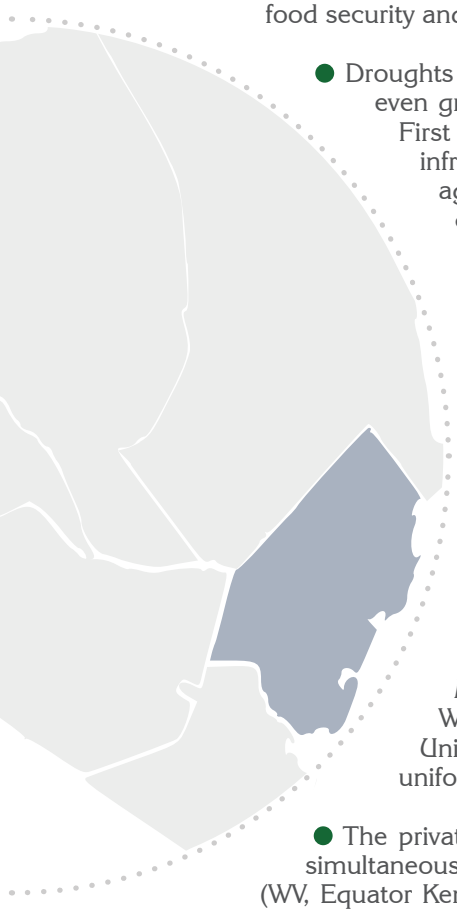
Climate Risk Profile
Kilifi County

Highlights

- Kilifi County is characterized by high poverty estimated at 71.7% and widespread food insecurity affecting approximately 67% of the households. Low-input, rain-fed agriculture is the main source of livelihood in the County, contributing about 52.7% to the average household income and directly employing more than a half of the total County population. Cassava, chilli, local poultry, and dairy cattle are key value chain commodities that contribute to both household food security and livelihoods.



- Droughts and floods compromise productivity and food security in Kilifi and are expected to pose even greater challenges in coming years, as future projections predict increasing drought risk in First Season (January-June) and increasing flood risk in Second Season (July-December). Poor infrastructure, limited coverage by extension services, poor quality and eroded soils, and low agricultural input use are some of the key factors that exacerbate the impacts of climate change and variability and at the same time limit the ability of farmers and livestock keepers to cope with these impacts.

- Farmers employ a number of on-farm strategies to cope with climate risks and shocks, including: utilization of drought-resistant crop varieties, water harvesting, conservation agriculture, tree planting, animal feed conservation, value addition strategies, and organizing farmer groups for easier access to credit, farm inputs, markets and information.

- The main barriers to wider adoption of these strategies include limited knowledge of new technologies and the know-how to implement them, the inaccessibility of inputs due to prohibitively high costs, and a lack of access to financial mechanisms to overcome these obstacles.

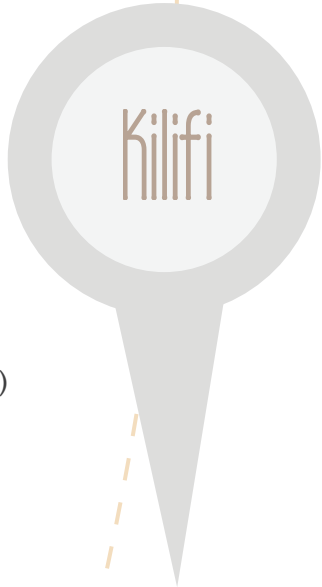
- Off-farm services for supporting farmers in dealing with climate change and variability are very limited in Kilifi County. They include early warning information on drought risks, food security assessments, and the Cash for Assets program by the National Drought Management Authority (NDMA). Several non-governmental organizations (NGOs) such as World Vision (WV), Kenya Red Cross (KRC) and Food and Agricultural Organization of the United Nations (FAO) provide financial services and extension; however, these services are not uniformly available.

- The private sector has played an important role in helping farmers adapt to climate change while simultaneously supporting market integration. With the support of non-governmental and private actors (WV, Equator Kenya Limited [EKL]) has encouraged the cultivation of African Bird's Eye chillies for export, providing inputs, financial support, extension services, and a stable market to predominantly female farmers. The Kilifi ABEC Cooperative plays an important role in marketing chilies from more hinterland areas, serving the local market. This type of collaborative support for adaptation through value chain development could potentially be scaled-up in the County by having more structured consultative meetings and sharing information on their activities.

KAPP
Kenya Agricultural Productivity Programme
Republic of Kenya
WORLD BANK GROUP

List of acronyms

ABEC	African Bird's Eye Chilli
ASAL	Arid and Semi-Arid Lands
ASDSP	Agricultural Sector Development Support Programme
CIAT	International Center for Tropical Agriculture
EKL	Equator Kenya Limited
FAO	Food and Agriculture Organization
GEF	Global Environmental Facility
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Programme
KFS	Kenya Forestry Service
KEFRI	Kenya Forestry Research Institute
KMD	Kenya Meteorological Department
KPHC	Kenya Population and Housing Census
KRC	Kenya Red Cross
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoENR	Ministry of Environment and Natural Resources (MoENR)
NCCRS	National Climate Change Response Strategy
NDMA	National Drought Management Authority
NEMA	National Environmental Management Authority
REWAS	Revise Early Warning & Analysis System
SCCF	Special Climate Change Fund
UNDP	United Nations Development Programme
VCC	Value Chain Commodity
WB	World Bank
WFP	World Food Programme
WV	World Vision



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 extremely susceptible to climate-related events, and projections indicate that the impacts are likely to affect the country even more in the future. In many areas, extreme events and variability of weather are now the norm: rainfall is irregular and unpredictable; some regions experience frequent droughts during the long rainy season, others severe floods during the short rains. The arid and semi-arid areas are particularly hard hit by these climate hazards thereby putting the lives of millions of households and their social and economic activities at risk.

