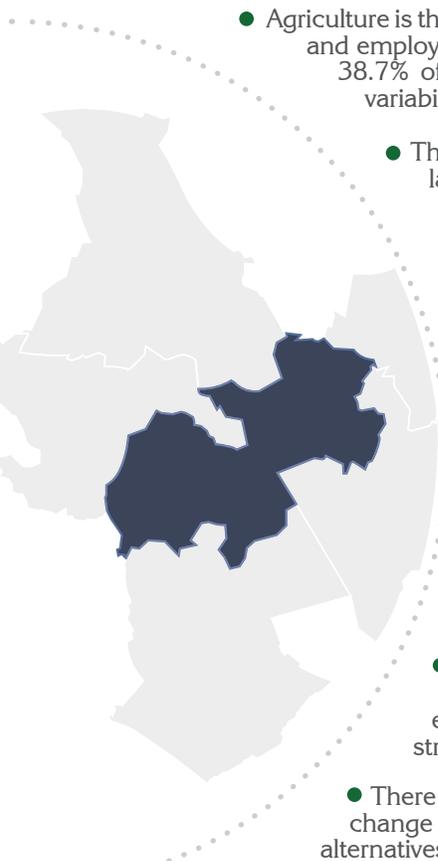


# Climate Risk Profile Kericho County

## Highlights

- 
- Agriculture is the main source of livelihood in Kericho County, contributes more than 80% of household incomes, and employs over 50% of the county's population. The county has an absolute poverty rate of 41.3% while 38.7% of the population lives below the food poverty line. Negative impacts of climate change and variability on agriculture further aggravate the food security.
  - The county has fertile soils and adequate rainfall but this has gradually changed especially in the last 3 decades due to climate change. There are prolonged dry spells characterized by high moisture stress that negatively affect crops like tea. Rainfall is now erratic throughout the year and this affects both the long and short planting seasons. Intense rainfall occurrence is also on the rise especially in the Second Season (July-December). Extreme precipitation over short periods has caused flash floods that have destroyed crops e.g. in Soin.
  - Adaptation strategies in crops and livestock include agro-forestry, conservation agriculture, planting drought resistant varieties and early maturing crops. water conservation strategies that include rainwater harvesting from rooftop catchments, water pans and dams, crossbreeding local breeds with drought resistant breeds such as Galla goats and Dorper rams, fodder conservation in form of silage and hay and use of maize stover/cobs as alternative livestock feed.
  - Poor coordination between different departments and institutions within the county has negatively influenced adaptation efforts. Contradicting programmes and policies and overlapping mandates between sectors and programs cripple adaptation efforts. There is a need to define clear-cut roles at the county level for key players and enhance coordination among stakeholders.
  - Research, conservation agriculture, early warning systems, insurance schemes and climate-focused extension services will go a long way in improving resilience and supporting adaptation efforts in the County. Strengthening of institutions capacity on climate change adaptation and streamlining institutions' mandates is important.
  - There is need for improvement in financial and human capacity related to implementation of climate change adaptation programmes in all relevant sectors to ensure that they provide sound solutions and alternatives to deal with climate change and variability.

## List of acronyms

ASDSP	Agricultural Sector Development Support Programme
AEZ	Agro-ecological Zone
ASAL	Arid and Semi-Arid Land
ASDSP	Agricultural Sector Development Support Programme
CBO	Community Based Organization
CIDP	County Integrated Development Plan
EMCA	Environment Management Coordination Act
ERA	Economic Review of Agriculture
ESP	Economic Stimulus Programme
GEF	Global Environmental Facility
GoK	Government of Kenya
IDA	International Development Agency (World Bank Group)
IPCC	Intergovernmental Panel on Climate Change
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research Organization
KAVES	Kenya Agricultural Value Chain Enterprises
KCSAP	Kenya Climate-Smart Agriculture Project
KDSDF	Kericho District Stakeholder Development Forum
KEFRI	Kenya Forestry Research Institute
KEWASCO	Kericho Water and Sanitation Company Ltd
KFS	Kenya Forest Service
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
KOCOPO	Kericho County Poultry Farmers Organization
KPHC	Kenya Population and Housing Census
KTDA	Kenya Tea Development Agency
KTGA	Kenya Tea Growers Association
LVEMP	Lake Victoria Environmental Management Project
MNLD	Maize Lethal Necrosis Disease
MoALF	Ministry of Agriculture, Livestock and Fisheries
NALEP	National Agriculture and Livestock Extension Programme
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NASA	National Aeronautics and Space Administration
NCD	Newcastle Disease
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
SCCF	Special Climate Change Fund
SIDA	Swedish International Development Cooperation Agency
TIMPs	Technologies, Innovations and Management Practices
TRI	Tea Research Institute
USAID	United States Agency for International Development
VCCs	Value Chain Commodities
WARMA	Water Resource Management Authority
WRUAs	Water Resource Users Associations



Kericho

# Foreword

Climate change is becoming one of the most serious challenges to Kenya's achievement of its development goals as described under Vision 2030. Kenya is already highly susceptible to climate-related hazards, and in many areas, extreme events and variability of weather are now the norm; rainfall is irregular and unpredictable; while droughts have become more frequent during the long rainy season and severe floods during the short rains. The arid and semi-arid areas are particularly hard hit by these climate hazards, thereby putting the lives and livelihoods of millions of households at risk. In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS), which recognized the importance of climate change impacts on the country's development. This was followed by the National Climate Change Action Plan (NCCAP) in 2012, which provided a means for implementation of the NCCRS, highlighting a number of agricultural adaptation priorities. The focus of these initiatives has been at the national level, and there is need to mainstream climate change into county level policies, programmes, and development plans; therefore ensuring locally relevant, integrated adaptation responses with active involvement of local stakeholders.

The Government of Kenya (GoK) through the Ministry of Agriculture, Livestock and Fisheries (MALF), with funding by the International Development Agency (IDA-World Bank Group) is therefore implementing the Kenya Climate-Smart Agriculture Project (KCSAP). This project's objective is to increase agricultural productivity and build resilience to climate change risks in targeted smallholder farming and pastoral communities in Kenya, and in the event of an eligible crisis or emergency, to provide immediate and effective response. This Climate Risk Profile has been conducted within the framework of KCSAP and aims to inform county governments and stakeholders on the climate change risks and opportunities for agriculture so they are able to integrate these perspectives into county development.

This document presents the Climate Risk Profile for Kericho County, which has a higher climate change vulnerability index (0.448) relative to some ASAL counties in the country but higher than the National average of 0.438<sup>1</sup>. Climate assessment reveals high

temperature variability<sup>2</sup> on one hand, and significant reduction of rain on the other, especially during the planting seasons, resulting to abnormally long dry spells. For instance, the droughts experienced in 2011 and 2012 resulted in a 25% reduction in tea (a major cash crop and source of livelihood in the county) production. Due to the low harvest, leaf processing was reduced to three days instead of six and 27,000 workers lost their jobs in the county<sup>3</sup>. In 2006, several tea factories in Kericho County stopped operating after a 75% drop in harvests due to ravaging drought<sup>4</sup>. This is further exacerbated by frequent hailstorms; Kericho County records the highest occurrence of hailstorms per year according to the Guinness World Records<sup>5</sup>. In 2013, smallholder tea farmers lost 12,890 kilograms of tea in a single day as a result of hailstorms<sup>6</sup>. The above being just a few of the many impacts of extreme weather events in the county. Considering the likelihood of increasing frequency of these events in future, strategic planning to improve the adaptive capacities of farmers will be paramount to ensure secure agricultural livelihoods.

The profile is organised into six sections, each reflecting an essential analytical step in understanding current and potential adaptation options in key local agricultural value chain commodities. The document first offers an overview of the county's main agricultural commodities key for food security and livelihoods as well as major challenges to agricultural sector development in the county. This is followed by identification of the main climatic hazards based on the analysis of historical climate data and climate projections including scientific assessment of climate indicators for dry spells, flooding and heat stress among other key climate hazards for agriculture. The document continues with an analysis of vulnerabilities and risks posed by the hazards on the respective value chains. Based on these vulnerabilities, current and potential on-farm adaptation options and off-farm services are discussed. The text also provides snapshots of the enabling policy, institutional and governance context for adoption of resilience-building strategies. Finally, pathways for strengthening institutional capacity to address climate risks are presented.

1 Source: GoK (2013b) [http://hdr.undp.org/sites/default/files/KNHD\\_report\\_2013.pdf](http://hdr.undp.org/sites/default/files/KNHD_report_2013.pdf)

2 Source: Okoth (2011)

3 Source: <http://www.theeastafrican.co.ke/business/Job-cuts-loom-in-Kenya-tea-firms-as-drought-prolongs/2560-3803370-r8viv5/index.html>

4 Source: The Standard (2006)

5 Source: Guinness World Records (2014)

6 Source: The Standard (2013)

# Agricultural context

## Economic relevance of farming

Kericho County covers a total area of 2,479 km<sup>2</sup>. It borders Nakuru County to the east and Bomet County to the south, Uasin Gishu County to the north, Baringo County to the northeast, Nyamira and Homa Bay Counties to the southwest, Kisumu County to the west and Nandi to the northwest. Kericho County has six sub-counties; Sigowet/Soin, Belgut, Ainamoi, Bureti, Kipkelion East and Kipkelion West. Kericho County is characterized by undulating topography where the lowest altitude is at 1800 m while the highest is at 3000 m above sea level (GoK, 2013b).

Agriculture is the main source of livelihood within the county and a major income earner through production and employment creation. The county is blessed with fertile soils and reliable rainfall with low annual evaporation rates which makes it conducive for agricultural activities. However, this is gradually changing owing to the emerging changes in the weather patterns. Rainfall and temperature within the county vary with altitude. Temperatures range between 10°C and 29°C with an average temperature of 17°C (GoK, 2013b). The major climate related challenges in Kericho include the emerging patterns of erratic rainfall and long spells of drought which have occasioned negative impacts on agriculture sector of the county.

Rainfall pattern in the county is unique in that: the central parts where tea is mainly grown receives the highest rainfall of about 2125 mm while the lower belts covering Kaplelartet, Soin and parts of Kipkelion West receive lower amounts of rainfall of about 1400 mm. For a long time, the two rainy seasons in the county had no clear distinction as both seasons enjoyed a lot of rain. The long rains fall between April and June while the short rains occur between October and December. January and February are usually the driest months in the county.

The county is divided into four agro-ecological zones (AEZ) which are sub-divided into minor agro-ecological and sub-zones:

- Upper Highland (UH): The zone is characterized by very long cropping seasons. It is sub-divided into Upper Highland 0 (UH0), Upper Highland 1 (UH1) and Upper Highland 2 (UH2). UH0 is forest zone, UH1 is suitable for sheep and dairy farming whereas UH2 is suitable for wheat and pyrethrum production.

