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What Policy Recommendations Can Promote Coping and Adaptation Strategies for Addressing Future Climate Change Impacts on Livelihoods in Kapsokwony Division, Mt. Elgon Sub-county, Bungoma County, Kenya?

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Abstract
The term adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It also refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change and climate variability. Estimates of likely future adaptations are an essential ingredient in impact and vulnerability assessments. The extent to which ecosystems, food supplies, and sustainable development are vulnerable or 'in danger' depending both on exposures to changes in climate and on the ability of the impacted system to adapt. There is need for the development and assessment of planned adaptation initiatives to help manage the risks of climate change. Enhancement and building of adaptive capacity and resilience is a necessary condition for reducing vulnerability, particularly for the most vulnerable regions, nations, and socio-economic groups. Long term and short changes in climate are disproportionately affecting all parts of the world in equal measure. The most impacted by vagaries of climate change are the most vulnerable and the poor who live in the developing world. Climate variability impacts the smallholder farmers though they continue to apply traditional technologies in order to cope with climate change vulnerabilities. In most of the parts the world over, adaptive coping strategies are lacking especially in the African States. The purpose of this study was to build new transformation knowledge by integrating the traditional and the modern adaptive technologies in order to transform lives of the indigenous communities in the study area. This paper therefore explores and highlights the existing traditional and modern technologies which can be employed by smallholder farmers to counteract the impacts of climate change and climate variability. Data collected through in-depth and informant interviews together with Focused Group Discussions (FGDs) and a structured questionnaire administered to 384 household heads in twelve sub-locations in the study area (Kapsokwony Division) formed the basis of these policy recommendations. The long and short term adaptive strategies and recommendations developed by all the actors including those from the academia and the traditional communities during the research are meant to build climate resilience at local and national levels. A framework that has been developed by this research will help support policy decisions in the agricultural systems, human health systems and social economic development to improve livelihoods. If fully implemented these policy recommendations will go a long way to bring a paradigm shift that will improve livelihoods and social economic development in the region. These policy recommendations can be replicated in any other region the world over to bring about desired changes to a people impacted by climate change and climate variability however the threats.

1. Introduction

Climate change is influenced by a variety of factors, both human-induced and natural forcings. The increase in the carbon dioxide concentration has been the principal factor causing warming over the past 50 years. It is also defined as any change or disturbance to the environment perceived to be deleterious or undesirable to livelihoods. Its concentration has been building up in the Earth's atmosphere since the beginning of the industrial era in the mid-1700s, primarily due to the burning of fossil fuels (coal, oil, and natural gas) and the clearing of forests. Human activities have also increased the emissions of other greenhouse gases, such as methane, nitrous oxide, and halocarbons. These emissions are thickening the blanket of heat-trapping gases in Earth's atmosphere, causing surface temperatures to rise causing global warming. Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soils. Human activities are changing the GHGs concentration in the air.

According to IPCC, there's a better than 90 percent probability that human-produced greenhouse gases such as carbon dioxide, methane and nitrous oxide have caused much of the observed increase in Earth's temperatures over the past 50 years. Human influences on climate have become increasingly obvious, and global temperatures have continued to rise sharply. Over the last century the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO_2) and other greenhouse gases. Though the African countries emit negligible amounts of GHGs, they are more hurt by climate change impacts.

Environmental degradation describes the erosion of the natural environment through the depletion of

resources, the destruction of ecosystems and the extinction of plant and animal species. The degree of the environmental impact varies with the cause, the habitat, and the plants and animals that inhabit in it. This process can be entirely natural in origin, or it can be accelerated by anthropogenic activities. Agricultural runoffs are deadly sources of pollutants which can degrade environments and water resources so much so that agriculture is identified as the primary source of water pollution. The sustainability of livelihoods impacted by climate change can be improved by good planning, efficient management of natural resources and implementation of new adaptive strategies and robust policies.

The aim of this study was to evaluate sustainability of impacts of climate change on livelihoods among rural households in the study area. The communities living in the study area were investigated from the perspective of a people who experienced the livelihood threats due to climate impacts. The findings of this study will have several policy implications for politicians and planners as policy makers and rural dwellers have different and often conflicting perceptions and concerns. Dialogue and inclusion of all stakeholders in development initiatives can mitigate this gap. The respondents in this study represented households that face increasingly frequent and severe livelihood impacts. These climate-related stressors come on top of a wide range of structural vulnerabilities, such as high poverty levels, rapid population growth, increased pressure on natural resources, limited livelihood opportunities, and low educational levels. The high incidence of poverty and low education level undermine households' ability to diversify livelihood sources in ways that could enhance their resilience to climate events. Participants in the household questionnaire survey, FGDs, key informant and in-depth interviews reported significant changes in the frequency and severity of climate events and impacts, particularly on crop cultivation, livestock, food prices, houses and properties.

The study revealed how sustainability of impacts of climate change affects livelihoods in the study area. There was evidence of traditional knowledge and adaptive decision making that were essential in the improvement of livelihoods. Further, there was also the evidence of the degradation of livelihoods, risk management systems and increased poverty due to recurrent shocks of climate change. Therefore, in the face of increasing threats to livelihoods brought about by climate change, there is a critical need to support and strengthen existing adaptive capacity, while importing scientific transformation knowledge, new knowledge and innovative ideas and approaches to respond to the evolving scenario. Within communities that reside in the study area, variation in vulnerability and adaptive capacity exist, based on livelihood options available, access to resources and information and a range of other factors related to livelihood opportunities. Gender inequality means that women stand out as being disadvantaged due to restrictions by the traditional and being marginalized. The marginalization of women and other social groups reduces possibilities for household and community resilience that is equitable and sustainable over a long period of time. This study must therefore address gender inequality and social marginalization as important underlying causes of vulnerability to climate change.