In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS) which recognized the importance of climate change impacts for Kenya's development. This was followed by the development of the National Climate Change Action Plan in 2012. Since the focus of these initiatives has been the national level, as the country shifts towards County Governance and focus, there is however a need to mainstream climate change perspectives in programs and development plans at the County level.

To strengthen local capacities of stakeholders to reduce the near-, medium- and long-term vulnerability to current and future climate variability, the Kenyan Government, through the Ministry of Agriculture, Livestock and Fisheries (MoALF) is implementing the Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL) project. The project is funded with a grant from the Global Environmental Facility (GEF)/ Special Climate Change Fund (SCCF) through the World Bank (WB). The present study is part of the KACCAL project and aims to inform the County Government and stakeholders on the climate change risks and opportunities for agriculture so that they are able to integrate these perspectives into their development plans and processes.

This document presents the Climate Risk Profile for Kilifi County, where climate variability has been accompanied with a significant increase in attendant risks, as repeatedly documented in national and international news coverage. Lack of rainfall, as well as the late onset and early cessation of both long and short rains, have made crop failure a recurring hazard in Kilifi. Drought has created a cycle of food insecurity, starvation, and reliance on emergency relief that has been repeated in the County every year since 2013. At the same time, Kilifi County is experiencing increasingly worse and more frequent flooding. In 2015, the County was subjected to the worst floods in more than 20 years. Six seasonal rivers burst their banks cutting off the road network, destroying homes and crop farms, and affecting more than 3,000 people, especially in the Magarini Sub-County[1] The magnitude and severity of these climate hazards makes the identification of impending climate risks an urgent matter: likewise, considering how practices that help citizens become more resilient in the face of climate change becomes an exercise with the potential to affect hundreds of thousands of lives.

The profile is organized into six main sections, each reflecting an essential analytical step in studying current and potential adaptation options in key local agricultural value chain commodities. The report first offers an overview of the County's main value chain commodities key to food security and livelihoods, as well as major challenges to agricultural sector development. In the next section, the main climate hazards are identified based on the analysis of historical climate data and climate projections. Then it continues with an analysis of the vulnerabilities and risks posed by the hazards deemed to be potentially most harmful to 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 policy, institutional and governance context that can enable adoption of resilience-building strategies, and finally presents potential pathways for strengthening institutional capacity to address potential future climate risks.

1 The Star online news paper (The Star, 2015)

Agricultural context

Economic relevance of farming

Kilifi County is one of the six counties located in Kenya's coastal region. The County covers an area of 1,260,970 hectares (ha) and borders Athi River (Galana/Sabaki) to the north, Kwale County to the southwest, Mombasa County to the south, Taita Taveta County to the west and the Indian Ocean to the east.

Agriculture is the main income earning activity in the County, contributing about 52.7% to the household income (GoK, 2013). The sector employs half of the total County population. Adult women provide half of family labour in crop production, while adult men and youth provide the rest in almost equal share. In livestock production, adult men and women contribute the highest share of labour (with each gender providing 46%) while the youth provide the least. The mean daily per capita income is KSh 47.

People and livelihoods

According to the Kenya Population and Housing Census (KPHC) of 2009, the projected population in 2012[2] was 1,222,928, of which 51.7% were women and 48.3% men. Around 78.5% of the population resides in rural areas and depends on agriculture as the main source of livelihood (GoK, 2009).

The County is characterized by a very high rate of absolute poverty (71.7%) compared to the national rates (47%). Several factors are tied to the high incidence of poverty, including: landlessness estimated at 11.3% of the households, limited access to piped water (48% of the population), limited access to electricity for lighting (11.7%); dependence on firewood for cooking (71%) and on expensive sources of energy such as kerosene for lighting (83%). Firewood is mostly collected by women from farms and mangrove forests. Water is mostly obtained from boreholes, protected and unprotected springs, water pans, and rivers whose access is not guaranteed and quality not known. The average distance to the nearest water point is 5 kilometers (GoK, 2009).

Food insecurity, characterized by a limited availability of food, infrequent eating, and low food diversity, is high in the County affecting 98% of the households (GoK, 2014). There is high rate of undernourishment, which is evidenced by the high prevalence of stunting in children of 39.1% (KNBS, 2014). Food insecurity in Kilifi County is partly attributed to low productivity because of limited use of inputs and improved agricultural technologies. The situation is further exacerbated by the unreliability of rains: the uneven temporal and spatial distribution of long rains undermines farmers' efforts to produce a wide array of foods that would be key for ensuring food security. In the same vein, maize is often planted in lieu of other more climate resilient crops in areas that are unsuitable for maize cultivation such as the ranching zones found in Ganze, Magarini and parts of Malindi resulting in crop failure and directly affecting household food security.