- Lower Highland (LH): This zone is further divided into sub zones LH0, LH1, LH2 and LH3. LH0 is forest zone, LH1 is the tea and dairy zone with permanent cropping possibilities divided into two variable cropping seasons with first rains starting February and second rains around end of July. LH2 is a wheat, maize and pyrethrum zone with long cropping seasons. LH3 is the wheat, maize and barley zone.
- Upper Midland (UM): This zone can further be divided into four sub zones; UM1, UM2, UM3, UM4. 1-is for Coffee and Tea; 2-is for Coffee only; 3-is marginal Coffee zone; 4 is Maize-Sunflower zone.
- Lower Midland (LM): The zone is suitable for marginal sugarcane growing with medium- to long-term cropping seasons. First rains occur towards the end of February with second rains starting towards the end of August. This zone can be divided into two sub zones. The zone is also suitable for cotton growing.

Land resources are mainly used for crop and livestock production. According to the ASDSP Kericho, 2014, about 80% of the population (of which 78% were male-headed and 82% were female-headed households) drew their livelihoods from crop-related on-farm activities, while 58.5% (53% male-headed and 64% female-headed households) earned income from livestock activities. Agriculture within the county produces both cash and food crops. The main crops include tea, coffee, sugarcane, potatoes, maize, beans and horticulture (tomatoes, bananas, vegetables, pineapples) while the main livestock kept include dairy and beef cattle, sheep, goats and poultry. (GoK, 2014a)

The major source of income for the people of Kericho County is on-farm employment; which accounts for about 50% of total employment in the county. Employment by Multi-national Tea Companies such as James Finlay, Unilever and George Williamson is also a significant income source to Kericho inhabitants in form of wages earned by the high number of workers employed on contract basis. Agriculture related wage-earning labour force was estimated at 436,580 in 2012 and is projected to rise to 494,710 by 2017 (GoK, 2013b). This labour force comprises mainly of men because women are mostly involved in “un-paid” household chores and cultivation of subsistence crops for domestic consumption. Unemployment rate is high, standing at 47% in 2009 with indication that it is on the upward trend. This puts high pressure on the working population within the county.

Although not a well-established economic activity, fish farming is also practiced in Kericho County. It was introduced by the government in 2009 to create employment among the youth through the Economic Stimulus Programme (ESP). There are 1100 individual fish farmers owning 800 fish ponds occupying an area of 240,000 m<sup>2</sup> (GoK 2013b).

## People and livelihoods

Kericho County had a total population of 758,339 in 2009 as per the Kenya Population and Housing Census (KPHC) of 2009 (GoK, 2009a). With a 2.5% per annum growth rate, the 2012 population was projected to be 817,402 with a male to female ratio of 1:1. The population of the County was projected at 881,064 in 2015 and was to further increase to 926,237 by 2017 (KNBS, 2014). By 2012 the rate of urbanization was estimated to be less than 10% implying that more than 90% (735,662 persons) of the county's population resided in the rural areas (GoK, 2013a).

Kericho County is located in the former Rift Valley province of Kenya. Its capital town is Kericho which is also the largest urban settlement in the County. According to the GoK, (2013a), most parts of the county enjoy favourable climatic conditions with reliable rainfall. However, these have recently become unpredictable with longer dry spells and erratic rainfall. The average precipitation is still high and can support agriculture but the unpredictability has negative impacts on agriculture.

The main livelihood of the people of Kericho County is agriculture with an estimated more than 80% of the HHs depending on farming. About 78% of male-headed and 82% of female-headed households earned income from crop-related on-farm activities while 53% and 64% of these respective households earned income from livestock activities (GoK, 2014a). Another livelihood strategy in the county is employment by the county government, NGOs, banks and multinational companies among others. By 2012, a small percentage of male-headed (4.7%) and youth-headed households (7.1%) sought employment as a mitigation measure against declining on-farm livelihood opportunities (GoK, 2014a). In contrast, none of the female household heads (FHHs) sought for employment as an adaptation measure against the negative effects of climate change. Other livelihood strategies include income diversification through beekeeping especially in the lower drier zones of the county.

According to GoK (2013), the county has an absolute poverty rate of 41.3% compared with the national

average of 46%. Poverty among the urban population 42.3% is lower compared to poverty 57.7% in the rural areas (Weismann *et al.*, 2014). Consequently, the high poverty rates coupled with instances of landlessness within Kericho, puts part of the population at risk of starvation and malnutrition during periods of drought and flooding. Furthermore, only 6% of the population in the county have access to potable water while 6.1% have access to piped water (GoK, 2013a). Literacy rates are at 75% within the county. In 2012, only 11.8% of the county had access to electricity for lighting (Weismann *et al.*, 2014; GoK, 2013b).

The above characteristics also negatively affect nutrition of the most vulnerable groups within Kericho's population. According to the Kericho County Integrated Development Plan of 2013, the nutritional status of children under 5 is poor: prevalence of stunting in children is 30.9% while 6.7% are severely wasted.

## Agricultural activities

Most of the land (about 80%) within Kericho County is arable i.e. while the remaining 20% is non-arable (GoK, 2014a). The total land under crops is 79,200 ha consisting of 45,200 ha for food crops and 34,000 ha for cash crops. The county also has a total of 39,492 ha of gazetted forests and 5,983 ha of non-gazetted forests (GoK, 2013b). Both cash crop and subsistence farming are practiced. Food crops are usually cultivated on smallholder farms for both sale and consumption purposes. Cash crops, majorly tea and cut flowers occupy vast tracts of land and are mainly under the management of multinational companies.

The average land holding size in the county is 0.9 ha for small-scale farms and 14 ha for large-scale farms (GoK, 2014a). Large tracts of land are held mostly by multinationals corporations such as Unilever Kenya and Finlays who engage in tea and flower farming. Multinationals are mainly concentrated within Ainamoi, Belgut and Kipkelion East sub-counties. A higher percentage of the county's land is owned by individuals who use it mainly to produce cash and food crops and to rear livestock. The percentage of landholders with title deeds in the county is 76 (GoK, 2014a; GoK 2013b). Kipkelion East and West Sub-counties have the largest percentage of landholders without title deeds as these were formerly white settlement areas. There are also instances of landlessness; this mainly affects the Laibon and Nubian communities. According to the Agricultural Sector Development Support Programme (2014) of Kericho County, irrigation in Kericho County is almost non-existent, with

# Livelihoods and agriculture in Kericho

## Demographics

ND Of Kenya's population

817,402 inhabitants



## Access to basic needs

41% of the population lives in absolute poverty

Potable water 6%

Electricity for cooking 0.5%

Electricity for lighting 12%

Education (youth literacy rate) ND



## Food security

39% of the population suffers from food poverty

ND of household income spent on food

ND People undernourished  
31% Children stunted  
7% Children wasted

ND: No data

Infographic based on data from the County Integrated Development Plan (GoK, 2013), the Agricultural Sector Development Support Program (GoK, 2014), and Kenya National Bureau of Statistics (KNBS, 2015)

## Farming

County's farming area

198,300ha 80%

ND of the population employed in agriculture production

76% of farmers have title deeds ND are women

## Farming activities

Food crops



23%

Cash crops



17%

Livestock



ND Group ranches  
ND Company ranches

Of county's agricultural land

## Farming inputs

### Water uses



### Fertilizer types (% of households)



### Pesticide types (% of households)





and packing ready for the factories. The multinationals also provide employment to members of the population to carry out different activities at different stages of tea production. The main challenge facing the tea industry in the county is climate change and variability, in particular the prolonged dry spells that are causing tea bushes to dry up. Incidents of hailstorms/hailstones and frost which have become more frequent within the county also pose a serious threat to the tea industry.

A major concern in the tea industry at county level is that farmers are price takers. The price of tea set by tea processing factories for example Toror Tea Factory, has for a long time been fixed at KES 16.0 per kilogramme as the first payment for a long time. The second payment is a bonus paid at the end of the year and is determined by the volume of tea sold per year and the tea auction price. Other players in the tea industry are multinationals; Finlays, Unilever Kenya, Kuresoi, Kaisugu, Mau among others whose tea price per kilo fluctuates periodically but currently averages at 22 KES per kilo. The unfair prices coupled with changes in weather patterns have resulted in cases of tea being uprooted to pave way for rental housing and dairy farming that offer better economic prospects for some farmers. Factory retail shops, hawkers, Kenya Tea Packers' Association (KETEPA) and supermarkets play a major role in marketing and sale of tea.

### Chicken (local)

Local chicken production is also an important value chain in Kericho County and between 61-80% of the population is involved in the value chain. It is practiced by almost all households and is a major source of livelihood. In 2012, the value of local chicken in the county was estimated at KES 227 million (GoK, 2014a). In Kenegut, Ainamoi, Kipkelion and Kasurer areas, local chicken are kept under large-scale systems. In Bureti, Kabianga, Sosit and Kipchimchim, chicken are kept under mixed farming systems with maize crop. In parts of Kericho and Kapsoit local chicken are kept under mixed farming systems with dairy cattle. Local chicken meat is highly nutritious as it is high in protein; this makes it popular within households. Eggs obtained from the birds are also highly nutritious and are a bonus to farmers that keep local chicken for meat purposes.

Poultry farming is mainly controlled by women and youth. They are involved in all stages of the value chain from cleaning of poultry houses, feeding, egg selection and grading, to the sale of eggs and processing of chicken meat. Men are often involved in acquisition

of vaccines, cleaning and spraying of the poultry house, preparation of feeds and giving water but rarely engage beyond these activities. By 2014, local chicken population in the county was 507,138,000 (GoK, 2015). Local hens typically lay 21 eggs per cycle; there are 3 cycles of egg-laying per year. The eggs and chicken meat is consumed within households and also sold for income generation.

Flock sizes range between 5-30 local chicken mainly owned by women and children. However, there may be farmers with up to 500 chicken under low-input production system. Local chicken were initially kept under free-range systems where they were allowed to scavenge for food during daytime and housed at night. Emerging parasites, diseases and unfavourable weather has led poultry farmers to rethink free ranging of poultry. Emergence of facial parasites such as the red fleas in local chicken is perceived to be linked to climate change. Extreme weather conditions are prevalent in the county and is responsible for the high chick mortality rates witnessed during the wet seasons. Cold weather predisposes the birds to incidences of diseases such as Newcastle Disease (NCD) and pneumonia which are the major causes of sporadic reduction in poultry population. Therefore, the performance of poultry enterprises largely depends on quality and availability of inputs and good management. The key inputs at farm level include extension services, feeds, drugs, vaccines, and equipment.

Contrary to most crops, poultry and specifically local chicken do well during warm weather as egg laying and chances of chick survival are higher. Extreme heat on the other hand has been noted to cause sudden death in birds due to heat stress. Today, an un-identified disease has emerged in the county. It incubates within 3-5 days and is expressed in form of greenish-cream colouration in the droppings. The disease poses both qualitative and quantitative threats in the value chain and should be further researched on. The sale and marketing of local chicken is still on a local scale and this presents challenges in pricing and quality of produce. To deal with some of these issues Kericho County Poultry Farmers Organization (KECOPO) was established recently. Its effects are already felt as poultry activities are becoming more streamlined.