The policy recommendations below provide actors and practitioners options of reflecting and responding to challenges in practise. These recommendations should be availed to the communities and all the stakeholders so actions can be taken to improve livelihoods in the region. This is because climate change impacts have contributed to reduction of vulnerability of women, men as well as the youth. Emerging themes that will follow this particular study will continually be shared through dialogue and results be put to good practise to improve livelihoods and sustain social economic development in the region. Interventions by the government and NGOs are required to support households in preventing threat impacts that jeopardize lives and livelihoods and that throw people back on their development paths. An important requisite for interventions to succeed is that the communities be consulted properly and given a voice in decision-making. This is especially true for interventions such as improvement in crop production, livestock rearing, and investments in infrastructure and ecosystem rehabilitation.

Some possible policy interventions listed are based on suggestions from questionnaire respondents (section 4 of the questionnaire), focus group participants, informant and in-depth interviews. As a disclaimer, it should be noted that policies to address loss and damage were not the main focus of this research, and the author recognizes that some of the interventions and policy reorientations suggested here, might be more complex to achieve than study participants imagine. It would be good to explore the possibilities of interventions that can help exploit the opportunities presented by threats for agricultural transformation to increase food production and incomes of rural households. Risks and harmful effects associated with threats can be minimized with proper forecasting and early warning. The Mt. Elgon Environment Conservation Network has an important role to play here and should collaborate with other public and private agencies such as BIKO KAPKORRET Community radio. Although the use modern technology is highly recommended, households may also benefit from traditional early warning signs that are known to some 'local experts'. More research is needed to assess this indigenous knowledge and its applicability in the study area.

Disaster management officers can benefit much more than they done hitherto from local communication structures to facilitate preparedness, organization of evacuation and emergency assistance in case of livelihood threats. Loss and damage due to threats will likely increase as human population increases and as more people

get into harm's way. There is a need to anticipate threat events by taking proactive steps to prevent them and minimize their effects.

Proper land use, good planning and efficient use of natural resources is must in order to sustain and improve livelihoods. Indeed, many of the questionnaire respondents, participants in focus group discussions and in-depth interviewees proposed similar interventions that they think could permanently solve the problem of livelihood threats. They proposed that what are needed are better adaptive strategies and policies to combat climate change. Laws can help to protect people who fail to see or recognize livelihood threats. Laws and regulations should be enacted and enforced to ensure public safety by controlling the types of agriculture and livestock rearing to be practiced by area residents. For example, practice of modern agriculture and organic livestock farming, planting of indigenous trees along river watersheds and control of soil erosion are strategies that can improve livelihoods. Pressure on land due to population increase is one of the critical factors driving ecosystem degradation in the study area and in the process; households and communities are increasingly exposed to livelihood threats. While the suggestion for policy formulations and interventions will not all be feasible in the short-term, it is clear that with current land-use practices, poor planning and ever increasing population, threats will continue to turn into disasters. The area is already witnessing increased resource – use conflict.

There is the danger of food insecurity due to the intensification of climate change vagaries in the region. Hunger and malnutrition are set to be prevalent in this region soon or later due to environmental degradation. All agricultural systems may collapse, hence, the collapse of the agricultural production. An increase in water pollution could lead to an increase of waterborne infectious diseases, and good quality drinking water is bound to be hard to find. The plundering of the forest and other forest resources could eventually further decrease in water quantities in rivers deepening humanitarian wellbeing. To achieve a sustainable future, there must be a balance between the population and the utilisation of the natural resources. Appropriate adaptive technologies must be put in place in terms of energy harvesting, increase efficiency, re-use, recycling, and avoid policies that promise short term economic returns at the expense of future generations. By engaging communities and other local stakeholders in a process of dialogue and reflections on climate change, livelihoods and gender, the study tried to unravel the critical issues that influence the vulnerability and adaptive capacities of both men and women smallholder communities in the study area. Institutions of learning (e.g. youth and women groups) should be put in place to create an enabling environment for local actions.

2. Policy recommendations

2.1 Accessing a decent basic education to drive economic development

Literacy level in the study area is wanting, worrying and low. A decent basic education is an important tool to drive economic development and improve livelihoods. To promote human resource development, education must be accorded top priority. The major reason for low education is the lack of information and high levels of poverty. There is need to put up more institutions to expand education. The socio-economic development potential in the region can be unlocked through the enhancement of literacy levels. For instance, education will help eliminate glaring gender disparities at household levels and at the same time inspire behavior change by creating awareness of individuals and communities. A decent education will promote knowledge and skills to help apply technologies to protect the environment while working towards a brighter future. Education is an important tool to invest in because it can empower, spur and cushion families against livelihood challenges. The national and the county government leadership should provide an enabling environment and the necessary infrastructure for effective learning in schools. Good education among area residents will create cross sector linkages of public and private sector for optimal resource utilization, enrich technical education and training.

