015b). Climate change also exacerbates biodiversity loss, reducing the resilience of agriculture and leaving food systems more vulnerable to pests, diseases, and extreme weather events.



The precise impact of climate change on food production is challenging to predict, as shifts in temperature and rainfall may also yield positive effects, such as increased rainfall in drought-prone areas of the cattle corridor. However, the uncertainty surrounding these changes, combined with the severity of their implications, underscores the urgent need for adaptive strategies to safeguard Uganda's agricultural sector and food security in the face of a changing climate. With minimal climate change adaptation efforts, these changes will detrimentally impact agricultural production, exacerbating existing food insecurity (MoWE, 2015a).

Climate challenges for Livestock farming

Climate change poses challenges for livestock farming in Uganda, especially in the cattle corridor. Shifts in temperature and precipitation patterns reduce availability and quality of pasture and water sources. These climatic changes also increase the prevalence of pests and diseases, particularly ticks and tick-borne diseases, which reduce livestock productivity (MoWE, 2015a). During dry seasons, farmers move their animals to game parks in search of green pastures, increasing contact with wildlife and exacerbating pest and disease issues. Livestock movement across borders, due to reduced pastures and water sources, also complicates pest and disease management.

2 Effects of climate change on desired food system outcomes

Climate change poses a significant threat to Uganda's food system, with climate variability projected to cost Uganda's socioeconomic sectors, including agriculture, between USD 270 and 332 billion over a 40-year period (2010-2050).

Uganda's agricultural sector is already feeling the economic strain of climate change. Shifts in rain patterns and rising temperatures have significantly reduced productivity in both crop and livestock enterprises, disrupting food supply chains (Thornton et al., 2019). Droughts in 2010/11 caused losses of USD 470 million in food crops, cash crops, and livestock, equating to about 16% of these goods' total annual value. With shrinking crop production areas, forecasts predict that key export crops, like coffee and horticulture, could lose 50% of their value by 2050 – equating to USD 1.4 billion (MAAIF, 2018b). This decline in export earnings not only threatens national economic growth but also affects the livelihoods of those reliant on agriculture.

With 80% of Ugandan households engaged in agriculture, the decline in harvests caused by climate change has far-reaching implications for food, nutrition, and income security (UBoS, 2019). In addition, extreme weather events, such as floods, not only devastate crops but also damage critical infrastructure and storage facilities, disrupting food distribution and contributing to price volatility. The reduced availability and accessibility of nutritious foods exacerbates the risk of malnutrition, particularly in rural areas where communities are already more vulnerable (Omona, 2022).

3 Mechanisms of farmers and communities to cope with impacts of climate change

In the face of climate change, Ugandan farmers and communities are increasingly adopting a range of strategies to adapt and secure their livelihoods. This section explores the various mechanisms employed by these farmers, focusing on technological innovations, afforestation efforts, and knowledge sharing.

3.1. Technological innovations

Ugandan farmers are adopting different technologies and innovations to adapt to current climate conditions and secure their livelihoods. Techniques such as manure, intercropping, and grass mulching to retain soil moisture, enhance soil fertility, and reduce weed growth, are used. Farmers also use improved seeds, apply ashes to combat pests, and practice water harvesting and dig ditches for water drainage.

Research indicates that these innovations lead to higher yields and economic benefits. For example, a study by Pincus et al. (2016) in Mukono District found that vegetable yields were highest when fertilizer was applied at a ratio of 67% organic to 33% mineral fertilizer. Fatumah et al. (2021) studied the effects of four soil tillage systems on common beans grown in Mukono District and found that water use efficiency and grain yields was generally higher under no-tillage and stubble-mulching compared to deep tillage and conventional tillage treatments.

The adoption of improved crop varieties has also had a transformative impact on agricultural productivity, farmer income and resilience. According to (Kiyingi et al., 2024), adoption of National Agricultural Research Organization (NARO) bean and maize varieties increased yields by 141 kg ha-1 (19%) for beans and 414 kg ha-1 (22%), for maize. These improved varieties not only enhance food security but also contribute to climate resilience, as they are bred to better withstand pests, diseases, and environmental stresses. Adoption of NARO bean varieties raised bean income, farm income, and household income by UGX 709,000 (80%), UGX 1,143,000 (37%), and UGX 1,650,000 (36%), respectively. Similarly, adoption of NARO maize varieties increased maize income, farm income, and household income by UGX 661,000 (65%), UGX 1,560,000 (54%), and UGX 2,083,000 (48%), respectively.