### Banana

Banana cultivation is emerging as a very important enterprise within Kericho County and is practiced for both subsistence and commercial purposes by 41-60% of the population. Bananas (*Musa spp. L*) are predominantly grown in the lower and warmer areas

of the county by small-scale farmers who have an average land holding of 0.3 ha. However, due to the ever increasing demand for bananas in the urban markets within the county, medium-scale farmers have started to engage in banana cultivation. In Cheplanget and Kiptere areas and some parts of Ainamoi, banana is grown under small-scale commercial basis. In Sasiat and Ainamoi, and some parts of Chelangat and Kiptere, banana is grown for subsistence purposes under small-scale mixed cropping systems. Banana is a very nutritious crop, rich in carbohydrates and minerals. It can be eaten fresh, cooked, fried and processed which makes it popular within households.

Women and youth are both involved in the banana value chain from on-farm production to harvesting and transport to collection centres. Initially, the youth had no interest in banana farming and very few registered as banana farmers through agricultural officers and/or cooperative societies. But owing to the sensitization of older farmers on the need to allocate land to the youthful, the number of younger banana farmers is increasing. The area under banana cultivation in Kericho was 423.40 ha in 2014 generating a total production of 8,740 tons with a value of KES 349.6 million (GoK, 2015).

The banana value chain is experiencing several challenges as a result of climate change. Moisture stress during prolonged dry spell has reduced banana production as farmers continue to rely solely on rain fed agriculture. Initially, banana-growing areas experienced dry spells only in the month of January. During the other months there was no clear distinction between long or short rains as the rains occurred more-or-less throughout the year. Banana pests such as beetles and thrips are now frequently attacking the canopy of the banana crop. During prolonged dry periods, sun scorching causes early death of bananas.

There are two cultivars of bananas namely dessert/ ripening and cooking types. The main varieties grown in Kericho County include; Grand Nain, William, Apple, dwarf Cavendish and Uganda green. Establishment of banana plantations is popularly being done using tissue cultured planting materials. Tissue culture plantlets technology, which is now available, has the following advantages to farmers; healthy planting material free of disease and pests, higher survival, early maturing and higher yields, and well-known fertilizer and manure application regimes. Banana fruits mature for harvesting within 90-150 days after fingers start to form. Under good management, bananas can be in production for up to 8 to 10 years with average yields of 30 to 45 Tons/Ha. Marketing of bananas is done either by congregating the produce in collection centres where selling prices are unified or directly in the local retail markets. Collection centres give farmers a strong voice in the negotiation of banana prices. In Ainamoi for example the marketing of banana is done through Ainamoi Banana Producers Cooperative Society.

## Local vegetables (African Nightshade and Spider plant)

The local vegetables value chain was reported to be very resilient to climate change and variability across Kericho County. The most popular local vegetables are African Nightshade (*Solanum nigrum* complex) and Spider plant (*Cleome gynandra*). These varieties of local vegetables are grown by a high number of households in the county. The vegetables can survive across a wide range of different climates and soil types. Between 61 and 80% of the population is actively engaged in the value chain. In most parts of the county, local vegetables are grown under small-scale subsistence mixed cropping systems. However, small-scale commercial production of the crop is unfolding across the county notably in the environs of major urban settlements like Chepkemel, Kiptere, Kabianga, Kapsurer, Kericho Kapsoit, Kapsoil, Kipsitet, Kapkiam, Chepsir, Tugunon, Kedowa, Kipkelion, Barchell, Bureti and Londiani.

Local vegetables rapidly grow during the onset of rains but still thrive in the dry spell. Their ability to survive harsh conditions has led farmers to cultivate the local vegetables not only for household consumption but also for commercial purposes. According to the Horticulture Report of 2014, the coverage of African Nightshade within the county between 2013 and 2014 averaged at 50 Ha while that of Spider plant averaged at 38.5 Ha in the same period. Their volume of production averaged 753 MT and 577 MT respectively in the same period. Value of production in the same period averaged 47 million KES for African Nightshade and 41.8 million KES for Spider plant (GoK, 2014b).

Both youth and women are fully involved in the value starting from on-farm production to harvesting, value-addition, transportation, and marketing. Generally, local vegetables require low inputs which makes them very attractive to smallholder farmers; they sometimes emerge in the fields without seed planting.

Most of the local vegetables produced are consumed within households or sold locally in the market. Their popularity arises from their nutritive and medicinal value as well as high demand from proximate towns and tea factories with high populations. Supermarkets are also stocking the vegetables, hence the rise in demand. Although farmers are facing challenges especially due to climate change and variability, they have started to engage in value adding activities such as prolonging the consumable period of vegetables. Some vegetables are being sun dried to preserve them or kept under shade and sprinkled with cold water to keep them fresh for longer. Some farmers have built stores in cool areas to preserve their produce. Kericho

County has a good road network and this offers farmers the opportunity to reach the market on time at low transport cost.

## Agricultural sector challenges

There are several factors that affect the agricultural sector in Kericho County. The major one being over-reliance on rain fed agriculture which has undermined the capacity of the county to realize the yield potential of most crops. Because of climate change and increases in climate variability within the county especially in the last two decades, rain fed agriculture is no longer viable to maintain high agricultural production. Irrigation on the other hand is very low and almost non-existent within the county. However, irrigation infrastructure is also expensive and requires proper planning.

Diversification is regarded as a viable and realistic option as an adaptation measure across the county. This is however disadvantaged by the farmers' inadequate access to agricultural extension and advisory services. Farmers reported that prior to devolvement of agriculture at the county level, extension workers used to reach them through field visits and demonstrations. Today, this has drastically gone down due to insufficient transport and financial support given to agricultural extension workers to capacitate them to effectively offer advisory services. As a result, there is little exchange of agricultural information between the technical experts and farmers. The critical agro-production aspects suffering from information deficiency include; appropriate fodder conservation techniques, poultry feed formulation, management of emerging pests and diseases, conservation agriculture technologies, value-addition techniques and many others.

Poor coordination among agricultural players within the county also emerged as a serious challenge. There is overlap of duties and lack of harmonization of activities. Policies are not integrated into developmental plans and in some cases are contradictory as there is no consultation during formulation. For instance, title deeds have been given to individuals to own wetlands and riparian areas despite the fact that this is prohibited by the National Environmental Management Authority (NEMA). This has encouraged the encroachment of the riparian belt and water catchment area. Major constructions have also been approved near marshlands. Such activities show serious disjointed coordination between the departments that are supposed to safeguard the environment. This also shows that policies that protect riparian areas are not respected or adhered to.

# Agricultural value chain commodities in Kericho



Provision of seeds and other inputs



On-Farm production



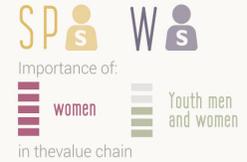
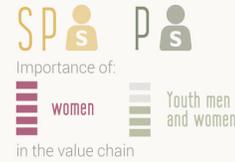
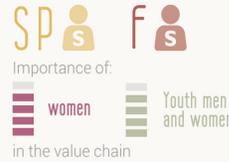
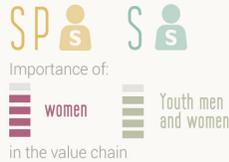
Harvesting storage and processing



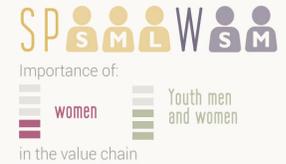
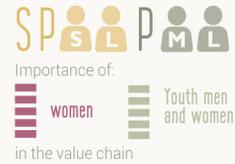
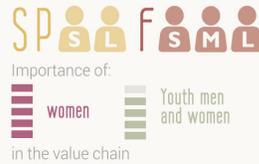
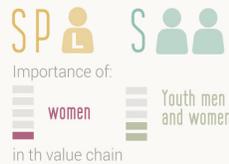
Product marketing

## Types of actors engaged in Value Chain

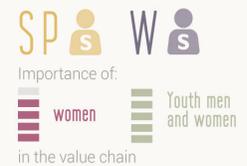
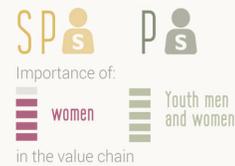
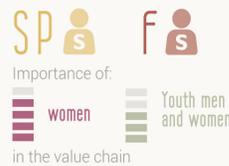
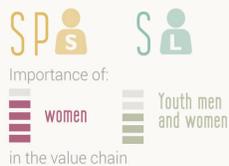
% of people engaged in the value chain  
**41-60%**  
 Banana



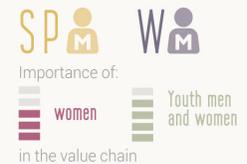
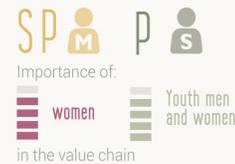
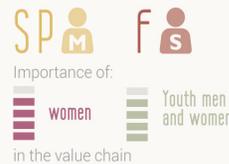
% of people engaged in the value chain  
**61-80%**  
 Tea



% of people engaged in the value chain  
**61-80%**  
 Vegetables  
 (local-sagaa, spider plant)



% of people engaged in the value chain  
**61-80%**  
 Chicken  
 (local)



### Conventions

Types of actors: SP Service providers S Suppliers F Farmers P Processors W Wholesalers/retailers

s small-scale m medium-scale l large-scale

ND: No data

Importance of women, youth men and women: 5 4 3 2 1  
 1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high; 0 = non-existent; N/D = no data.

## Climate change-related risks and vulnerabilities

### Climate change and variability: historic and future trends

Kericho County has a relatively cool climate with mean annual temperatures being predominantly below 21°C, with only a north western section having mean annual temperatures above 21°C. Rainfall in the county is high, with the eastern parts receiving annual average precipitation of between 1,000-1,250mm, the central parts receiving 1,250-1,750mm and a large pocket of area in the south of the county receiving over

1,750mm of rainfall per year. The cool temperatures and high rainfall make Kericho conducive for large scale tea production. Although rainfall is high in the county, there is still high vulnerability to droughts, dry spells and heat waves all of which pose a threat to the production of tea and other major agricultural commodities. The county also experiences severe hailstorms which often cause widespread damage to tea plantations, and this represents one of the greatest hazards in Kericho.

Analysis of temperature trends in the county over 25 years (1980 to 2005), shows that although second season temperatures have remained relatively constant, mean first season temperatures have risen by 0.7°C

during the measurement period. Despite the relatively large increase in mean temperatures, this has not been accompanied by an associated increase in the number of heat stress days. This may be due to an increase in rainfall, which over a 35-year period (1980-2015) showed that average seasonal rainfall had increased by over 50mm in both the first and second seasons. There has also been greater variability of rainfall about the mean in recent years and this has resulted in increases in both drought and flood risk. Despite some differences in the changes in temperature and rainfall patterns between the two seasons, temperatures in both seasons are on the rise and rainfall from year-to-year has become more variable.

Looking ahead to the period 2021-2065, climate projections based on two representative concentration pathways (RCPs<sup>10</sup>) indicate that under both scenarios there is expected to be a moderate increase in the flood risk<sup>11</sup> as well as an increase in the length of the dry period<sup>12</sup> from about 63 days to almost 80 days in both halves of the year. Under both scenarios, moisture stress in the first season is expected to increase, however under the high emissions scenario (RCP8.5), the changes are expected to be more pronounced and likely to affect both seasons.