2.2 Accessing climate information is critical to adaptive decision making

Accessing climate information and understanding impacts of climate change is critical to adaptive decision making in transforming livelihoods. In order for communities in the study area to effectively adapt to climate change, their wealth of indigenous knowledge must be complemented with scientific technical information that enables adaptive decision making. Through this research, there is need to create demand for information systems and help the community members to understand the value to use integrated traditional and scientific knowledge for planning. This applies to making decisions as when to plant crops and what quality of animals to be reared to improve the quality of livelihoods. It also involves short and long term decisions such as when to sell off the livestock and the economic trees and what to do with the family assets when climate threats are experienced. The needed information ranges from long and short term climate projections to seasonal forecasts to early warning of threats. Facilitating climate information is an ongoing process which is necessary to building adaptive capacity. To access the required information, it is important that communication systems are put in place to ensure equitable access to information for all.

2.3 Food security is becoming a complex problem in the area

Due to high population density, most households own small parcels of land for crop subsistence farming (crops and livestock) in the research area. Food security is a major issue in the area and it is becoming a complex problem. Over nine out of every ten respondents (90%) reported that they experience food shortage and had to eat less during certain months in the past year. Major food shortages occur between January and June. In addition, a sizeable proportion of the food consumed in households is bought when own production fall short of consumption needs. Unsuitable agricultural practices are still the norm in the study area and food security is dependent on maize, potatoes, beans, onions and tomatoes. To achieve food security locals should adopt Climate Smart Agriculture (CSA) to achieve improved livelihoods sustain economic development and practice organic livestock farming. GM farming is an aspect that can help improve food security in the study area. GMOs are animals or plants that are produced from organisms that have specific changes into their DNA. This allows for the production of specific changes of desired traits into the plant or animal e.g. increased resistance to drought or disease. Very often genetic modification leads to early maturation, increased yields, enhanced nutrient content and use of less convection fertilizers. The local farmers should be allowed to enjoy the best technology to be able to meet the challenges of feeding the people.. It offers a premium on both quantity and quality

2.4 Poor management of animal diseases significantly contribute to low productivity

Disease management remains a pressing challenge among livestock keepers in the study area due to ignorance, animal movement and open grazing systems. Animal diseases and pests contribute significantly to low productivity and lead to low income for livestock keepers. In addition, disease outbreaks impact livestock trade and the prevalent livelihoods. It is for these reasons that diseases be identified as a critical area for livestock management. Good management of livestock will enhance productivity and commercialize the livestock sector, ensuring livestock keepers earn handsomely for their efforts. New livestock management should be done through co-operatives which will provide access to credit at zero interest. This credit can be used to open and scale up agro-vets from which farmers can buy drugs to treat their animals thereby help to enhance animal health service delivery for their members. This will enable livestock farmers access animal health services and lessen drug shortages and grow health services. This will enhance monthly income from livestock sales in order to improve livelihoods.

2.5 Diversification of livelihoods impacted by climate change

Diversification of livelihoods impacted by climate change is a fundamental strategy in building resilience but it must be done in an informed and empowered way in order for it to be effective. There is currently limited knowledge about the ability of communities in the study region to adapt to future climate change. It is important to improve the understanding of how to enhance community's capacity to adapt to a changing climate in the context of other environmental stresses. The decision to diversify is always driven by recurrent climate shocks and stresses to existing livelihood strategies. Having many options for securing food and income provides a people with alternatives when one strategy fails. However, in the absence of the necessary information and support, the effectiveness of diversification as a strategy for building livelihood resilience may be limited. Engaging in new activities requires new skills and knowledge that may not exist in the community, requiring capacity development and technical assistance from external actors. However, in the absence of the necessary information and support, the effectiveness of diversification as a strategy for building livelihood resilience may be limited. Engaging in new activities requires new skills and knowledge that may not exist in the community and this requires capacity building.

2.6 Embrace potential for changes in gender roles and relations

Climate change is a driver to gender roles and relations. As the impacts of climate change become more apparent, households in the study area are increasingly required to shift from traditional livelihood strategies and practices, and at the same time embrace potential for changes in gender roles and relations. Within households and communities, men and women have different roles and levels of adaptive capacity. Among the different communities that live in the study area, adaptive capacity is not the same. Women are now actively engaged in crop production and marketing while men contribute in tilling farms both which are important livelihood strategies. Community social structures are also changing due to access to education. However, generally women's voice, movement and participation in public and household decision making which in turn creates limitations to their adaptive capacity is still low. Roles of men and women are therefore not the same as manifested by constraints to their access to information, opportunities to earn income and power to make decisions. It is imperative that vulnerability and adaptive capacity must uncover these differences and build an understanding of the specific roles, responsibilities and challenges faced by both men and women in securing their livelihoods and adapting to climate change.

2.7 Area residents are faced with water stress of water quality and quantity

Availability of water in the area is no problem but only a few household access piped water due to poor planning and management. One of the biggest threats facing livelihoods is the availability of the clean drinking water resource at household levels. Already residents in the study area are faced with water stress on the basis of water quantity and water quality. In future water scarcity will stress food production, trigger several new diseases, worsen fuel shortages which are already strained and retard economic development. Due to increased temperatures, diseases like malaria which is the Africa's biggest killer may become more prevalent in the area. The threat of malaria and waterborne diseases looms in the area though the county and national governments have tried to reduce mortality rates since independence time. Unreliable rainfall in the future will play a big role in any crisis over water resources. All residents must practice efficiency by managing energy resources effectively. All must switch from non-renewable to renewable energy sources. Carry out more research to bring forth new ideas on how to exploit potential energy resources. The residents must carry out reforestation and expand forested areas or embrace green economy. All households must be advised to plant economic trees to increase their income.