About 65.5% of the population in Kilifi County is literate (GoK, 2013), with a gender bias favouring men's educational achievement. Access to education is affected by the distance that students must travels to school: 65% of primary schools and 72% of secondary schools are located more than 5 kilometers away from students' homes (GoK, 2013). This complicates students' access to basic education and their ability to empower themselves socio-economically.

Most livelihoods in Kilifi County are based on crop and livestock farming. The main food crops include maize, cowpeas, green grams, and cassava, while the main cash crops are coconuts, cashew nuts, sisal, mangoes, and pineapple. Cash crops are typically cultivated in Kilifi South, Kilifi North, Malindi, Kaloleni, Rabai and Magarini. The main livestock include cattle (Zebu), goats, sheep, poultry and beekeeping. Most of the livestock are indigenous breeds. Fishing is also an important livelihood activity for more than 5,000 families with an annual catch of about 443,689 tonnes (GoK, 2013) (Annex 1).

2 based on a 3% growth rate.

Agricultural activities

Agricultural land in Kilifi comprises 689,120 ha, representing 55% of the County's total land area. The area under food crops and cash crops is 52,519 ha and 47,681 ha respectively, 7.5% and 6.9% of the total agricultural land (GoK, 2013). The rest of the land remains idle or underutilized most of the time.

Four agro-ecological zones (AEZs) can be identified in the county as follows (Jaetzold et.al., 2010):

- The Coconut-Cassava zone, also referred to as Coastal Lowland zone (CL3), has the highest potential for crop production with precipitation of 1,300 mm per annum and mean annual temperature of 24°C. The altitude ranges from 1-450m above sea level.

- The Cashew nut-Cassava zone, also referred to as Coastal Lowland zone (CL4), has an average precipitation of 900 mm and annual mean temperature of 24°C. The zone has similar crop types like the medium potential zone (CL3) but with less production. In between the above two zones, there is the Coconut-Cashew nut-Cassava zone that has the potential for the crops grown in both the Coconut-Cassava zone and the Cashew nut-Cassava zone.

- The Lowland Livestock-Millet zone, also referred to as Coastal Lowland zone (CL5), is of lower agricultural potential with precipitation of 700-900mm and temperatures of 27.0-25.2°C. The area is suitable for dry land farming especially drought tolerant crops and livestock ranching.

- The Lowland Ranching zone, also referred to as Coastal Lowland zone (CL6), varies in altitude of 90-300m with a mean annual temperature of 27°C and annual precipitation of 350-700mm. The major activities include ranching and wildlife.

Other important commodities include the African Bird's Eye chilli - mostly found in the drier parts of Ganze, Magarini, Malindi, and Kilifi North - in CL3, CL4 and CL5 due to its drought tolerant nature, and livestock (beef), which provides food and income in areas such as Ganze, Langobaya and Magarini found mainly in the livestock-millet zone which are also the ranching zones. For dairy, the main areas are found along the coastline, including Kilifi South, Kilifi North, Malindi, Rabai and parts of Kaloleni found in coconut-cassava zone (CL3 and CL4). Poultry farming is found virtually everywhere in the County.

Rain-fed agriculture is the predominant form of farming and only 2% of the farmers in Kilifi County use irrigation water. There is high irrigation potential along the River Sabaki, which crosses the County as it drains into the Indian Ocean. Small-scale farming is the predominant production system, and farms average about 3 ha (small scale) to 8 ha (large scale). About 66% of the County's households do not possess land titles, which discourages them from making long-term investments in the land. Landlessness also contributes to high poverty levels throughout the County (GoK, 2007). On the other hand, 41% of the female farmers in the County have access to, and ownership of, land for production, which they leverage to secure credit for investing in agricultural technologies.

Aside from land, few other inputs are used by crop and livestock farmers in Kilifi. Farmers mainly use organic manure and field pesticides. Factors such as the lack of access to basic needs (water, electricity, education) and resources (incomes), as well as high input prices, limited extension coverage, and prohibitively long travel distances to input outlets prevent farmers from investing in inputs. This has seriously hindered crop productivity in the County.

Agricultural value chain commodities

There is a broad diversity of agricultural production systems in the County of Kilifi. Various value chains have been prioritized for development interventions by different government organizations and programs, such as the Agricultural Sector Development Support Programme (ASDSP), the Kenya Agricultural and Livestock Research Organization (KALRO) and University of Nairobi survey, and the Kenya Agricultural Productivity Program (KAPP). For the development of this County Climate Risk Profile, four major Value Chain Commodities (VCCs) were selected for in-depth analysis, based on their productivity characteristics, contribution to food security, and importance to the

Livelihoods and agriculture in Kilifi

Demographics

3% Of Kenya´s population

1,222,928 inhabitants

79% Live in rural areas

52% 48%

Access to basic needs

72% of the population lives in **absolute poverty**

Potable water	63%
Electricity for cooking	1%
Electricity for lighting	12%
Education (youth literacy rate)	65%