Although hail is not modelled in the scenarios, increasing temperatures and increased intensity of rainfall may also result in increased occurrence and severity of hailstorms, thus presenting an added adaptation dimension to consider for the resilience of agricultural production in Kericho. Although the projections of future climate change under the two GHG emissions scenarios, both indicate a need to build resilience of agricultural production Kericho County to current and future weather variability and climate change.

## Climate Perceptions by the farmers

Farmers in Kericho County have for a while been experiencing climate variability which affect their agricultural activities. Initially, farmers used to plant at specific dates but with the changing weather, there is no certainty on when to start planting. Farmers attributed these changes to natural changes in weather patterns, deforestation especially of the Mau Forest and environmental pollution. Although the county's forest cover (22%) is above the national recommendation

forest cover of 10%, the increased deforestation rates within Mau and other forests is drastically reducing the forest cover within the county. Forest fires that are linked to increases in temperature and prolonged dry spells have also reduced forest coverage. Such occurrences have worsened water availability within the county and resulted in water shortages.

Farmers have been experiencing longer dry spell which have caused crop failure in some instances. This is an emerging phenomenon in Kericho County and it is worrying to farmers as they used to receiving reliable rainfall over the years. In earlier years, there was no clear distinction between the long rains and short rains as the county only experienced dry weather between January and February. Currently, farmers have to wait for the rains to plan when to plant unlike before. Also cases of flooding have increased in the lower zones of Kipkelion and Soin/Sigowet. There is delayed onset of rains and high incidence of torrential rains in short time spans. This causes massive soil erosion and destruction of crops. In extreme cases, incidences of mudslides and landslides have occurred destroying farmlands and other properties. In 2013 and 2014, flash floods were experienced in Soin area where crops were destroyed and washed away.

Farmers also attested to an overall increase in temperature in Kericho County. This has increased losses in perishable crops such as vegetables and fruits. Incidences of heat stress leading to death of livestock have been reported in Kipkelion. Furthermore, the prolonged dry spells have drastically reduced availability of pasture and some farmers had to import feed from the neighbouring Nakuru County. Pasture preservation is also threatened by the warmer weather.

The major rivers and streams that were initially permanent are now becoming seasonal. This is negatively affecting water availability within the county. Permanent water sources made it possible for water to be tapped directly and channelled into homes using pipes. This is no longer possible as water levels have dropped to the lowest levels ever experienced in the county. The rivers Tuiyobei, Sambula and Chebilat are now drying up exposing the river bed with cracked mud. There is no longer enough water for domestic and livestock use, forcing household members to travel longer distances to fetch the commodity.

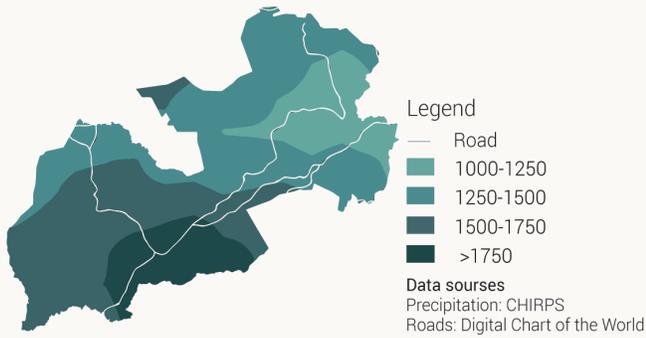
10 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m<sup>2</sup>, respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible depending on how much greenhouse gases are emitted in the years to come. RCP 2.6 assumes that global annual GHG emissions (measured in CO<sub>2</sub>-equivalents) peak between 2010 and 2020, with emissions declining substantially thereafter. In RCP 8.5, emissions continue to rise throughout the 21st century

11 Indicated by the maximum 5-day running precipitation average in mm/day

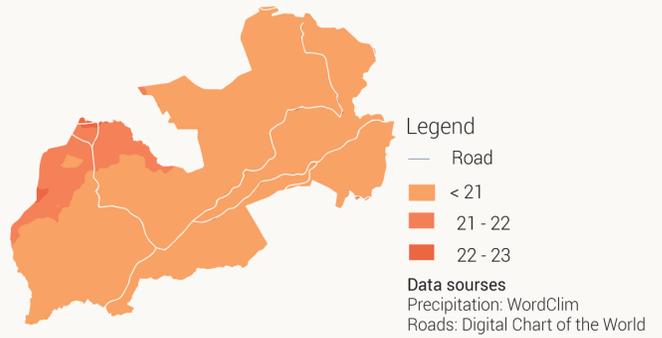
12 Indicated by the maximum number of consecutive days receiving less than 1mm/day of rainfall.

# Past and future impacts of climate hazards in Kericho

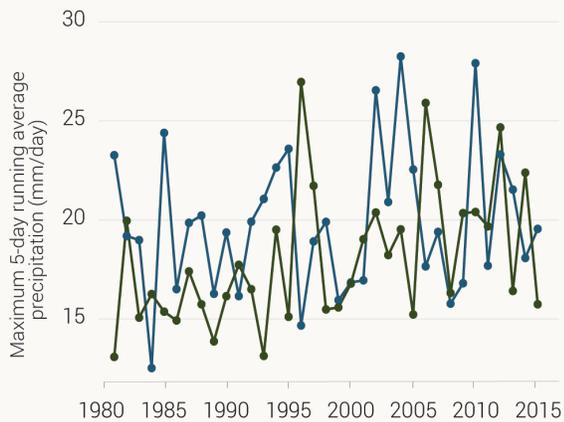
## Historical annual mean precipitation (mm/year)



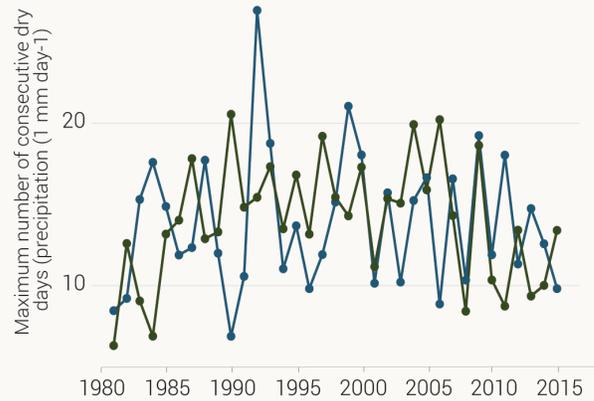
## Historical annual mean temperature (°C)



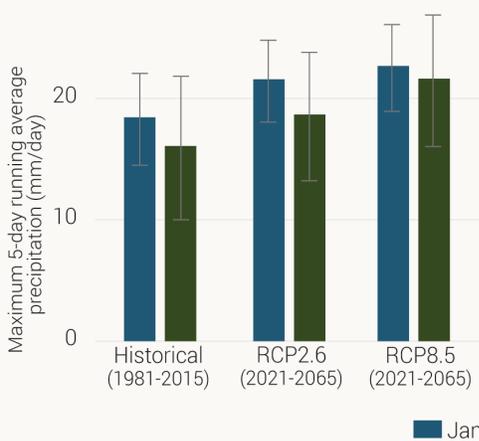
## Historical extreme flood events



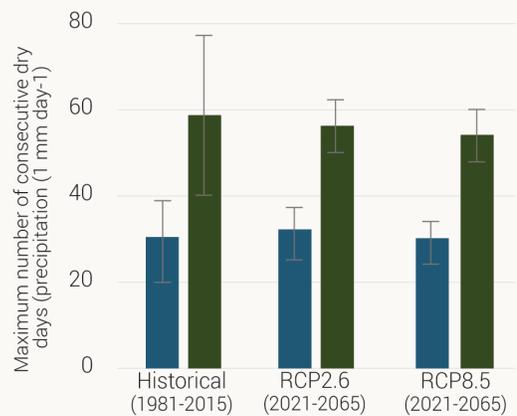
## Historical drought stress events



## Historical and expected extreme flood events



## Historical and expected drought stress events



The water shortages have resulted in changed roles within households, for example men now also go out to look for water especially for livestock or remain behind to feed children. The water shortage has also led to community conflicts as residents pump water for irrigation from rivers leaving none for domestic and livestock use. Recently, tension was reported amongst users of R. Chebilat. Data from the past 50 years analysed by the ASDSP in conjunction with the Meteorological Department of Kericho confirms that annual rainfall has decreased but seasonal rainfall has increased showing poor distribution of rainfall. Emerging pest and diseases include Maize Lethal Necrosis Disease (MLND) and Fall Army worm affecting maize and Tuta Absoluta affecting tomatoes.

### Climate vulnerabilities across agriculture value chain commodities

Present and future climate scenarios pose a great threat to the various value chains identified as important for Kericho County. The relevant climatic hazards identified included moisture stress, drought, extreme and/or intense rainfall, hailstorms/hailstones, floods, increased temperatures and uncertainty in seasons. Out of these, the hazards that pose the worst threat to the value chains were increased moisture stress, drought, extreme and/or intense rainfall and hailstorms.

#### Tea

The most relevant climatic hazards identified in the tea value chain included moisture stress and drought. The areas within the county identified to be more prone to drought include Kiptere, Ainamoi, Kapsoit, Kapkiam and Chepsir, while the areas identified to be more prone to moisture stress include Bureti, Kabianga, Sosit, Kapsoit, Kapsuser, Kericho and Kipchimchim. Tea is a crop that requires high and well distributed rainfall and a shift in this will have adverse effects on the value chain.

Drought and moisture stress negatively affect the supply of seedlings (clones) because of low production or total loss in extreme cases. In addition, the cost of maintenance at the nursery increases due to high evaporation rates. Drought and moisture stress also negatively affect yields as only limited amounts of fertilizer are being applied because fertilizer requires adequate moisture to dissolve and be absorbed by the crop. Farmers should be encouraged to embrace irrigation (although the infrastructure required puts resource poor farmers at a disadvantage). To minimize water loss, pruning is inevitable and requires additional labour. On the other hand, this causes demand for tea pickers to decline because of reduced foliage because

of low yields. The marketing and transport sector is also affected as low yields reduce marketing and transport needs. The layoff of workers at several stages of the value chain threatens many livelihoods given that between 60 and 80% of the population is involved in the value chain. Therefore, drought resistant varieties of tea must be promoted to reduce such impacts.

All actors across the value chain are affected by drought or moisture stress regardless of their gender or age. However, the extent of the effect depends on the farmers' coping mechanisms. Farmers are able to cope with moisture stress through rainwater harvesting from rooftops, water pans and dams. Male farmers who are in a better position to obtain information on how to deal with moisture stress will be able to cope better than women and youth who are traditionally more excluded from information sharing. This is why women- and youth-headed households are more likely to be affected by climatic hazards. Poor farmers are also more vulnerable because they don't have the financial resources to invest in irrigation or water tanks to store water and their houses mostly have grass roofs which make rooftop rainwater harvesting impossible.