2.8 Traditional energy sources are a prerequisite to environmental degradation

Energy is a prerequisite to socio-economic development and securing livelihoods. However, the use of energy in the study area is both directly and indirectly associated with long term adverse environmental impacts which have significantly contributed to forest degradation due to cutting forest trees for biomass products. Energy production and consumption are instrumental in the region as residents continue to rely on traditional energy sources such as fuel-wood, charcoal, dung and agricultural residues. Reliance on these traditional energy sources have adverse health implications for women and children because of smoke in poorly ventilated indoor conditions as well as the time burdens associated with the collecting fuel-wood and agricultural residues. Losses of forest cover, rising population, existing land conflicts and fragmentation, inefficient utilization of land have combined to create negative impacts on the soil and water resources. The adverse effects of climatic events on energy production in the area are projected to grow due to climate change. Climate change could alter forest growth patterns and further shrink the availability of fuel-wood for energy and significantly lower the amount of water in rivers and compromise quality. The loss of forest cover due to demand for fuel-wood and charcoal has led to reductions of water in rivers.

2.9 Integrate traditional and scientific adaptive technologies to adapt

Smallholder farmers need to choose, use, and capitalize on scientific adaptation technologies to improve their livelihoods and their well being under a changing climate. To achieve food security and economic development of food production and trade systems must be made more accessible for smallholder farmers. Adaptive strategies devised by incorporating the scientific and the indigenous experiences are very important in the designing of adaptive policies that will help residents in the region to adapt to the vagaries of climate change. Knowledge of the indigenous community based on observations, perceptions and experiences over the years can effectively be blended with scientific knowledge to improve climate change mitigation and adaptation strategies. Other strategies that should be considered when designing adaptive technologies include cost efficiency, co-benefits, trade-offs and feasibility. The technologies to be adapted must be beneficial under the current climate conditions and those that might be adaptive under the future climate conditions. Technologies are supposed to build resilience to climate shocks and support adaptation. Adaptation strategies should use both top-down and bottom-up approaches leading to higher effective, efficient, equal, sustainable, flexible, legitimate, robust and replicable.

2.10 Adopt Climate Smart Agriculture (CSA) to achieve food security

Due to high population density, most households own small parcels of land for crop subsistence farming crops and livestock in the region. Food security is a major issue in the area is becoming a problem. The adoption of Climate Smart Agriculture (CSA) would be a sure solution to achieving food security and economic development in the region under a changing climate. The smallholder farmers should feature CSA as a solution to resolving many livelihood challenges and make modern agriculture development a priority in achieving food security and earn higher incomes from the sale of surplus farm products. Under this approach, smallholder farmers will be required to use agro-ecological approaches which are essential in achieving sustainable development in the context of climate change. Despite efforts to maintain the natural resource base, unsuitable agricultural practices are still the norm in the study area and food security is dependent on maize, potatoes, beans, onions and tomatoes. Climate change increases the likelihood of extreme and unpredictable weather, and so crop diseases that are new are likely to occur. Uses of chemical fertilizers are justified as climate smart because they can be used to increase yields and reduce deforestation by reducing the need for agricultural expansion.

2.11 Actions that develop agri-business to boost agricultural outputs to sale

Most agricultural development plans always focus on supply side intervention, such as improved seed and fertilizers. Many people pay too little attention to the demand side, the place where the increased production will ultimately end or go. The increase will probably produce more farm products which can be sold for the expected economic gains once the subsistence requirements have been met by the local communities and the households, The County and National governments can help facilitate the sale of the surplus farm products through the combination of the technical assistance, economic and political measures. The government can also establish a breadbasket in the region to supply more maize, beans, potatoes and tomatoes to the market. Funding the farmers can empower them to buy the correct seed and avail water where necessary to increase food production. The challenge is to ensure that quality standards and infrastructure, roads and power must be put in place to marketing a possibility. Reliable domestic sources of demand are particularly important in areas where poor transport connections or lack of comparative advantages constrain the ability to access the required market. Strict compliance mechanisms must be put in place. Improved seed, fertilizer and good weather can cause a surge in the production causing the farmers to be unable to sell the surplus.

2.12 Promote organic livestock farming to eradicate poverty and improve livelihoods.

Organic livestock farming refers to a system of production of livestock products that use biological and natural principles while observing animal welfare principles. Organic livestock farming follows strict certification measures to lock out unscrupulous farmers who may want to benefit from high prices charged for organic products. These measures are meant to ensure that bare minimum standards are met at every step of organic livestock production. The main products of organic livestock farming are eggs, milk and meat. Organic livestock farming requires that you apply organic on-farm inputs with very little off-farm inputs. Feeds to feed the animals must be cultivated organically using traditional tillage and application of organic farm manure. In other words, an organic farm must be a self contained system. In applying this system, animals are allowed freedom in their natural environment as much as possible to exhibit their natural behaviours. Supposedly products of organic livestock farming are of very high quality in order to fetch high returns. Organic livestock farming is only good with good management, good planning and health soils that produce organic feeds to produce excellent organic products, bio-security measures, minimal stress levels if any and a sustained immune system.