Food security

67% of the population suffers from **food poverty**

ND of household **income spent on food**

ND People **undernourished**

34% Children **stunted**

11% 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)

Kilifi

Farming

County´s farming area

689,120ha 55%

50% of the population employed in agriculture production

31% of farmers have title deeds

42% are women

Farming activities

Food crops 8%

Cash crops 7%

Of county´s agricultural land

Livestock

8 Group ranches

4 Company ranches

Farming inputs

Water uses

ND ND ND

Fertiliser types (% of households)

16% Organic manure

2% Basal fertiliser

0.6% Top dress fertiliser

Pesticide types (% of households)

31% Field pesticides

4% Storage Pesticides

1% Herbicide

economy. These VCCs have been selected from a list compiled from documents of the above-mentioned institutions, using the following prioritization indicators: harvested area (hectares), production (90 kg bags), variation in production (in the past five years), value of production (US$/bag), dietary energy consumption (Kcal/ capita/ day), protein content (gr of protein/ 100 gr of product), iron content (mg of iron / 100 gr of product), zinc content (mg of zinc / 100 gr of product), and Vitamin A content (IU Vitamin A / 100 gr of product). The VCCs selected are: cassava, African Bird's Eye chilli, local poultry, and dairy cattle.

Cassava

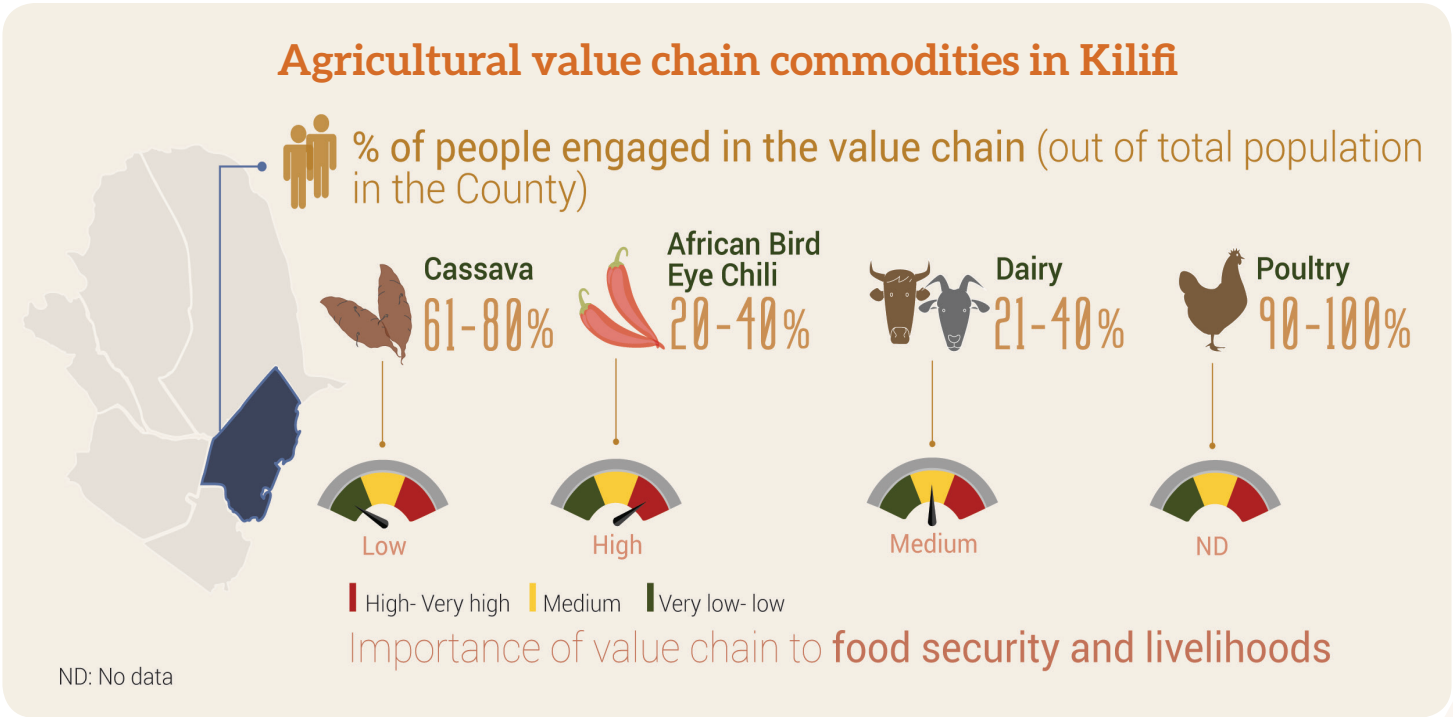
Cassava is a key staple food and livelihood source for Kilifi´s population and is grown on 5,779 ha (0.8% of the County's agricultural land). Cassava is mostly grown by women, who lead activities from land preparation to harvesting. Production has risen incredibly fast in recent years, from 137,938 tons in 2012 to 207,060 tons in 2014. In terms of productivity, yields in 2014 reached 35.8 ton per hectare up from 16.4 tons per hectare realized in 2012 (GoK, 2015).