However, a farmer's ability to adopt these practices depends largely on their environment and socioeconomic conditions.

3.2. Afforestation

Deforestation and forest degradation has led to significant forest cover loss in Uganda, particularly in the central region as well as Masindi and Hoima districts in the western region. Many forests in these areas have been cleared for farmland or sugarcane plantations. Private forests are especially vulnerable, as owners gain more benefits from converting these areas than retaining them as forests. Aside from exacerbating tree loss, deforestation is driving land degradation – leading to soil erosion, floods, and soil nutrient depletion, all of which undermine the climate resilience of local ecosystems (MoWE, 2016).

To combat deforestation and enhance climate resilience, farmers are incorporating tree planting into their farming systems. This agroforestry approach is becoming common in districts such as Bushenyi, Mukono, and Mubende where farmers plant trees for fruits, shade, poles, timber, and firewood (MAAIF, 2018a). In addition, to help combat deforestation, several women groups have been trained to produce and sell cooking briquettes, using maize combs, bean leftovers, and cassava flour. These briquettes offer a climate-friendly alternative to traditional charcoal, reducing the need to extract wood or cut down trees.

2.3. Knowledge sharing

In many districts, such as Mukono and Mubende, farmers work in organized groups and gather on demonstration farms or plots to learn about new technologies and innovations with support from local extension workers. Farmers then trial these innovations on small plots on their farms before scaling them out. In some districts, farmers participate in peer learning visits, to share experiences, observe agricultural practices and exchanges seeds (MAAIF, 2018a).

A study by Jogo et al. (2011) highlighted the critical role of rural social networks in managing in crop diseases. This study investigated farmers' awareness of symptoms, transmission mechanisms, and control options for Banana Xanthomonas wilt. Over 90% of farmers were aware of the disease and its symptoms, and more than 50% were aware of recommended control measures – with farmer-to-farmer interaction serving as the as the primary channel for sharing this knowledge.

4 National and local climate adaptation strategies and their implementation

Over the past few years, there are various policy documents developed regarding climate adaptation strategies. The most influential policies are summarized in table 1. Most policies are covered in one of the versions of the National Development Plan which serves as a roadmap for Uganda's development efforts, focusing on transforming the economy and improving the well-being of its citizens while addressing emerging challenges such as climate change. The Third National Development Plan (NDPIII) is directly aligned with Uganda's Vision 2040, serving as a strategic framework to achieve the long-term goals outlined in Vision 2040.

The Vision 2040 builds on progress in addressing strategic bottlenecks, particularly the underdevelopment of agriculture and services that have hindered Uganda's socio-economic growth. It aims to strengthen the economy by capitalizing on opportunities in agriculture, where Uganda is a leading producer of coffee, bananas, tea, cereals, livestock, and fish. However, crop productivity has declined due to high input costs, poor production techniques, limited extension services, and reliance on rain-fed agriculture. To boost productivity, the government is investing in irrigation schemes and researching improved seeds and livestock breeds. It has reformed the extension system to enhance farmers' access to information, reversed land fragmentation for mechanization, intensified environmental controls to improve soil fertility, strengthened regulatory capacity, and empowered cooperatives to enhance farmers' management and entrepreneurship skills. Maize and cassava are prioritized by the Ugandan government for their significant roles in household food, nutrition, and income security. Cassava, in particular, stands out not only for its multi-industrial use but also for its resilience to climate change. Its drought resistance makes it an essential crop in the face of increasing climate variability, allowing for stable production even during prolonged dry periods. Once mature, cassava can also be stored underground for up to two years, providing protection against seasonal effects (NPA, 2020).