2.13 Control livestock diseases that kill livestock thereby negatively impacting livelihoods.

Disease management remains a pressing challenge among livestock keepers in the study area due to ignorance, animal movement and open grazing systems. Animal diseases and pests contribute significantly to low productivity and lead to low income for livestock keepers. In addition, disease outbreaks impact livestock trade and the prevalent livelihoods. It is for these reasons that diseases be identified as a critical area for livestock management. Good management of livestock will enhance productivity and commercialize the livestock sector, ensuring livestock keepers earn handsomely for their efforts. New organic livestock farming which is taking the whole world by storm is the most important thing to do to improve livelihoods. New livestock management should be done through co-operatives which will provide access to credit at zero interest. This credit can be used to open and scale up agro vets from which farmers can buy drugs to treat their animals thereby help to enhance animal health service delivery for their members. This will enable livestock farmers access animal health services and lessen drug shortages and grow health services. This will enhance monthly income from livestock sales in order to improve livelihoods. Financial support to the farmers will go a long way to enhance productivity, nutrition value addition and market access.

2.14 Adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS) for conservation of forest natural resources and improve livelihoods.

Sustainable development and sustainability of livelihoods impacted by climate change for smallholder farmers who live adjacent to Mt. Elgon forest can be attested to by the Plantation Establishment and Livelihood Improvement Scheme (PELIS). The whole idea of this scheme is to establish plantations, protect the forest natural resources and at the same time secure livelihoods and also sustain socio-economic development. For the very fact that smallholder farmers live adjacent to the forested ecosystem, this arrangement has indeed helped them to access food, water, fuel-wood, timber, pasture and earn some income. The PELIS scheme allows forest adjacent communities through Community Forest Associations (CFAs) the right to cultivate agricultural crops and establish forest plantations where land is scarce. Cultivation is normally to continue for 3 to 4 years until the canopy closes. The PELIS system is meant to improve economic gains of participating farmers while ensuring nurturing of planted trees, and at the same time achieve food security and effectively manage forest natural resources that include water, wood resources, and other managed systems to provide life support for society.

2.15 Vulnerability to climate change including extreme events at local scales is influenced by factors including land fragmentation, increased poverty levels and literacy levels.

Increasing exposure to climate shocks and stressors is only one dimension of increasing vulnerability to climate change in Kapsokwony Division. Adaptive capacity is a dynamic concept affected by a range of social, environmental, economic and political variables many of which are beyond the control of the households. The main asset base of adaptation is influenced by population growth, unplanned development leading to land fragmentation, poverty levels and low literacy levels. Recurrent climate shocks and poorly designed response mechanisms have undermined the community's ability to innovate and engage in flexible decision making. Traditional systems of adaptive management of resources and livelihoods have been overcome by external actors view development and policies that value the smallholder farmer way of life. All these factors play role in inhibiting adaptive capacity and increased vulnerability which must go beyond exposure and sensitivity to climate impacts to explore different dimensions of adaptive capacity. There is need to identify new adaptive options that reinforce and build upon existing adaptive capacity and mainstream ecosystem services to diversify economic activities.

2.16 Actions of communities to embrace Genetically Modified Organisms (GMOs) to enhance food security to improve and secure livelihoods.

GM farming is an aspect that can help improve food security in the study area. GMOs are animals or plants that are produced from organisms that have specific changes into their DNA. This allows for the production of specific changes of desired traits into the plant or animal e.g. increased resistance to drought or disease. Very often genetic modification leads to early maturation, increased yields, enhanced nutrient content and use of less convection fertilizers. Not enough food is being grown especially in the study area, and enough must be grown soon to feed the escalating population. The local farmers should be allowed to enjoy the best technology to be able to meet the challenges of feeding the people. GM farming will offer a worthy alternative for an increasing consumer group conscious about the plant and animal and their environment. It offers a premium on both quantity and quality. The ban of the GM foods in Kenya is not a scientific one but a political one. The GMO plants are safe to grow and consume. Productions of GM foods are the only guaranteed option to ensure food security. The production of GM foods has been perfected and refined over the last two decades in the developed world, and this technology has cautioned even developed countries against food insecurity. Other than giving higher yields, GM foods are less susceptible to the vagaries of climate change and global warming. The debate of GM foods in Kenya should be conducted in a manner of sobriety and rational manner and the mongering scare should be stopped immediately. GMO is the use of biotechnology to transfer desirable genes into a plant creating varieties that are meant to increase output per unit area. An acre of GMOs maize crop could produce 40 – 50 bags of the maize yield unlike the ordinary which would produce 20 – 30 bags only. The GM technology would enable farmers use three – four pesticide on the GM crop, and be able to move away from local farmers' use of 15 pesticides before the maturing of the crop. The GMOs research has shown that crops grown by this method grow very well in very harsh climatic conditions. The crops take a shorter time to ripen and are resistant to diseases. To embrace GMOs technology is the best resolve to improve livelihoods and sustainable development.