#### Chicken (local)

The most problematic hazards identified within the local chicken value chain in Kericho County are drought and hailstorm and/or intense rainfall. Areas that are prone to drought include Kipsitet and Fort Ternan while areas prone to intense rainfall include Bureti, Kabianga, Sosit, Kapsoit, Kapsoil, Kericho, Kipchimchim, Ainamoi and Kapkiam. The extreme rainfall phenomenon is likely to reduce the availability and quality of poultry feeds produced on-farm because of the nutrient leaching occasioned by water logging and leaching of nutrients. Production cost of poultry normally increases during periods of extreme cold weather since low temperatures require heating and/or artificial lighting of poultry houses. Furthermore, extreme cold and wet weather affects the ability of chicken to withstand diseases which in turn leads to early chick mortality and a reduction in egg production. Subsequently, more frequent vaccination will be required. Collection, grading and selling of eggs would also be moderately affected because of lower sales. In addition, the delivery of extension services is hampered as roads become impassable.

Drought also affects the local chicken value chain especially the production of feeds because of water shortage. Stress caused by heat during drought periods results in early chick mortality. In addition, high temperatures may reduce the quality of vaccines.

Youth and women are most likely to be affected not only because they are the major players in the value chain but because they lack knowledge and financial resources to adapt to these extreme events. The less educated will also be affected as they do not possess the knowledge required to adapt to these climatic hazards. Efficient on-farm extension services will be required to address these problems.

## Banana

In the banana value chain, the main threats identified were drought and extreme rainfall/hailstorms. Areas that are prone to drought include Chepkemel, Kiptere, Kipsitet, Ainamoi and Kenegut. Areas at risk of extreme rainfall /hailstorms include Cheplanget, Kabianga, Kiptere, Sosiot, Kapsurer, Kericho, Kapsoil, Kapsoit, Ainamoi, Kipchimchim and Kenegut.

Drought poses serious threats to the banana value chain especially during sprouting of the suckers because of soil moisture deficit. Additional labour and expensive equipment is required to break through the surface soil and improve infiltration. This mainly affects poor farmers who lack the financial capacity to buy this equipment. Drought will lower production severely because of delayed planting, delayed acquisition of inputs such as suckers and fertilizer and delayed decomposition of organic manure which plays a key role in banana farming. Drought also negatively affects the quality of bananas as high temperatures lead to rapid ripening before the produce reaches the market. This also affects grading of bananas; bananas graded as unripe/green at the farm would be ripe on arrival at the market/collection centres.

Extreme rainfall/hailstorms is likely to severely affected banana farming especially during the production and hardening of planting materials as hailstorms damage plantlets in the uncovered nursery beds. Heavy rain also affects the quality of organic manure by eroding and leaching decomposed nutrients. There is a likelihood of severe water-logging and rotting of the banana suckers as well as disruption of farming activities during extreme rainfall events. Heavy precipitation also causes damage to fencing and storage facilities. Transportation is also hindered as intense rain renders most of the roads impassable. Furthermore, extreme rainfall and hailstones cause mechanical damage to bananas in the fields and during transport.

Women and youth are likely to suffer more from these climatic hazards because they lack the financial capacity and knowledge to deal with extreme events. Farmers in regions more prone to extreme events such as Ainamoi, Cheplanget and Kiptere wards are more

likely to suffer due to biophysical factors. Resource poor farmers who cannot afford inorganic fertilizer would also be affected as they mainly rely on manure and as such will not be able to provide adequate nutrients required in banana production.

## Local vegetables (African Nightshade and Spider plant)

The hazards that are more likely to affect this value chain are increased moisture stress and drought. The areas within the county that were identified to be at risk of moisture stress include Melaget, Kedowa, Chepsir, Kapkiam, Kipchimchim, Kericho, Kapsurer, Kapsiol, Kapsoit, Kipterer, Kabianga, Bureti and Litien. The areas identified to be more prone to drought include Kisiara, Chepkemel, Kenegut, Kipsitet, Fort Ternan, Tugunon, Kipkelion, Londiani and Barsiele.

Increased moisture stress and drought greatly affects all stages of the local vegetables value chain. In terms of input supply, the quality and quantity of seed will be greatly affected, and the quality of manure will be moderately affected due to inadequate moisture required for decomposition. In terms of production, there will be delays in land preparation due to hard pans on the fields. This leads to delayed planting and or no planting at all as removal of hard pans is a labour intensive and expensive activity. Incidence of crop wilting will also increase because of moisture stress. As such, reduction in quality and quantity of vegetables is likely to occur on a major scale. Reduced yields will have an impact on the demand for labour and thus on the livelihoods of farmers. Low supply of vegetables in the face of high demand will force prices to go up. Value addition and processing activities will be also affected because there will be less produce for processing. Cost of transportation to collection points would increase due to low volumes of produce.

Women and the youth will be most affected, as they are the major players in this value chain. Their source of income will be threatened as they produce the local vegetables and sell them locally. Poor farmers will also be affected because vegetables highly contribute to their livelihoods. The less educated and illiterate who cannot decipher information are also more prone to the effects of increased moisture stress and drought in the county.



## Adaptation to climate change and variability

Climate has been known to change over decades. But because these changes were small and occurred over several decades, farmers were able to cope. However, in the last 2 to 3 decades, especially in Kericho County there has been remarkable change in climate. This is evident from the several events that have occurred throughout the county particularly the rainfall patterns in terms of intensity, amount and distribution). A good example is that planting seasons usually coincided with the onset of the long rains. However, this period has recently been experiencing dry spells leading to delay in planting. In addition, the harvesting period used to be dry and on-farm storage facilities were dry and clean. This is no longer the case. The harvesting season is continuously coinciding with wet weather conditions. This has resulted in serious destruction of crops. For example, in Kipkelion sub-county maize has been affected especially with rotting and Aflatoxin contamination. In addition, forest fires also occur during the dry season especially within forests like Londiani forest.

Most parts of the county experience above average rainfall. For example, rainfall in June 2013 surpassed the average annual rainfall for the county (County Director of Agriculture Rainfall Report, 2014). Such occurrences have had consequences throughout the county. Roads have been destroyed in most parts of the county, several small gullies and landslides developed on roads leading to disruption of movement of people and agricultural produce. Several landslides have occurred displacing families and disrupting livelihood activities such as what has been witnessed in the Sub-counties of Kipkelion West and Kipkelion East over the past five years. Leaching of soils also affects crop output which has fallen far below annual averages. In addition, excessive soil moisture levels and water logging have also lowered crop performance. Furthermore, crop and livestock pests and diseases are on the rise.

Although there are several institutional, financial and social challenges that affect adaptation to climate change and variability within the county, farmers have been able to include several on-farm and off-farm activities in order to adapt.

### On-farm adaptation practices

Dependence on rain-fed agriculture makes farmers of Kericho County vulnerable to climate change and variability especially because irrigation is almost non-existent. Only 2% of the water in the county is used

for irrigation and less than 2.5 % of the population irrigate some part of their land (GoK 2014; GoK, 2013a). Despite the increased need for irrigated agriculture, there are indications that water resources in the county is declining. For example, Kericho Water and Sanitation Company (KEWASCO) reports that its water supply has fallen by 50% over the past few years. This has forced the company to introduce water rationing as a mitigation measure, an eventuality which has not been experienced in the past. Some of the mitigation measures adopted by the county to bridge the water deficits during periods of prolonged drought involve roof water harvesting, water-pans and water-dams. Long term measures such as restoration of the previously destroyed wetlands and the uprooting of inefficient water consuming tree species like the eucalyptus trees have also been instituted. Consequently, catchment areas that were encroached are being reclaimed through planting of indigenous tree species.

Farmers have embraced improved seed varieties such as seeds that mature early and are able to withstand harsh climatic conditions. These improved seeds are more resistant to pests and diseases compared to recycled varieties. In Kericho County, over 90% of the farmers use improved maize varieties, more than 25% use improved bean varieties, over 65% use improved kale varieties, and more than 40% use improved Irish potato varieties according to a 2013 Household Baseline Survey in the county (GoK, 2014a).

The drilling of boreholes is on the rise as rainwater is no longer adequate for both domestic and on-farm production. For example, more permits are being requested from Water Resource Management Authority (WARMA) - Kericho as compared to previous years. Watering points and water vendors are also on the rise in Kericho County in the effort to cope with water shortages. Women nowadays spend less time on farm as they have to cover long distances in search of water for domestic use. In extreme situations, the men have also been found to search for water for their livestock and even taken up household chores like feeding the children while women fetch water. The county is also investing in huge water tanks to act as water points during the dry seasons. These will be placed in strategic areas, e.g. schools and institutions.

Flooding is not a new phenomenon in Kericho but was manageable and occurred in the low lying areas of Sigowet/Soin sub-County where river banks burst during high rainfall seasons. Farmers are warned especially by WARMA through flood monitoring and advised to move away from low areas. No agricultural or settlement activity is allowed near rivers that are prone

to flooding. More flooding is experienced because of increased precipitation which now occurs within shorter time spans. To deal with this, the government, through the county, is developing retention dams to store water as a long-term adaptation measure. Dams like Londiani and Koru dams which are national dams are strategically located to control flooding in the county. Dams not only control flooding but also double up as sources of water for irrigation and household consumption during dry spells.

There are various challenges that are affecting the tea crop due to climate change and variability. For instance, phenomenon such as frost, sun scorching and drying of tea, and hailstones/hailstorms have become more frequent and severe. To mitigate some of these calamities, farmers have planted trees such as *Grevillea* spp. around their tea farms. These trees provide a windbreak and reduce the harsh impacts of hailstorms and hailstones on the leaves of tea. Tree planting is also encouraged and practiced in areas prone to frost on farm. In the county 39.8 % of the farmer households have adopted tree planting where 42.6% of these are male-headed households, 27.3% are female-headed households and 33.3% are youth-headed households (GoK, 2014a).

Mulching and pruning of young tea bushes to deal with sun scorching and excessive water loss and to prevent drying up of tea is also on the rise. Pruning is an example of a good tea management practice. During drought periods it is done at tea tipping stage (i.e. when still green) and this drastically reduces heat impact and water loss through evapotranspiration. Furthermore, the pruned material is also used as organic mulch. Farmers also place plucked tea leaves under the shade in hot areas to prevent withering due to high temperatures. This is also common in the banana and local vegetables value chains as hot weather tends to dry up the crops before reaching the market. Spot/drip irrigation is also gaining ground especially during water stress periods. According to the ASDSP survey in 2013, only 19.4% of the households practice soil and water conservation in Kericho County.

Farmers are encouraged to diversify and grow favourable crops that are drought tolerant and pest and disease resistant. According to the ASDSP, 31.8% of the households have adapted crop diversification (GoK, 2014a). Purple tea is a good example and is promoted by KALRO-TRI as drought resistance as well as pest and disease tolerant. Furthermore, it has medicinal properties that prevent and control lifestyle ailments such high/low blood pressure and different types of cancers. Frost detection by TRI as an adaptation measure is also being done in the county

and is sponsored by SERVIR in South Africa. SERVIR is a joint development initiative funded by National Aeronautics and Space Administration (NASA) and United States Agency for International Development (USAID); both of the US.