Table 1: Influential policies regarding climate change adaptation

Policy	Year	Summary
Initial National communication prepared for the UNFCCC	**2022**	Outlines uganda's greenhouse gas (GHG) emissions, and provides potential mitigation options. It also includes vulnerability assessments of key sectors, proposed adaptation measures, and an overview of the policy and institutional framework for addressing climate change.
National Adaptation Programme of Action (NAPA)	**2007**	Aimed to strengthen the adaptive capacity of vulnerable communities in uganda's drought-prone areas, particularly in the arid and semi-arid cattle corridor zone. The program focused on key issues such as eradicating extreme poverty and hunger, promoting environmental sustainability, enhancing gender equity, and combating major diseases.
National Climate Change Policy	**2015**	Aims to harmonize and coordinate strategies for achieving a climate-resilient and low-carbon development pathway to support sustainable development in the country.
Uganda Vision 2040	**2010**	Emphasizes the importance of climate adaptation as a critical component for achieving sustainable development and national resilience. The vision outlines strategies to enhance the country's capacity to adapt to climate change impacts, particularly in sectors such as agriculture, water resources, and energy. It advocates for the integration of climate change considerations into planning and development processes, promoting the use of climate-smart technologies and practices to safeguard livelihoods and ensure environmental sustainability.
National Adaptation Plan framework for the agricultural sectors	**2018**	Aims to enhance the resilience of the agricultural sector to climate change impacts. Key components of the plan include: ○ Identifying vulnerable agricultural practices and regions to prioritize adaptation efforts ○ Enhancing the skills and knowledge of stakeholders at all levels, including farmers and local governments, to implement adaptation strategies effectively ○ Establishing a framework to attract investments for climate-resilient agricultural practices and technologies. ○ Developing systems to assess the effectiveness of adaptation measures and track progress over time

Implementation

In Uganda, the implementation of climate change policies remains a significant challenge. Despite the existence of various frameworks, most of these policies are far from fully operational. Acknowledged limitations within both national and local governments result in very few farmers receiving the adequate support needed to adapt to climate change and variability. Widespread perceptions of government corruption further undermine trust in these policies, leading to the belief that they are ineffective. Additionally, many farmers remain unaware of government laws and public policies concerning land use, environmental protection, agriculture, climate change, and natural resources like forests and wetlands. This lack of awareness not only limits their ability to engage with available resources and support programs but also hinders their capacity to adapt to climate-related challenges effectively.

There are various initiatives aimed at improving the effectiveness of developed policies. For example, the government's Operation Wealth Creation initiative, launched in 2013, aims to supply farmers with agricultural inputs, including improved seeds, tree seedlings, and livestock and poultry, as well as some limited extension services (Schreckenberg, Mwayafu, & Nyamutale).

Another initiative is the UN's LoCAL program, which supports local governments in integrating climate adaptation into their development plans and budgets (UNCDF, 2022). LoCAL has been increasing community and local economic resilience by providing regular, predictable, systemic, and verifiable climate finance in support of Nationally Determined Contributions and the National Adaptation Plan (NAP) aligned with locally-led adaptation actions. LoCAL also facilitates access to climate finance for local governments (districts), enabling them to implement adaptation investments—particularly in nature-based solutions, sustainable water management, and climate-smart agriculture. Additionally, LoCAL leads awareness campaigns for local governments on the importance of climate change adaptation and supports the integration of climate change into local planning and budgeting processes (GoU, 2021).

5 Key uncertainties related to climate adaptation in Uganda

In the foresight approach, key uncertainties refer to unpredictable factors that can significantly impact decision-making processes. These uncertainties can arise from environmental changes, policy and governance, and social dynamics.

In response to increasing GHG concentrations, air temperature over Uganda is projected to rise by 1.5 to 3.5 °C (very likely range) by 2080, depending on the emissions scenario. Compared to pre-industrial levels, median temperature increases are are expected to be around 1.4 °C in 2030, 1.7 °C in 2050 and 1.8 °C in 2080 under the low emissions scenario (RCP2.6). Under the medium/high emissions scenario (RCP6.0), temperatures are predicted to rise by 1.3 °C in 2030, 1.5 °C in 2050 and 2.3 °C in 2080.