2.17 Actions to reduce climate change threats to human health in the study area.

Risks to human health in the study region will in the future increase due to climate change. Harmful health impacts of climate change are related to increasing heat stress, waterborne diseases, poor air quality, extreme weather events, and diseases transmitted by insects and rodents. Climate change poses unique challenges to human health. Realistically assessing the potential health effects of climate change must include consideration of the capacity to manage new and changing climate conditions. Whether or not increased health risks due to climate change are realized will depend largely on societal responses and underlying vulnerability. Climate change variability influences the prevalence of communicable diseases such as highland malaria, fever, bubonic plague, cholera and tuberculosis. High incidences of malaria are caused by the spread of vectors into the Mt. Elgon region which is warmer than ever before due to climate change. These diseases can deal a deadly blow to human survival and other biota in the region. Emerging evidence indicate that drastic weather patterns now pose a big threat to health, with the emergence of exotic infections. Climate change is known to fuel a rise in the infection of most waterborne diseases because increase in temperatures and humid conditions support the thriving of pathogens which cause these emerging diseases. Children, the elderly, and the poor, are most vulnerable to a range of climate-related health effects. Amoebic dysentery caused by *Entomoeba histolytica* protozoan is an example of a waterborne disease that is likely to attack area residents who drink contaminated water.

2.18 Embrace Carbon Credit Trading (CCT) reduce poverty and ecosystem degradation.

Carbon Credit Trading (CCT) is the business of exchanging one's reduction of emission of carbon (iv) oxide in the atmosphere particularly in a tree planting project for an income. A tree is eligible for credits between three to six months after planting. Firms with huge carbon dioxide emissions pay a fee for every tonne of the carbon dioxide they emit. This fee is then paid to firms involved in activities that help reduce carbon dioxide emissions. To earn from carbon credit trade, farmers must sign an agreement with a carbon trading company and have their trees evaluated. Specialists evaluate the amount of carbon trees can absorb before farmers with small parcels of land may not benefit from carbon trade unless they team up with others for a collective evaluation. Thus, climate change problem has come with many opportunities that County governments can tap into including the creation of jobs and poverty alleviations. To earn carbon credits, it is required that GHG experts identify the type of and sources of emissions then they package the emissions into carbon (iv) oxide equivalents which is calculated as carbon credits. Carbon trade is a new energy system that promotes clean energy. Carbon trading is still an alien idea or concept to most though for decades. Farmers in rural Kenya must be given incentives to contribute the reduction of GHG emission to help promote global climate change agenda. Trees remove high concentrations of carbon dioxide from the atmosphere which has been attributed to global warming and climate change. As of now TIST enters into a twenty year program with farmers within which trees under the program can be pruned for wood products e.g. timber and wood – fuel. However such trees cannot be felled. In Kenya, NEMA co-ordinates carbon trading activities under its owners watch. Land owners and farmers can therefore earn from planting of trees if carbon trading can gain a foothold in the study area. At the moment tree farmers earn only Shs. 1.50 per tree they plant per year. Ample rewards have been promised for those who are committed to cleaning the environment of high concentrations of carbon dioxide. However, new incentives must be brought forth to increase the numbers of people who can contribute to the reduction of the GHG emissions through carbon trading. Area residents should embrace carbon trade to escape poverty.

2.19 Control soil erosion by construction of terraces and grow tree plantations.

Soil is the topmost layer of the Earth's surface and the medium for plant growth. It is made up both abiotic and biotic components, i.e. air, water, organic materials, inorganic materials and living organisms. It is used either to raise livestock, grow food-crops, generation of materials to build homes, waste disposal, community recreational activities, construction of urban centres, building of roads and provision water for various community uses. A great threat to soil fertility is the removal of the top vegetation cover followed by soil erosion. Removal of the top vegetation cover accelerates the removal of the top soil by the process of erosion. Soil erosion results in the loss of soil fertility which in turn translates into low and poor farming yields. Here farmers cultivate on steep slopes where vegetation has ultimately been removed by fires or indiscriminate removal of vegetation exposing the soils to agents of erosion. Use of inappropriate farming methods that include overgrazing, monoculture and ploughing down the slopes have reduced the once fertile soils to poor unfertile soils in the study area. The people of this area however are not interested in the growing of cash-crops but have concentrated their energy in production of food-crops though they practice horti-cultural farming whose products are readily sold for immediate consumption. Among the crops that are grown here are maize, beans, irish potatoes, onions, carrots, wheat, tea, coffee, sunflower, and pigeon peas. Vegetation allows excessive rainfall to soak into the soil from where water is gradually released. This minimizes both downstream flooding and drought conditions.

2.20 Need to in-calculate a positive attitude towards correct agriculture to increase food security

There is a lot of negative attitude towards agriculture and livestock production by area residents that has consequently resulted in low food productivity. Food security can be improved by efficient and effective use of natural resources, practice of correct agriculture and by the growing of traditional food crops. This entails the fact that farmers be trained in issues like farm management, agricultural finance and trade, marketing and natural resource use and management. Further, this will help farmers make correct decisions concerning risks and uncertainty of agricultural production, reliance on natural resource management. Therefore, there is need to train more people to work in the sector and a supportive government which will come up with new adaptive policies to improve agricultural productivity. Area residents should view agriculture as a business and source of an income that can transform livelihoods. Many people in the study area might not be having the slightest idea about agricultural business management. They need to be made aware of the changing trends in agriculture and livestock production under a changing climate. These residents should develop an interest in agricultural and livestock development and at the same time have a sharp analytical mind to increase productivity. Farmers should be able to interact with internal and external worlds involved in agricultural production. They should also go out in the field to collect and analyze data. This will enable them come out with positions on whatever they want to achieve. They should understand things from different angles and simulate scenarios. They must expand their knowledge in agriculture and livestock management. Farmers should be encouraged to practice conservation agriculture, crop rotation, agro-forestry and crop livestock integration. They should grow locally

adapted plants and seeds; multiplication of crop varieties adapted which are disease resistant. They should practice low tillage, maintenance of permanent soil cover that can increase soil organic matter, and reduce impacts of flooding, erosion, heavy rain and winds. The farmers should also be encouraged to grow traditional nutritive foods that ripen faster to alleviate food shortages because of the weather variations. Silos to be put up to store farm produce and good marketing structures be initiated and improved road infrastructure be in place to transport farm products. Soils should be tested regularly to know the inputs to be made and at the same time be able to fight diseases. We propose that area residents in-calculate a positive attitude towards agriculture. .