Although not widespread, adoption of conservation agriculture (CA) is on the rise notably through the practice of minimum tillage to conserve moisture and nutrients within the soil. It is still challenged by the fact that there is no training at grass root level and that the older farming population which forms the majority of landowners in the county does not like change and is reluctant to adopt new interventions.

Livestock in Kericho County is also facing challenges as a result of climate change and vulnerability. This is further aggravated by the fact that land parcels are often too small to include fodder (trees and bushes) including Napier grass in the farming systems. In the highlands, priority is given to tea as it is a high value crop while in the lowland crops like sugarcane are preferred to pasture. Frost as a result of climate change has also been noted to smother grass. Fodder conservation is now gaining ground across the whole county in the form of hay, silage and Boma Rhodes. In 2013, only 7% of households conserved feeds with no female-headed household practicing the adaptation measure (GoK, 2014a). Maize stover and cobs are also used as livestock feed, 100% of all the fodder maize in Kericho is planted using improved varieties (GoK, 2014a). In Kipkelion for example, a motorized machine is used to chop maize stover/cobs into sizes that livestock can feed on. The chopping also makes it easier for storage and conservation.

Change of livestock is also an arising adaptation measure as 17.9% (GoK, 2014a) of the household in the county practice this. The county government has plans to acquire the Galla Buck breed for goats and Dorper Rum for sheep which are drought resistant especially in the lowlands. These breeds also have a fast growth rate and are resilient to climate variability. Another form of diversification that is on the rise is beekeeping which is practiced for commercial purposes in the drier regions of the county. Drought resistant crops (sorghum and millet) are also encouraged as an adaptation measure and are continuously being grown in different parts of Ainamoi and Soin/Sigowet Sub-counties.

Apart from building up-to-standard poultry houses, farmers usually use warm blankets and 'jikos' to warm up poultry houses during extremely cold weather. Egg-laying and hatching is higher during warm weather and farmers are taking advantage of this period to

maximize production and sales. Farmers are now letting out chicken late in the morning to avoid dew and extreme wet conditions.

Most local vegetable production in Kericho County is rain fed. In the dry season, people adopt risk-avoidance strategies. This includes production along riverbanks and supplementary watering. Management practices are basically traditional where seeds are sown without applying precise spacing. Weeding is often done alongside the main crop. As for soil fertility improvement, most farms have vegetable plots in areas with high nutrient concentrations, such as kitchen waste dumping sites, and former cattle sheds.

Value addition is also present at the post-harvest stage where farmers add value to prolong the shelf life of a product or process produce to fetch a better price in the market. Milk can be added value to become cheese, ghee, milk powder or yoghurt while bananas can be converted to crisps or flour. Farmers also dry local vegetables under the sun to conserve them. In the county, only 8.5% of the households practice some form of value addition (GoK, 2014a), but this is expected to rise through sensitization by the County government.

Uptake of insurance is also present in Kericho County, but on a very low scale. Insurance facilities cushion farmers during climate change related calamities that can cause death to livestock and/or total crop failure. Moreover, less than 1% of the County's population insures their agricultural activities (GoK, 2014a), and all these are male-headed households.

## Off-farm adaptation practices

Several services are offered to farmers by various organizations within Kericho County in the effort to mitigate and/or adapt to climate change and variability. For example, research and development is being undertaken in various organizations to come up with various crop and livestock varieties that can withstand harsh weather conditions. Tea Research Institute (TRI), Kenya Forestry Research Institute (KEFRI), Kabianga University, Egerton University and Maseno University are some of the organizations active in research on climate change and variability. TRI activities include development of suitable tea clones while KEFRI researches on trees species suitable for different regions in the county.

Extension services are also offered especially by County Department of Agriculture, Livestock and Fisheries (DALF) staff in conjunction with the Kenya Meteorological Department (KMD). They reach

farmers to provide agricultural and climate advisories and also perform demonstrations for farmers on new technologies. Although agricultural services function was devolved to the county government and has affected the smooth running of extension services in the county, the impact of the services cannot be overlooked. The number of extension workers does not match the farmer's demand hence affecting efficiency.

Agricultural climate information is also provided through early warning systems. For example, the meteorological department sends out sub-county specific climate-based advisories to farmers in the form of quarterly bulletins and this helps farmers with preparations of farm activities. Information includes dates of onset of rains or changes expected during cropping seasons. Farmers are advised to move from areas prone to flooding to reduce calamities. Farmers are also advised not to cultivate or settle near areas prone to mudslides and landslides especially in some areas of Soin/Sigowet and Kipkelion. Frost monitoring and forecasting is also present within the county. This is possible through collaboration between the Regional Centre for Mapping, Finlays, TRI, Unilever and Sotik Tea. However, more effort should be put towards addressing issues of illiteracy so that all farmers are able to decipher this information.

Climate/weather information is also disseminated to farmers through the media (television and radio) in the local language. Farmers also receive advisories in form of short messages through their phones (SMS) to make them more prepared for different situations. However, farmers who do not own mobile phones or whose contacts are not in the DALF database are disadvantaged. There are also forums for climate information sharing through WhatsApp, and advisories on resilience through the same by the Department of Agriculture in conjunction with ASDSP.

The government through Kenya Forestry Service (KFS) promotes activities that are geared towards mitigation of climate change through short sensitization meetings and 'barazas'. They also provide seedlings to farmers with the help of multinationals like Unilever, Finlays, KTDA and Toror Tea factory who provide the inputs and facilitate tree-planting activities. Farmer Field days (FFD) also have a positive impact as they educate farmers on appropriate farm activities.



# Adapting agriculture to changes and variabilities in climate: strategies across major value chain commodities

## Vegetables (local)



	Provision of seeds and other inputs	On-farm production	Harvesting storage and processing	Product marketing
<p><b>Moisture stress</b></p>	<p>Low supply of seeds/planting materials; low quality manure causing scorching effect on crops; reduced farm activities hence low demand for labour</p>	<p>Increased cost of and time for land preparation due to hardpans; fuel and energy; delayed planting; poor germination; wilting; disturbance of root hairs and exposure of roots</p>	<p>Higher loses of seeds; wilting for vegetables; withering and scorching; reduced quantity and quality ;low volume/lack of enough biomass for processing</p>	<p>Supply is very low and demand is very high; increase in pricing</p>
<p><b>Magnitude of impact</b></p>	Moderate	Major	Major	Major
<p><b>Farmers' current strategies to cope with the risks</b></p>	<p>Collection, processing and preservation of own seeds; rain water harvesting e.g. roof, run-off water through tanks, water pans and dams; bridging the seasons activities by use of conservation practices such as irrigation, mulching, greenhouse farming</p>	<p>Conservation agriculture especially zero-tillage, minimum tillage; adopt good agriculture practices e.g. plough at a right depth addition of manure, mulching; rain water harvesting, construction of dams for irrigation; use of greenhouses</p>	<p>Harvesting at the right maturity period; harvesting in the early morning or late evening; proper post-harvest handling e.g. wrapping with banana leaves, spreading evenly for proper aeration; improved technology; use of refrigerated vans</p>	<p>Farmers sell the vegetables at farm gate to reduce transportation/marketing costs.</p>
<p><b>Other potential options to increase farmers' adaptive capacity</b></p>	<p>Commercialize collection of seeds; proper storage, processing of seeds; commercialize manure production; plant two successive crops to ensure throughout supply of seeds; increase the efficiency of irrigation systems</p>	<p>Promote conservation agriculture practices such as minimum tillage; use of greenhouses; introduce new/high resistance varieties; construction of water dams, pans, earth dams; ZAI pits to enhance water harvesting and use of irrigation</p>	<p>Train farmers on low cost post-harvest technologies such as solar driers, insulated containers; cold rooms/facilities; use of refrigerated vans; proper packaging equipment</p>	<p>Information dissemination through SMS and other media to source for local markets; maximize profit gains through processing and value addition</p>
<p><b>Droughts</b></p>	<p>Low production in quantity and quality of seeds; crops will dry up and poor seed development; poor quality manure; low demand for labour</p>	<p>Hardening of the ground surface; delayed land preparation and planting; no weeding; disturbs the roots</p>	<p>Reduced quantity and quality ; product loss due to insect pests damage/high perishability</p>	<p>No/low supply/high demand; increased prices; reduced volume for processing</p>
<p><b>Magnitude of impact</b></p>	Major	Major	Major	Major
<p><b>Farmers' current strategies to cope with the risks</b></p>	<p>Purchase from agro-dealers especially seeds; agroforestry farming practices; rain water harvesting; use of manure, agroforestry, conservation agriculture and irrigation which increases demand for labour</p>	<p>Conservation agriculture e.g. minimum tillage; adoption of good agriculture practices e.g. use of farmyard manure; irrigation; adjust planting dates</p>	<p>Adoption of technologies and best agricultural practices to improve quality; proper handling and loose packaging through even spreading to reduce postharvest losses; harvest only on demand</p>	<p>Farm gate sales. Use of middlemen to link the produce to the market</p>
<p><b>Other potential options to increase farmers' adaptive capacity</b></p>	<p>Put effort to produce seeds e.g. through irrigation; reforestation, afforestation and or agroforestry farming practices; enhanced water harvesting technologies; conservation agriculture; irrigation; mulching</p>	<p>Soil and water management through minimum tillage, mulching and use of organic manure, crop irrigation, water harvesting using water pans ; diversification through crop mixing to include pumpkin, cowpeas and other drought-tolerant vegetables</p>	<p>Adoption of best postharvest practices; increase aggregation centres for easier transportation in bulk; Increase shelf life by using refrigerated trucks for transportation to the markets</p>	<p>Capacity building of vegetable marketing cooperatives. Contract growing of vegetables</p>



# Tea



## Moisture stress

Increase in cost of maintenance of tea clone nurseries; slow growth of clone in nurseries; sparing application of fertilizer; low supply of fertilizers; moderate use of labour

Increased cutting of tender leaves; minimal weeding; low moderate harvest/green leaf production; Reduced shooting of new buds

Low yields; reduced plucking regime; moderate tea production from fields and factories; moderate transportation activities

Reduced sales; moderate volume of processed tea for auction; moderate cost of production; moderate production of tea

### Magnitude of impact

Moderate

Moderate

Moderate

Moderate

### Farmers' current strategies to cope with the risks

Water harvesting e.g. shallow wells, roof harvesting; establishing shade trees in nurseries; erosion control to minimize loss of inherent fertility; applying equity principle in labour supply; labour transfer to other operations (excess labour); establish drought resistant tea clones

Use of tea pruning to suppress emergence of weeds; use of early warning information to do minimal pruning before moisture stress occurs; skiving-cutting of tender leaves to reduce moisture loss before on set of moisture stress; use of in-field soil and water conservation measures

Good agronomic practices to enhance yield; pooled transportation to minimize costs; Establishment of new satellite tea processing plants to process excess tea during 'glut' and sell/market during period of low supplies

Diversification into transporting other products e.g. wood fuel used in tea processing