In line with rising mean annual temperatures, the annual number of very hot days (days with daily maximum temperature above 35 °C) is projected to rise substantially and with high certainty over most parts of Uganda. Uganda could experience 13 more hot days per year compared to 2000, increasing to 26 more by 2050 and 39 more by 2080 under RCP6.0. In northern Uganda, this could result in around 150 very hot days per year by 2080.

Projections for precipitation are less certain due to high natural year-to-year variability. However, global warming is expected to intensify heavy rainfall events. In Uganda, the number of days with heavy precipitation is projected to increase under RCP6.0, from 8 days per year in 2000 to 10 days by 2080. Under RCP2.6, no significant change in the number of heavy rainfall days is expected.

Summary of key uncertainties regarding climate adaptation and mitigation

Critical uncertainties	Uncertainty variation	
Extent of climate change	Global temperatures stabilize with minimal changes, and extreme weather events occur infrequently.	Global temperatures rise drastically and unpredictably, and frequent extreme weather events become the norm.
Knowledge on climate adaptation	Food system actors remain largely uninformed and dismissive of climate change adaptation knowledge.	Climate change adaptation is the cornerstone of agricultural policy, driving unprecedented levels of innovation and investment.
Dietary patterns	Widespread consumption of low-nutrient quality and unsustainable diets drive poor health and environmental degradation.	Most people eat healthy and environmentally sustainably produced diets.
Food system infrastructure	Decentralized, local production networks, with short supply chains.	Food production is spread over rural areas, with long supply chains.
Trade balance	Negative trade-balance, with high dependence on imported food.	Positive trade balance, with high self-sufficiency and exports of cash crops.

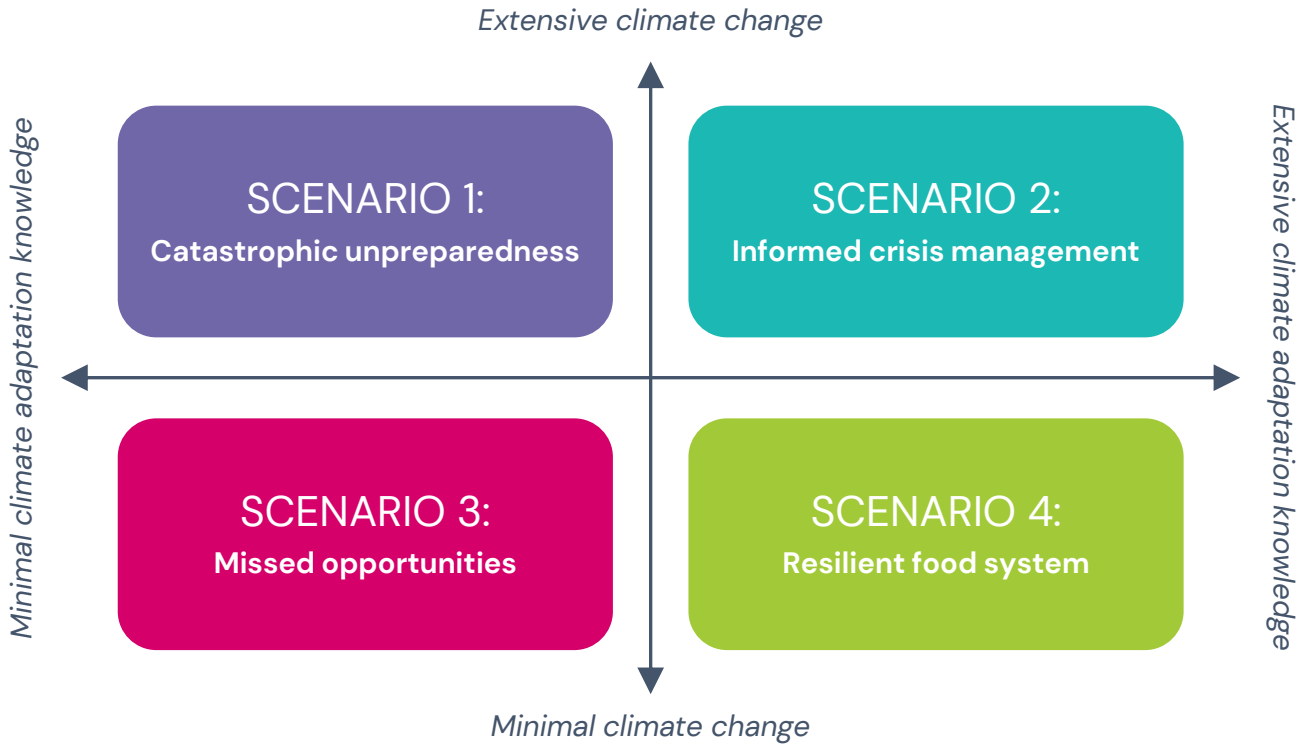
6 Future scenarios regarding climate adaptation and their implications for key players