2.21 Vulnerable social groups are at risk of being adversely affected by climate extremes.

Climate extreme events are ravaging the most vulnerable especially the poor households in the study area. These groups are those which are restricted access to and control over resources leaving them less able to cope with climate shocks and stresses. Particularly, vulnerable to the impacts of climate events are members of the female headed households, orphans, the disabled, people living with HIV/AIDS, internally displaced, the widows and widowers. While all these groups are at high risks of being adversely affected by climate extremes, more attention should be given to the women because of their household responsibilities and a greater dependence on weather sensitive livelihoods. Women manage smallholder household farms and provide for most of the labour for crop production, and they also spend long hours looking for fuel-wood and collecting water. Climate disasters in the region are likely to increase women's household responsibilities and cause disproportionate economic losses for households. The household responsibilities for women can also increase if the male partners leave households in search of economic fortunes elsewhere. Greater resource scarcity can also increase the likelihood of women and children being affected. Women are also at risk during the occurrence of malaria, typhoid and dysentery to which pregnant women and children are more vulnerable in the study region because of inadequate health care. Women vulnerability is exacerbated by the fact that they are restricted to access resources, and the fact that they lack full control of the land they farm or access to capital and agricultural credit. Therefore, in comparison to their male counterparts, they are less able to control agricultural measures that could reduce their vulnerability to climate events. They also have very little capacity to seek off-farm income generation opportunities. Whatsoever, women are good natural resource managers and this can increase their capacity to cope with various climate hazards. Climate change could compound the vulnerability of women, children and other marginalized groups in the study area. Further changes in weather conditions could very easily complicate matters for these groups resulting in destruction of infrastructure, increase levels of poverty, reduce crop yields, cause in childhood multi-nutrition, make water resources to become less available and also cause increase waterborne and convectional diseases. These changes may further limit marginalized groups' economic opportunities and potentially deepen their levels of poverty. New policies should be put in place to improve livelihoods for vulnerable groups.

2.22 Smallholder farmers need to choose, use, and capitalize on adaptation technologies to improve their livelihoods and wellbeing.

Smallholder farmers need to choose, use, and capitalize on adaptation technologies to improve their livelihoods and well being, while enabling them to respond effectively to continuous and unpredictable climate change. To achieve food security and economic development, systems of food production and trade systems must be made more accessible for smallholder farmer. Funds from Green Climate Fund (GCF) as per the Paris Climate Change Conference 2015 must be made available for the smallholder farmers so that they can achieve their food production targets. Not all of this money will be invested in agriculture, but some will go into other sectors of investment to secure and improve livelihoods. Most of the financing will likely be offered as loans, not grants, to enable replenishment of the Fund. Adaptive strategies devised by incorporating the scientific and the indigenous experiences are very important in the designing of adaptive policies that will help residents in the region to adapt to the vagaries of climate change. Knowledge of the indigenous community which is based on observations, perceptions and experiences over the years can effectively be blended with scientific knowledge to improve climate change mitigation and adaptation strategies. Other strategies that should be considered when designing adaptive technologies include cost efficiency, co-benefits, trade-offs and feasibility. Sometimes vulnerabilities of a community may result from differences in traditions, culture, socio-economy, lifestyles and gender differentiated responses. The technologies to be adapted must be beneficial under the current climate conditions and those that might be adaptive under the future climate conditions. Technologies are supposed to build resilience to climate shocks and support adaptation. Without adequate scientific knowledge of future conditions, technologies can be ineffective or even harmful. Adaptation strategies should use both top-down and bottom-up approaches leading to higher effective, efficient, equal, sustainable, flexible, legitimate, robust and replicable. They need to be shaped in the context of available projected climate and impacts for the area under the study consideration. The way forward is to evaluate scenario methods and compare their strengths, weakness, and infrastructure and capacity requirements. We recommend the implementation of good, dynamic and robust

adaptive technologies for poor in the community to recover from climate shocks, achieve sustain economic development and improve livelihoods.

2.23 Reforestation is a sure method of climate change mitigation through carbon sequestration.
Forests absorb billions of tons of CO_2 every year and they are good established carbon 'sinks'. Forests contribute to climate change protection through carbon sequestration as well as being able to offer economic environmental and social cultural benefits. Forests are a major store of carbon and when they are haphazardly removed or cut down or burnt, CO_2 is released into the atmosphere. Continued deforestation is currently thought to be responsible for an annual emission of 1:1 to 1:7 tonnes of carbon per year and approximately one-fifth of CO_2 human emissions. Removal of trees or forests also destroys soils or open ground to release the CO_2 that is held therein. When forests are removed by use of fires, CO_2 equivalent of 40% of the world average yearly releases carbon emissions from fossil fuels. The release of GHGs into the atmosphere consequently increases global temperatures. Presence of forests increases water retention capacity especially during drought periods, and reduces the chances of flashfloods and maintenance of vegetation as a carbon 'sink'. To better mitigate the rate and impacts of deforestation of forest communities, sustainable livelihood activities, good planning and decisive policy management should be emphasized to tackle deforestation as a pragmatic integration activity into the national legislative policies. Hence, communities should protect forest resources as a way forward to mitigate their own livelihoods.