### Other potential options to increase farmers' adaptive capacity

Establish water harvesting tanks for nurseries; use of drought tolerant clones; carryout research for integrating supplementary irrigation; use of high-yielding clones; product diversification to keep hold of labour

Improve early warning systems and climate information for farmers; promotion of establishment of drought tolerant clones; use of herbicides for controlled weeding; enhance tea extension services; promote efficient irrigation technologies

Capacity building on post-harvest technologies for tea farmers; financial and technical support to processors; structuring transport system with integration of semi-tea industry transporters into tea transportation

Value addition for tea to maximize on low supply of green leaf tea; Promote new tea marketing channels (e-marketing)



## Droughts

High cost of nursery maintenance; loss of seedlings (clones); fertilisers are never applied on tea crops during drought; mass layoffs; reduced need of labour

Minimize water loss through evapotranspiration (reducing number of foliage); increased pruning; no weeding

Reduced collection of green leaf; reduced plucking and delivery to factories; factories run under capacity

Price fluctuations; low volumes available for auction; high prices; minimal transportation of processed tea and green leaf

### Magnitude of impact

Major

Major

Major

Moderate

### Farmers' current strategies to cope with the risks

Shallow wells for water; planting of shade trees to minimize moisture losses; application of the pruning on the soil surface to provide fertility; erosion control to minimize nutrient losses; regulating the output per worker to ensure that all workers get some work (tea picking) and avoid layoffs; re-deployment of labor to avoid lay-offs

Use of early warning information to ensure that pruning is done before on-set of drought, this enables the extent of pruning to be reduced; mulching using pruning to suppress any emerging weeds; gap to increase capacity of the crop to resist effect of drought; planting of drought tolerant clone e.g. purple tea

General good agronomic practices to enhance resilience to drought; 'processing planning' (closing some factories to allow few to process tea at full capacity); value addition e.g. green tea, granules; pooled transport for tea delivery

Increase processing capacity by establishing new factories to absorb excess tea leaves during rainy season (and store to release during period of shortage); diversification into transporting other tea-related products e.g. wood fuel

### Other potential options to increase farmers' adaptive capacity

Establish large commercial seedling nurseries in designated areas equipped with water supply systems e.g. water dams; conduct research into possibility of irrigating tea as an adaptation to drought risk; insuring labor against the risk of lay-off during drought conditions; develop policy framework for labour stability during lay-off periods; product diversification to keep labour

Improve drought early warning; use of herbicides to control weeds and hand weeding during drought period; enhancement of good agricultural practices to increase yield; use of irrigation to address shortage of improved tea leaf production; farmer linkages in order to improve research and selection of drought tolerant clones

Enhancement of good postharvest practices; promote establishment of drought tolerant tea clones; close some factories to allow those running to operate optimally hence sustaining cost of production; outsourcing transport services to reduce cost

Increase capacity of processing factories to cope with glut production, this will ensure tea for auction is available even during drought season; formalize marketing networks so as to increase viability of linkages

# Chicken (local)

Provision of seeds and other inputs



On-Farm production



Harvesting storage and processing



Product marketing




Extreme rainfall

Reduced availability of feeds; low temperatures will need extra heating/warming leading to extra cost of electricity and equipment; reduced delivery of extension services

Increased cost of production; more feed required to keep the birds warm; increased energy consumption; more vaccination visits

Reduced income; low supply of grade eggs; poor quality of meat

Delayed deliveries due to poor rural roads; poor market accessibility disruption of market processes; high price of poultry products

Magnitude of impact

Major

Moderate

Minor

Moderate

Farmers' current strategies to cope with the risks

Use of feed supplements; improvising using locally available housing materials; farmer to farmer information sharing

On farm feed formulation; improvised brooders (jua kali technology); bulk purchase of vaccines to reduce cost; Raise chicken houses to avoid destruction by water run off

Farmers opt to sell the chickens live to reduce processing costs; Sale is done only on demand

Linkage through social media platform (e.g. Kericho poultry forum-WhatsApp group); use of alternative mode of transport other than motor vehicles e.g. 'bodaboda'

Other potential options to increase farmers' adaptive capacity

Working through organised groups and purchasing inputs in bulk; purchase proper equipment in bulk to lower the cost; e-extension

Implement new designs of chicken housing with considerations of future extreme climatic events; bulk purchase for unavailable feed ingredients and vaccines by farmer groups; use appropriate technologies; use improved chicken breeds

Put up proper housing and related structures; install proper slaughtering facility; putting up cold storage facilities through groups

Increased linkage through social media; improved communication network; streamlined marketing channels; upgrade the market structures



Droughts

Need for additional water storage facilities; increased, equipment cost; increased cost of feeds; increased demand for drugs for disease control

Increases production cost; prices of feeds likely to be high; wastage of vaccine due to increased temperatures

Phytosanitary concerns; inadequate availability of clean water for processing; reduced shelf life; deterioration of quality due to unfavourable temperatures

Reduced supply of poultry products(meat and eggs); increased demand raises prices

Magnitude of impact

Moderate

Moderate

Moderate

Moderate

Farmers' current strategies to cope with the risks

Outsourcing of feeds; improved equipment from locally available materials

On farm feeds formation; farmer units in place for efficient vaccination of poultry

Reduce processing activities and only sell on demand

N/A

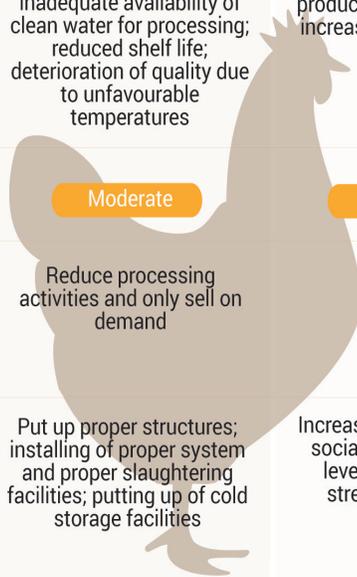
Other potential options to increase farmers' adaptive capacity

Work through organised groups and purchase is bulk; purchase proper equipment in bulk to lower the cost; proposed e-extension

Keep climate resilient chicken breeds; integrate chicken production with cropping systems to access additional forage; increased frequency in the early warning advisories by the meteorological department

Put up proper structures; installing of proper system and proper slaughtering facilities; putting up of cold storage facilities

Increased linkage through social media; improves levels of production; streamlined market channels



# Banana



Droughts

Hardening of ground which necessitates mechanised equipment with a high energy and time requirement; delay in sprouting/planting material; increased costs of production

Hard pan formation making it difficult to make holes for fencing; delayed decomposition; planting/delay in planting period; poor germination of banana suckers

Reduced yield and low quality of the product; faster ripening of bananas in the store; spoilage of ripe bananas; inconvenience in sorting the bananas in terms of green, partially ripened and the fully ripened

Spoilage of ripe bananas especially in the open air market; increased rates of perishability and low quality cause price fluctuation

Magnitude of impact

Minor

Severe

Severe

Major

Farmers' current strategies to cope with the risks

Farmers use tissue culture bananas; industrial organic fertilizer; Reduce inputs use due to costly expenses

Use of intensive human labour during land preparation; shift in planting season; introduce crop covers through intercropping to enhance optimum water infiltration

Staking the banana tree to support it to maturity; use of ripening chamber; controlled harvesting to control ripening (harvesting in intervals)

Introducing incentives that enable quick banana sale; transporting of bananas before ripening; refrigeration by the able businessmen; Farm gate sales to reduce transportation costs and maximise profits

Other potential options to increase farmers' adaptive capacity

Change cropping materials during drought season from suckers to tissues culture; irrigation water projects to assist in providing water required for manure decomposition

Mulching to conserve water and overcome hard pans; use of appropriate tools such as augers; mechanised production; strengthen drought early warning information

Establishing pack houses for bananas; Value addition of bananas by drying, frying etc

Encourage formation of cooperatives; link farmers to processing plants; install refrigeration facilities for vendors and farmers cooperatives; conduct market survey through cooperatives



Extreme rainfall/hailstorms

Hailstorms damages the suckers at the seedbed causing crop damage and serious economic losses

Delayed land preparation; delayed decomposition; rotting of the suckers stems and water logging; destruction of fencing poles; increased incidence of pests and diseases e.g. blight

Reduced value/quality of bananas during harvesting; destruction of storage facility and hindrance to ripening of bananas; destruction of transport infrastructure and impassable road network

Low consumption by buyers and low sales due to rains minimizing contact between sellers and buyers; compromising the quality of the bananas making it difficult for sorting poor banana quality; drop in prices

Magnitude of impact

Severe

Major

Major

Major

Farmers' current strategies to cope with the risks

Net shed to prevent hailstorms in nurseries; covering of the manure using nylon paper; regular maintenance of tools e.g. greasing, keeping them in dry place

Drilling the pits and planting the suckers immediately; cut off drain; adjusting planting dates or shifting the cropping area

Cover the banana with banana leaves from the top to protect from hailstorms; keeping the bananas in the ripening chamber

Hawking of the bananas to the buyers; varying the prices according to quality; introduce incentives buy one get one free

Other potential options to increase farmers' adaptive capacity

Use iron sheet shades (open-sided) and a wall raised to height able to prevent runoff; regular maintenance of tools e.g. greasing, storage in dry place

Drilling pits and planting the suckers immediately; construct check dams; creation of cut off drains; employ agroforestry farming; introduce crop insurance to manage extreme climate change risks

Maintain covering of the banana using banana leaves from the top; maintaining use of ripening chamber

Build banana bands; construct market stalls with shelter from rain; promote farmers cooperatives for collective bargaining



## Policies and Programmes

Several policies, acts and programmes have been developed and implemented in Kericho County as a response to climate change and variability challenges. The Agricultural Sector Development Strategy Programme (ASDSP) was initially initiated through a collaboration between the Kenyan and Swedish governments to formulate specific policies, work plans, projects and programmes to deal with food security and nutrition issues at the county level. ASDSP Kericho County took over some of the activities of National Agriculture and Livestock Extension Programme (NALEP) after it exited. ASDSP enhances farm productivity while conserving the natural resource base within the county. The overall goal of ASDSP in the county is to revolutionize agriculture and re-orient it to stimulate establishment of economic and commercial enterprises that can provide employment to the youth and improve livelihoods within the county. Years of collaboration with other development partners has also made the mandate of ASDSP more relevant at the county level. ASDSP efforts have been felt in part of the county where value chains like dairy, tomatoes and poultry have been promoted and supported. NALEP was a programme whose mandate was to contribute to and develop agriculture and livestock, alleviate poverty by promoting pluralistic, efficient, effective and demand-driven extension services among farmers and agro-pastoralists.