To construct four potential scenarios for the future food system (Figure 1), two critical uncertainties were selected based on their high likelihood of shaping future climate adaptation and mitigation efforts in Uganda. These uncertainties provide a framework for exploring different pathways the food system could take, depending on how these factors evolve.

Primary critical uncertainties	Secondary critical uncertainties
Knowledge on climate adaptation Extent of climate change	Trade balance Infrastructure Dietary patterns

Figure 1: Selected Uncertainties For Scenario Planning

By placing the two uncertainties in a matrix, four scenarios were created. These scenarios provide a framework for envisioning diverse futures and guiding strategic decision-making and advocacy efforts in relation to climate change adaptation and mitigation. By illustrating how various factors interconnect to impact climate mitigation efforts, these scenarios help key stakeholders and policymakers navigate uncertainty and complexity.



Each scenario also outlines potential implications for key players in the agricultural sector – government, donors, businesses, and farmers/local communities – that need to be considered by decision-makers.

Scenario 1: Catastrophic unpreparedness

This scenario is characterized by environmental degradation, economic decline, social unrest, and political instability. A lack of adaptation knowledge leaves leaders unable to effectively respond and communities are continually reactive, struggling to manage the growing challenges. Over time, social order could deteriorate, and possibly ecosystems may face irreversible damage.

Potential implications:

Government: Faces policy gaps, increased pressure on resources, economic instability, and potential public unrest.

Donors: Shift focus toward humanitarian aid, such as food relief or temporary shelter, rather than sustainable, long-term interventions.

Businesses: Experience production losses, market instability, investment risks, and innovation stagnation.

Farmers/local communities: Face increased vulnerability, economic hardship, health and nutrition decline, and potential migration and displacement.

Scenario 2: Informed crisis management

In this scenario, extensive climate change occurs alongside comprehensive climate adaptation knowledge. The world faces profound environmental challenges but leverages advanced strategies to mitigate their impact. Although the challenges of climate change are significant, widespread adaptation knowledge enables leaders and communities to mitigate many impacts. Communities continue to face ongoing challenges and transformations as they adjust to a new climate reality, but they remain resilient and adaptive.

Potential implications:

Government: Implements robust climate adaptation policies, invests in resilient infrastructure, strengthens regulatory frameworks, and enhances disaster preparedness.

Donors: Make strategic investments, facilitate knowledge sharing, support innovation, and advocate for supportive policies.

Businesses: Invest in innovation, explore new market opportunities, enhance corporate responsibility, and build resilience in supply chains.

Farmers/local communities: Apply coping strategies to protect their resources, ensure a decent income, and maintain access to sufficient, nutritious food.

Scenario 3: Missed opportunities

In this scenario, the minimal extent of climate change means its immediate impacts are not severe causing only minor disruptions to daily life and economic activities. However, the lack of adequate adaptation knowledge limits the potential for optimizing responses and preparing for even minor future changes. While the situation remains manageable, society remains at risk if climate conditions worsen over time.

Potential implications:

Government: Faces ineffective policies, resource misallocation, increased disaster costs, and potential political and social unrest.

Donors: Encounter aid inefficiency, challenges in achieving goals, increased demand for assistance, and a need for knowledge dissemination.

Businesses: may overlook opportunities to invest in resilience, innovation, and sustainable practices, potentially creating long-term challenges.

Farmers/local communities: Experience increased vulnerability, economic instability, declining health and nutrition, and potential loss of livelihoods.