2.24 Train the youth and the women in entrepreneurship to transform the quality of livelihoods and foster sustainable development.
Entrepreneurship is the development of a business enterprise from a concept or idea. It entails coming up with an idea and turning it into a profitable business. It is a risk undertaking that involves the exploration of an opportunity and risk management to create value for profit or social good. Further, entrepreneurship entails recognizing the right opportunity, finding resources for instance funding and tools to be able to pursue an opportunity and creating the correct environment to achieve the perceived target. Training in entrepreneurship will enable the participants attain an opportunity to become innovators and increase their creativity through the acquisition of technical skills and information. People who are trained in entrepreneurship will be able to formulate development strategies, long term policies and shared future visions for generations to come. The training will help women and the youth prosper in the face of climate change by helping them develop adaptive capacity, reduce risks to livelihoods, manage their land and water and livestock sustainably. This concept will help give priority to an investment to transform the quality of livelihoods of the people and foster sustainable development. It will give them a chance to have the ability to choose and use the technology that assist them in leading the kind of life they value without compromising the ability of others and that of the future generations to do the same. Entrepreneurship increases competition and create employment across the board. It requires harmonized, optimal resource utilization and good performance to achieve the end product. The community can set up a revolving fund from which they can access credit and loans to invest in agro-ecological approaches to realize food security and agri-business services.

2.25 Efficient and effective early warning system structures to be put in place
An Early Warning System (EWS) is a comprehensive monitoring framework for early detection and response to environmental threats. The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response (ISDR). It is more than just a prediction because it comprises a chain of four elements, starting from knowledge of the risks faced through to preparedness to act on early warnings. The use of available technology such as mobile phones and community radio is an effective means of disseminating climate information and seasonal forecasting among smallholder farmers communities in the study area. Efficient and effective early warning system endows the communities with wider range of information and enhances their ability to take decision during climate extremes. Disaster management officers can benefit much more than they do hitherto from local communication structures to facilitate preparedness and emergency assistance in case of occurrence of climate change vagaries. Failure in any one part can mean failure of the whole system. The components of an efficient and an effective early warning system include the following: a) **Risk knowledge:** prior knowledge of the risks faced by communities; b) **Warning service:** technical monitoring and prediction service for these risks; c) **Dissemination:** dissemination of understandable warnings to those at risk; and d) **Response capability:** Knowledge and preparedness to act by those threatened. Before a decision is made, risks arising from both the hazards and the vulnerabilities should well be known and the patterns and in the said factors should be readily available. At the same time, the correct parameters should be monitored so the correct decisions can be made. Timely warnings generated should be understood by the people and the warnings should contain relevant and useful information.

The ability of users to successfully extract relevant and accurate information from the climate information products is fundamental for the correct decision to be reached from the accurate information products. There is need for attitude change to establish ways of working of the communities and organizations/governments that serve them in collaboration and involvement of all stakeholders to build links between all actors. This local context can be improved by incorporating IK/local knowledge and modern technologies through participatory methodologies which should be used to involve communities in hazard mapping and vulnerability assessments. Their knowledge can be used in validating the derived maps or creating new accurate ones. Since this exercise happens at the beginning of projects, it can also be used as part of an effort of getting community buy-in to the early warning system. Their knowledge can be used in validating the derived maps or creating new accurate ones. Since this exercise happens at the beginning of projects, it can also be used as part of an effort of getting community buy-in to the early warning system by use of conventional and indigenous or local knowledge.

Incorporating government officers from different sectors, and other users we were able to deliver the message in practical, usable terms. Having identified the hazards prevalent within a region, and having also understood the needs of the community members, the warning service would concentrate in forecasting the potentialities of the hazards. The use of two sets of warning services namely: Conventional and indigenous/traditional/local methods. Conventional climate science identifies the hazards and the community vulnerabilities through the analysis of historical climatologically data patterns and trends of the hazards and vulnerabilities. The right parameters should be monitored based on a sound scientific basis for making forecasts in order to make accurate and timely warnings.

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You cannot be running if you are not on the right track. You can have the best dreams ever but you cannot achieve the best results in your life if you cannot allow them to happen. You can live your life on purpose but if your life is empty then you stand for nothing. To be an entrepreneur, you must believe in yourself and make the correct decisions at every step of your life. It is vital that you discover exactly who you really are, and you are the only one who can decide what you want and what you want to achieve. Do not allow yourself be held back by fear. The fear of success is the cause of our failures. You have to strive all along to achieve your ultimate goal. Put your impressive talent to test and do not waste time looking back. Start your journey now. I am very proud of my mother Helen Nabangala because she is the best mother in the world and I love her so very much. At her of 86 years she still encourages and appreciates my journey towards academic excellence despite the fact that she hardly stepped into a classroom. Mother, I hope and believe that I have made this indelible mark partially because of you and this will form part of my contributory legacy when I finally exit. You are indeed a wonderful and fabulous mother. I am so very happy, meticulously inspired, fulfilled and amazingly proud of you.

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