The Agriculture Sector Development Strategy (ASDS) is the overarching policy framework for agriculture development in Kenya. Its goal is “to achieve a progressive reduction in unemployment and poverty, the two major challenges of poverty and food security that Kenya continues to face”. It is aligned to Kenya Vision 2030 and guides the sector’s medium-term plans. ASDS places the principles of the Comprehensive Africa Agriculture Development Program on a national platform, under the New Partnership for Africa’s Development. ASDS proposes a consolidation of numerous agriculture sector reforms to streamline the legislative framework that governs the agriculture sector in Kenya. It aims to foster agricultural and land-use best practices and align the sector to the new Constitution of Kenya (2010). Some of the reforms and pilot projects being implemented in the sector that could benefit the tea industry are the following: *Consolidated Agricultural Policy Reform Legislation: The Agriculture, Livestock, Fisheries and Food Authority Act 2012; Kenya Agricultural and Livestock Research Act 2012; Pyrethrum Act 2012; and Crop Act 2012.*

Through this strategy, it is anticipated that the tea industry will grow at an annual rate of 7 percent for the period 2010-2020. The programme takes into account the impact of climate change and the associated risks to Kenya’s climate-

sensitive agriculture sector - especially in terms of its leading industrial crop - in relation to its foreign exchange revenue and GDP. In addition, the strategy outlines the policies and institutional adjustments that are necessary to create a vibrant and productive industry, recognizing at the same time the importance of public-private partnerships within the industry. Although the ASDS does not explicitly identify the challenges specific to the tea industry, it does recognize the potential of value addition to increase its competitiveness in the global market. It should be noted that despite the importance of tea in the country’s economy, it so far has been operating without a policy framework<sup>13</sup>.

The Agricultural (Farm Forestry) Act of 2009 advises farmers to maintain at least a 10% forest cover on every agricultural landholding and to preserve and sustain the environment in efforts to combat climate change and variability (GoK, 2009b). These rules purpose is to promote and maintain forest and conserve soil. In accordance with the act, Kericho County is at 22% forest cover which is safely above the national targets but still under threat for timber and fuelwood, especially because over 90% of the population within the county still use forest products (firewood and charcoal) as fuel wood for cooking (GoK, 2013b). The drastic reduction of the Mau is causing water shortage in the county as well as contributing to global warming. Trees act as carbon sinks and forests are able to sequester huge amounts of carbon (IV) from the atmosphere (IPCC, 2014). The Act also discourages the maintenance of any Eucalyptus spp. in wetlands and riparian areas because they take up large amounts of water from the soil thus causing moisture stress. The Forest Act, 2005 established the Kenya Forest Service which is a state corporation mandated to develop, manage and conserve the forest resources within Kenya and assist county governments in achieving this. It also advocates that harvesting of trees must be done in a sustainable manner maintaining the 10% forest cover. Large-scale harvesting must be accompanied by a harvesting plan as dictated in the Act.

NEMA through the Environmental policy EMCA of 2009 is supposed to protect the environment. Within Kericho County, NEMA protects the environment especially the wetlands from encroachment. It promotes conservation measures to protect soil along rivers and within wetlands. NEMA activities are notably along key rivers of concern such as Kipchorian, Kipturet, Timbilil, Chemosit, Ainamoi, Malogit, Chebwagan and Kimugu. NEMA also monitors cultivation distance to water bodies to ensure protection of the same; for example, no settlements are allowed at 20 to 50 m distance from water bodies. Protection of indigenous forests found in wetland areas is also key as the forests are under threat to pave way for farming and settlements.

13 FAO. 2015. Kenya’s tea sector under climate change: An impact assessment and formulation of a climate smart strategy, by Elbehri, A., B. Cheserek, A. Azapagic, D. Raes, M. Mwale, J. Nyengena, P. Kiprono, and C. Ambasa. Rome, Italy.

Wetlands in the county contribute to control of floods and storage of underground water and are protected by NEMA.

Horticulture Support Programme is also ongoing where horticultural crops are produced under controlled environments, e.g. shed nets and greenhouses, to reduce negative impacts of extreme weather conditions. Within the Programme there are activities to promote biogas to reduce over-reliance on fuelwood for cooking and compost/manure making for fertilizer purposes. Within the county, Enhanced Food Security Programme supports promotion of resilient crops like sorghum and sweet potatoes. In some areas of Soin/Sigowet sub-county, value addition activities on sweet potatoes are on a high notch. There is also an Industrial Crop Programme within the county advocating expansion and promotion of diversification crops like coffee. The county also purchases and distributes seedlings to farmers under this Programme. The Livestock Disease Control Programme deals with diseases and parasites that affect livestock. The Livestock Feeds and Processing Programme aims to improve fodder and feeds for livestock while the Livestock Breeds Improvement Programme improves local breeds of livestock and introduces breeds that are more tolerant to climate change and variability.

A major challenge facing most of these policies and programs is in the implementation as there are human capital and financial constraints that hinder proper implementation. Most of these policies and programs are well outlined on paper but are far from proper enactment on the ground. Moreover, the population is not aware of these programs and policies and what they support. Where the population is aware of the policies, they are not strictly followed. Programs and policies lack harmony and there have been instances of contradictions further aggravating issues during implementation. Another major crosscutting issue is that there is no holistic approach on wetlands and riparian areas. Laws, policies and programmes are not integrated in development activities. Some are also contradictory as there is a lack of consultation during formulation. For example, there are clear rules by the Agricultural Act on the protection of wetlands and riparian areas but the Department of Lands has no clear demarcations to protect these areas. As a result, they have issued land titles in these protected areas. And although EMCA 2009 overrules all other policies, it is still not adhered to.

Despite the central role of tea in the Kenyan economy, the threat of climate change and the factors necessary to adopt relevant measures have not been adequately highlighted in the key strategies of the economic pillar. There is, however, a commitment to improve research and development, strengthen the human and financial capacities of research institutions and strengthen collaboration between research, policy and public-private partnerships.

Strategic interventions, in this case, should include the adoption of sustainable agricultural practices; investment in managing water catchments and water harvesting technologies; appropriate resumption of productivity after abiotic and biotic stress; and increased environmental research in the context of tea production.

Shifting to higher-value tea clones has substantial financial benefits and, therefore, research should focus on improving the plant's tolerance of biotic and abiotic stress, increasing yields and shortening the maturing period, in order to speed up adoption by farmers and, thus, counter the effects of climate change. Support will need to be provided to smallholder tea farmers so that they can adapt to the emerging challenges. The introduction of new high-yield crop varieties and drought-resistant plants, such as sweet potato, millet, sorghum and banana, has already taken place as a coping mechanism in the adaptation process.

While agricultural inputs may be available, improved access by the poor will remain important if they are to benefit from available technologies. Many poor farmers often lack access or cannot afford inputs hence are unable to use them even when forecasts predict good seasons ahead. There is need for policy reform to encourage individuals, groups and private companies to take advantage of good seasons by creating good and reliable business environment that may improve access to agricultural inputs and technologies. There is also need to address factors hindering the wider adoption of available technologies which could be beneficial to poor households to improve their returns on agricultural investment.

## Governance, institutional resources, and capacity

There are various governmental institutions, non-governmental (NGOs), community-based, and private organizations that deal with climate change and vulnerability issues. At the county level, such departments and agencies include: Water Department, Agriculture Department, Livestock Department, Fisheries Department, Department of Environment, Energy Department, Department of Lands, Kenya Meteorological Department, Kenya Forestry Service, National Environmental Management Authority, Water Resource Management Authority, Tea Research Institute, Kenya Forestry Research Institute, Kenya Tea Development Authority, Finlays Tea, Unilever Tea and Kabanga University.

Most of these entities provide agricultural extension, inputs, programs and policy support to farmers and resource users within the county. The extension staff

from the MoALF (Agriculture Department, Livestock Department and Fisheries Department) support farmers through field visits and supply of inputs. They also decipher climate information from the Kenya Meteorological Department (department providing climate information and advisories) and integrate this with agricultural information for use by farmers. The Water Department and Water Resource Management Authority are responsible for the protection and management of water resources within the county.

Energy Department, Department of Lands and the National Environmental Management Authority work hand in hand to protect and manage different environmental resources including land and forest resources. Within the county, there are other several governmental and private institutions (TRI, KEFRI, KTDA, James Finlay, Unilever and Kabianga University) that have made steps in coming up with better varieties of crops through research, have trained and capacity build farmers, have promoted different crops, and have protected forests among other activities.

Several research institutions within the county are doing research on climate change and variability. For example, TRI is doing research on tea and is currently involved in the implementation of the Tea Climate Change Strategy with other tea industry stakeholders and support from the Food and Agriculture Organization of the United Nations. Kenya Agricultural Value Chain Enterprises (KAVES) works within the county to promote specific value chains i.e. horticulture (Irish potatoes, purple passion fruit), maize and poultry and local vegetables. As adaptation measures KAVES trains and facilitate farmers in soil conservation and in afforestation activities in conjunction with the Lake Victoria Environmental Management Project (LVEMP). It also promotes intensification to maximize yields and support farmers to move from rain fed agriculture to irrigation e.g. through solar powered pumps.

One of the major challenges facing the extension work especially MoALF staff within the county is that the officers are not adequately facilitated which hinders their planning and efficiency within the county. The devolvement of agriculture has negatively affected the budget to support extension activities. The extension services lack manpower and are not able to cover the vast sub-counties, further hindering their efficiency. The funding and staffing problems across the various county government departments poses challenges to mitigation and adaptation efforts. Staff within different agencies and county departments confirmed that they have not been trained on climate change and vulnerability issues as it is still a new phenomenon within the county that has not been fully integrated

in developmental activities. Thus, there is the need to build capacity of the staff through training.

More funds should also be allocated to deal with climate change issues. Currently, such issues are dealt with on a crisis basis and this is not effective. For example, climate change issues are only discussed during Nile Day which is a national event. To deal with such issues, early planning of activities is encouraged to ensure activities are incorporated in the county budget. Another promising endeavour is the collaboration between government institutions and private entities during implementation of potential interventions. This ensures that financial burdens are split among different stakeholders and activities are completed on time.

A sector/territorial level assessment is the appropriate scale to develop a precise action plan that will be supported by an investment programme; institutional reforms; agricultural research and extension; market-level regulations; trade and other economic incentives to induce farmers, and forestry folks to adopt climate compatible technologies and practices. The sector/territorial level analysis of climate smart-agriculture is a necessary bridge between national cross-sectoral policy interventions and farm-level adaptation decisions. Solutions at the sectoral level will identify the links between evidence and policy-making which, in turn, can guide the formulation of interventions or strategies at the national or cross-sectoral level. For example, national policies for food security and climate adaptation and mitigation also can be facilitated under a regional strategic framework to tackle the common challenges and objectives.

## Synthesis and Outlook

Agriculture is the mainstay of Kericho County. Crippling of this sector will have serious negative impacts on the livelihoods of more than 80% of the county's population. There are various value chains that are important in the county in terms of value of production and involvement of the poor, youth and women. These value chains are also deemed to be more resilient to climate change and variability compared to other value chains within the county. These value chains include; tea, local chicken, bananas and local vegetables i.e. African Nightshade (*Solanum nigrum* complex) and Spider plant (*Cleome gynandra*).

Several climatic hazards pose a threat to agriculture in the county i.e. drought, increase in moisture stress and increased rainfall/hailstorm. This calls for appropriate adaptation strategies that will help farmers



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