In the past years, KALRO has been supporting the dissemination of improved cassava cuttings amongst farmers, hence facilitating increases in yields. In terms of post-harvest activities, most farmers dry the cassava and store it in their households for future use, while others add value by chipping, frying, and packaging it to produce crisps that are sold in urban centers and supermarkets. Dried cassava can be milled to produce flour that is used by families to prepare porridge or Ugali.

African Bird's Eye chilli

The African Bird's Eye Chilli, or ABEC crop was introduced in Kilifi as a climate change adaptation strategy, because of its high resistance to drought and as an income-generating alternative, largely due to its potential for processing and export. The income earned from the chillies indirectly contributes to household food security..

The ABEC crop is promoted by Equator Kenya Ltd., a company located in Malindi town, which also provides farmers with inputs (seeds and fertilisers),



4 Extensive production refers to the practice of allowing animals to graze freely.5)

extension services, and secure markets. The company collects the harvested chillies from the farmers for processing and marketing, ensuring that they adhere to the standards for export and certification schemes. Currently, the company has contracted about 8,000 small-scale farmers, 80% of whom are women. The company handles 75% of the total ABEC production, while 25% is sold to other small-scale traders through the cooperative movement (Kilifi ABEC). The export company has its extension staff on the ground, providing the necessary support to the farmers in all these activities. Initially, the chillies were harvested only five months per year, however, by introducing drip irrigation kits to the farmers on a credit basis, the harvest period has doubled to ten months per year. Women engaged in ABEC farming have organized themselves into groups to provide affordable labour, taking turns in working on group members´ chilli farms.

Poultry (local)

Poultry keeping is common among all households in Kilifi and is practiced semi-intensively (free range and chicken-holding structures). The majority of poultry farmers are women, as men tend to be more engaged in cattle farming. In 2015, there were about 998,600 poultry in the County (GoK, 2015). Farmers formulate the chicken feeds by mixing fishmeal, sand, and grains (mostly maize) and use prophylactic practices such as vaccination to protect poultry against diseases such as Newcastle and Gumboro. They have also formed groups to facilitate the buying and selling of feeds and to organize marketing. Local poultry take approximately 4 months before they are ready for the local market. Farmers sell the chicken to traders (who bulk them and transport to Mombasa town) or consume them in the household, given the important protein content founds in eggs and meat. Income from the sale of chicken and eggs is also used to purchase food that the farmers do not produce on their farms, supporting food security.

Dairy (cattle)

Dairy farming is mainly practised along the County's coastline, including Kilifi South (CL3 and CL4), Kilifi North(CL3 and CL4), Malindi(CL4), Rabai and parts of Kaloleni (CL3 and CL4). Most dairy farmers are small holders who own on average 3 ha of land and three animal heads per household. In 2015, there were about 51,518 heads of dairy cattle in Kilifi (GoK, 2015). Average milk production is between 3-7 litres per day per cow. Dairy farming contributes to the food and nutrition security of households as most milk is produced for home consumption. Small additional income is sometimes obtained from selling extra milk: the value of milk sales in Kilifi County was about KSh 1.14 billion in 2012 (GoK, 2014).

Agricultural sector challenges

Kilifi is among the poorest counties in Kenya[3] with an absolute poverty rate of 71.7% (GoK, 2007). Factors that contribute to the entrenchment of extreme poverty include the limited uptake of technology, especially in the agricultural sector, and limited access to education and training. Both of these factors contribute to the limited or non-use of inputs and the perpetuation of poor farming practices, which ultimately result in low productivity and the overuse of natural resources. The County's arid zone is a major source of charcoal for the towns of Mombasa, Malindi, Kilifi and Mtwapa. Deforestation caused by the uncontrolled felling of trees has led to widespread destruction of the environment. This is a major contributor to soil degradation which is rampant in the County since the lands do not have adequate soil cover to protect against erosion. Poor soils cause low crop productivity due to the lack of soil nutrients that support plant growth.

Low productivity is directly tied to poor soil quality, insufficient rainfall, and high incidence of pests and diseases. Moreover, production costs are high, given the high costs of inputs. Poor road networks and weak market structures challenge market accessibility and create important disincentives to production. Low coverage of extension services is another challenge to farming in the County. Government departments are understaffed and under-resourced and are unable to provide demand-driven services to the entire County. This, in turn, has adverse effects on farmers' capacity to improve agricultural productivity, as farmers lack information to make informed decisions on planting time, varieties, input use, and on coping with rainfall.

3 Kilifi was ranked 39th out of the 47 counties (GoK, 2007, as cited in KIRA, 2014)

Climate change and agriculture risks and vulnerabilities

Climate change and variability: historic and future trends

Kilifi County has a moderately hot and dry climate throughout the year. The average temperature is greater than 23°C throughout the majority of the county, with areas along the coast generally above 25°C annually. There is a strong east to west gradient of decreasing precipitation with eastern (coastal) parts of the country receiving greater than 1000 mm of precipitation per year, while a majority of the county central to west around 500-750 mm. Some small areas along the western side receiving less than 500 mm precipitation per year. As such, heat stress, dry spells, and drought are hazards that strongly contribute to agricultural risk in the county, especially in the central and western parts of the county. However flooding due to intense rains has also occurred historically and as such is a risk to the county, especially in the central to eastern parts (including the coast) of the county.