Scenario 4: Resilient food system

This scenario envisions a world where minimal climate change, coupled with extensive adaptation knowledge, fosters sustainable economic growth, social stability, and environmental preservation. Proactive governance, informed communities, and advanced technologies create a resilient and equitable future. Societies are well-prepared to handle minor climate-related challenges and ensure long-term sustainability– resulting in a more prosperous and equitable global community.

Potential implications:

Government: Develops informed policies, efficiently allocates resources, enhances disaster preparedness, and takes a leadership role in global climate initiatives.

Donors: Make strategic investments, facilitate global collaboration, advocate for supportive policies, and improve monitoring and evaluation.

Businesses: Invest in innovation, boost market competitiveness, manage risks effectively, and strengthen corporate social responsibility.

Farmers/local communities: Benefit from greater resilience, improved agricultural productivity, economic stability, and enhanced health and nutrition.

7 Policy recommendations

Developed with the above scenarios in mind, the following policy recommendations provide flexible and adaptive strategies to tackle climate change adaptation. The strategies aim to prepare communities and policymakers for potential climate disruptions while simultaneously seizing emerging opportunities. By integrating foresight into climate adaptation policymaking, enables agility in the face of uncertainty, promoting resilience in both the short- and long-term. The recommendations highlight the importance of collaboration, innovation, and the integration of local and global knowledge to create a robust framework for tackling the complex challenges posed by climate change.

Awareness creation and skills enhancement

The Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) should lead efforts to boost awareness and implement policies that support community resilience against climate change and variability. Such implementation should involve collaboration with other government agencies, including NARO and the Ministry of Water and Environment, among others. Additionally, local and international non-governmental organizations (NGOs) operating in Uganda should be engaged to promote the adoption of climate-smart agricultural technologies, such as no-tillage, regenerative agriculture, and moisture conservation, which can significantly improve soil health and crop resilience without requiring substantial financial investment. To ensure sustainability, it is crucial to involve local agricultural extension workers and community leaders in peer-to-peer training on climate-smart agriculture practices, leveraging existing knowledge and networks to effectively disseminate information.

Early warning systems and climate information services

The Uganda National Meteorological Authority should spearhead the implementation of low-cost early warning systems and climate information services across the country. Mobile technology and community radio stations can be used to deliver timely weather updates and early warnings, ensuring that even those in remote areas receive crucial information. Furthermore, installing more weather stations at the sub-county level would improve the accuracy of future weather forecasts. Existing weather stations should also be equipped with basic, affordable meteorological tools to strengthen local climate monitoring and forecasting capabilities.

Water management systems

The Ministry of Water and Environment, in collaboration with other stakeholders, should develop effective water resource management and small-scale irrigation solutions that can be promoted through various government initiatives, such as the Parish Development Model which aims to promote inclusive and sustainable development by decentralizing resources and services to the parish level, empowering local communities to improve their livelihoods through agricultural production, job creation, and poverty alleviation (Government of Uganda, 2023). Activities should include advocating for and supporting the construction of simple rainwater harvesting systems, like rooftop collection and storage tanks, to ensure water availability during dry periods. Additionally, smallholder farmers should be encouraged to adopt affordable drip irrigation systems, which are more efficient in water usage and can be implemented gradually.

Enabling environment for access to quality seed markets

As the MAAIF leads the implementation of the PDM, it should establish connections between farmers and input and output markets to enhance their adoption of climate-smart agricultural technologies. By partnering with NGOs and the private sector, farmers can receive training and support to produce Quality Declared Seed of crop varieties tolerant to environmental stresses, such as drought and low soil fertility. Furthermore, farmers should be linked to suppliers of solar pumps and driers to enhance crop production, productivity, and post-harvest handling.

Institutional capacity enhancement

MAAIF should enhance the climate-smart agriculture skills of local extension workers by organizing refresher courses and supporting staff career development in climate-adaptive strategies. Additionally, other government and non-government agencies working with farmers should be supported in improving staff capacity in climate-resilient practices through mentoring, coaching, and on-the-job training.

Multi-sector collaboration

There is a need for the vertical and horizontal integration of government agencies to reduce duplication, optimize resource utilization, and improve monitoring of climate change and climate variability programs. This integration will also strengthen national and sectoral development plans and budgets by mainstreaming and incorporating climate change considerations across various development initiatives.

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