Experts and farmers alike acknowledge that there has been significant changes and variations in climatic conditions over the past years, affecting agricultural production and livelihoods in the County. Historically, dry spells, moisture stress, and intense precipitation have occurred during both growing seasons of the year. Moisture stress and dry spells were observed to occur with approximately the same frequency during both growing seasons, with approximately 65 consecutive days of moisture stress in each season. However, there has been an increasing trend in moisture stress in the first wet season (January-June) since 1981, which has not occurred as strongly during the second wet season. Historic records show the first wet season more consistently experienced single days with higher precipitation, with more than 30mm falling in a single day during 8 years 1981-2015[4] However, the second wet season (July – December) experienced greater variability in extreme precipitation with most years below 20 mm precipitation in any single day, and only three years with a day above 30mm. But the second season had the two highest single days on record since 1981, with over 40 mm of precipitation falling on a single day in 2006, and over 50 mm falling on a single day in 1996.

Climate has already been observed to change in the county. Since 1981, the first wet season has experienced a very high (2.0°C) increase in mean temperature and associated reduction in crop cycle, a significant increase in heat stress days, and a strong trend for decreasing precipitation (on the order of 20%). The combination of increased temperatures and decreased precipitation make for an increase in drought risk in this first wet season. The second wet season experienced a mild (~0.5°C) increase in temperature, and no change in precipitation.

Looking to the future in the years of 2021-2065, both extreme precipitation and prolonged moisture stress are projected to occur, but the changes are different during different seasons. Within 30 years (by the early 2040's) temperature is projected to increase by 0.5°C, with the first wet season projected to experience even greater changes. And by this time, precipitation is projected to decrease by 13% in the first wet season, and 2% in the second wet season. Consecutive days of moisture stress is projected to increase in both seasons, from around 65 days per season to over 75 days of moisture stress. At the same time, increased extreme precipitation is projected to occur slightly during the second season, with the highest single day of precipitation increasing on the order of 10-20%. The first wet season is projected to experience a slight decrease in the single day greatest precipitation on the order of 10%. These projections of future climate change under the two climate scenarios[5] —RCP 2.6 and RCP 8.5—show some difference, with the climate change patterns described above being slightly greater with higher greenhouse gas concentrations.

4 Refers to the wettest 1-day event (mm/day) indicator in the infographic.

5 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/m2, 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 CO2-equivalents) peak between 2010 and 2020, with emissions declining substantially thereafter. In RCP 8.5, emissions continue to rise throughout the 21st century.7 Refers to the wettest 1-day event (mm/day) indicator in the infographic.

Climate from the farmers' perspective:

From the farmer's point of view, one of the most obvious indications of changing climatic conditions in the past few years is the systematic delay in the onset of rains: the first rains now tend to fall in April, whereas before they began in March. This, in their opinion, has brought about much uncertainty regarding planting times. Even when rains do come on time, they do not last long enough so as to enable the crops to mature. These days, they say, maize rarely grows to maturity and even where it does mature, yields are very low. This has obliged farmers to shift to other crops such as cassava, millet, sorghum and chilli. Farmers in Kilifi also perceive changes in the amount, duration, and intensity of rainfall: rains have a shorter duration (a few weeks instead of an entire rainy season – for instance this year (2016) there was rainfall only in the month of April and no rainfall in May and June as is normally the case – and are of increased intensity, affecting harvests and ultimately compromising household food security. As a consequence, farmers tend to spend less time on their fields and resort to looking for alternative, off-farm employment.

Changes and variations in climate have had important social consequences. For instance, the failed rains of 2016 resulted in total crop failure in ranching zones like Magarini and Bamba (CL5 zones) while in the areas along the coastline such as Kilifi North (CL3 and CL4), Kilifi South (CL3 and CL4) and Malindi (CL4) which only received rainfall in the month of April, only 30% of the normal harvest was realized. Women have to travel long distances taking up to an hour in search of water due to drying up of water reservoirs, whereas men spend more time moving with livestock in search of pastures and water. Men move from areas like Magarani (e.g. Adu) where there are ranches to areas along the coastline like Madunguni in Malindi to feed their livestock with pastures that are available. These changes have caused instability in families and social disturbance, as men venture out to look for off-farm income sources in urban centres and women remain in the household, engaging in unsustainable activities such as charcoal burning. Additionally, high school drop-out rates have increased as children (especially girls) are forced to abandon class in order to help their families in their search for food, which is related to the uncertainty created by these climatic events and their direct impacts of food and livelihood insecurity.

Climate vulnerabilities across agriculture value chain commodities

Cassava

Cassava production is mainly affected by drought and flood hazards, which in turn cause supply deficits and the loss of livelihoods. Droughts occur mainly in Magarini (CL5), Ganze (CL4), and Kaloleni (CL4) and affect the crop through poor germination rates or no germination at all because of the lack of soil moisture. For the cassava that manages to germinate, the roots are relatively small, compared to the ones that are grown under normal weather conditions. During droughts, high evapotranspiration leads to the hardening of soils, hindering land preparation, delaying planting, and challenging harvesting. On the other hand, floods that occur along the Sabaki River and in Kurawa and Kaloleni cause rotting of the cassava seeds and roots, due to excess moisture. The resulting tubers are of poor quality and are likely to develop aflatoxins when stored. The effects of these risks are disproportionately borne by women and youth.

African Bird's Eye Chilli

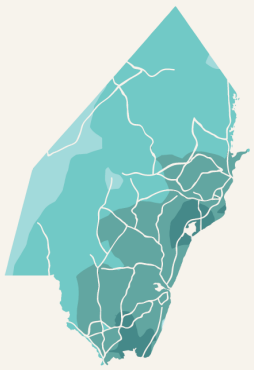
The production of ABEC is also affected by floods and droughts. Droughts cause low germination rates of the chillies. Many of the seedlings that germinate dry up due to lack of soil moisture and exposed roots or grow to produce small-sized chillies. During drought conditions, little or no transplanting is done. Fertilisers may burn the seeds when there is low moisture content in the soils. Farmers are also sometimes confronted by poor market supply of the chillies and no export markets due to compromised production quality. Women are most vulnerable to the consequences of droughts and floods on chilli production as they rely on the crop for seasonal incomes.

Chicken (local)

Droughts and floods also affect local chicken production. During drought events, there is an increase in poultry feed prices as a result of feed scarcity, as human food needs compete with poultry feed needs for grains. Aside from suboptimal feeding that results in underweight animals, chickens face the immediate threat of being washed away in floods,

Past and future impacts of climate hazards in Kilifi

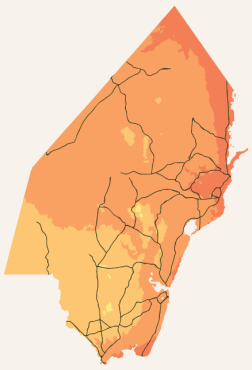
Historical annual mean precipitation (mm/year)



Legend
- Road
- <250
- 250-500
- 500-750
- 750-1000
- 1000-1250
- 1250-1500

Data sourses
Precipitation: CHIRPS (1981-2015)
Roads: Digital Chart of the World

Historical annual mean temperature (°C)



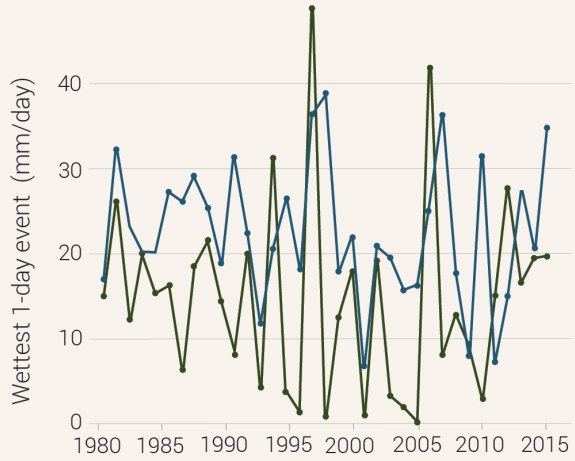
Legend
- Road
- <24
- 24 - 25
- 25 - 26
- 26 - 27
- < 27

Data sourses
Temperature: WordClim (1970-2000)
Roads: Digital Chart of the World

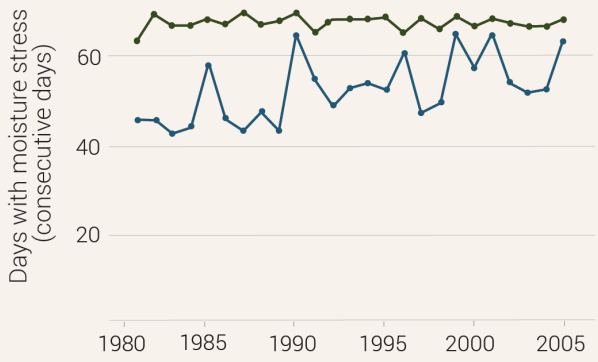
Flood hazards

Drought hazards

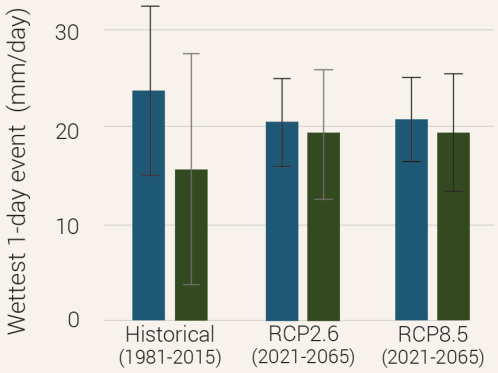
Historical extreme flood events



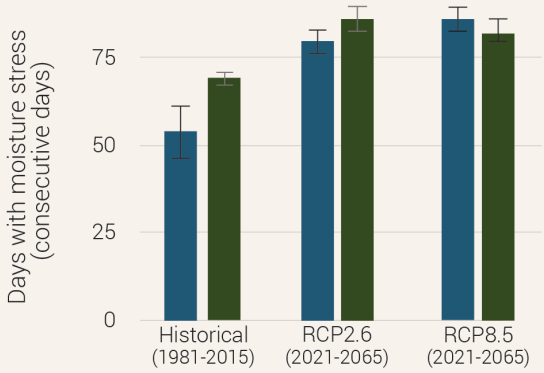
Historical drought stress events



Historical and expected extreme flood events



Historical and expected drought stress events



January - June July - December

compromising household food security and incomes. Chicken farmers in Magarini (CL5) and Ganze (CL4), especially women and youth, remain highly vulnerable to climate impacts on poultry production, given their scarce resources to buy the feeds and lack of access to vaccines.

Dairy (cattle)

Dairy cattle are highly sensitive to climate change related risks, especially drought. Drought results in little or no pasture and poor quality forages as well as scarce water resources, which are key for cattle production. Poor pasture conditions increases dairy animals´ susceptibility to diseases, which can eventually lead to death. Water is a critical nutrient for dairy cattle and drought contributes to the dearth of water. Additionally, high temperatures contribute to incidences of milk spoilage. Floods also causes increased incidence of diseases due to the wet conditions. For example, during floods, dairy cattle can get infected by worms that are found in flooded waters.

The groups that are most vulnerable to these threats are small-scale dairy farmers with on average three animals or less per household, who have low capacity to invest in inputs such as feed supplements, concentrates, vaccines, artificial insemination, and veterinary services. The regions most affected are situated along the coastline, including Kilifi South (CL3 and CL4), Kilifi North (CL3 and CL4), and Malindi (CL4).

Adaptation to climate change and variability

The risks posed by climate change have forced farmers in Kilifi to adopt various strategies to mitigate and cope with their changing environment while striving to maintain food and livelihood security. Some of the most important on-farm adaptation strategies are

On-farm adaptation options

Farmers' vulnerability to drought is linked to their dependence on rain-fed agriculture. Drought-resistant crops (cassava, ABEC, sorghum, millet) are being promoted as a strategy to mitigate drought risks. This is practised in all the AEZs except the arid zone. This include the coconut-cassava zone (CL3), cashew nut - cassava zone (CL4), livestock-millet zone(CL5) and the coconut - cashew nut- cassava (CL3 and CL4) zones.

Additionally, farmers in Kilifi have introduced short-maturity crops such as: pulses-cow and pigeon peas; green grams; and dryland hybrid maize (PH4, DH04, DH02). These crops are able to reach maturity in spite of the low availability of rainwater during planting season. The introduction of these drought resistant crops is supported by organizations such as the FAO, WV, and the KRC, who provide small-scale farmers (mostly women) with certified seeds, farm implements, fertilisers and extension services. This is practised in the zones which include the coconut-cassava zone (CL3), cashew nut - cassava zone (CL4), livestock-millet zone (CL5) and the coconut - cashew nut - cassava zones (CL3 and CL4).

The most severe consequence of drought is lack of water. On-farm interventions in Kilifi are mostly geared towards methods of harvesting or conserving water to boost crop production and improve pastures. These interventions commonly include: water pans, drip irrigation for chillies, zai-pits for trees, negarims for cereals, ridges, semi-circular bunds for pasture, and sunken beds for vegetables. Dairy farmers have established water harvesting techniques such as water pans to enable access to water in the event of drought. These are practised in all the four AEZs found in Kilifi County.

On-farm tree planting and the establishment of woodlots is another adaptation technology undertaken by farmers in Kilifi. Farmers have established nurseries to provide a supply of tree seedlings to be planted on farms to supply shade for pastures, crops, and animals. Mangoes and paw paws are most common fruit trees, while Casuarina is the most recommended forest tree species due to its potential to rehabilitate degraded lands. Trees improve the microclimate and ameliorate the environment. The main challenge to adoption of this strategy is the availability of the seed supply for establishing and maintaining the nursery. This adaptation is practised in coconut-cassava zone, cashew nut - cassava zone and coconut - cashew nut - cassava zones.

Soil conservation practices such as minimum tillage, adequate soil cover, and crop rotation are being introduced to farmers by FAO as a strategy to mitigate the effects of drought by preventing excessive soil water loss through evapotranspiration and soil erosion. Crop rotation helps control crop diseases, insects, and weeds, thus improving productivity. Although these measures are practiced by 71% of Kilifi's farmers, limited County coverage of extension services and lack of financial resources to implement some of these interventions bring about unsystematic adoption (spatially, temporally, and in terms of resources) of this strategy among farmers.

Fodder production and conservation is an adaptation being promoted to address the challenge faced in livestock production in the wake of droughts. Farmers are encouraged to grow hay and conserve it for future use by drying. Sorghum has been introduced as an alternative fodder grass to napier because it grows faster and requires less rain. Some progressive farmers especially in the dairy systems have embraced silage making to ensure a consistent supply of animal feed. Stovers and crop residues which previously were thrown away are now increasingly being collected, conserved and kept for future use. Rearing drought resistant indigenous cattle species and crossbreeding of indigenous breeds (that helps increase the genetic potential) are other strategies for increasing system's adaptive capacity to new climate conditions. Last but not least, farmers receive alerts from relevant departments and sell animals ahead of the critical time of the drought hazard to avoid massive losses occasioned by the hazards.

Off-farm services

NDMA generates, consolidates, and disseminates information on drought management and climate change adaptation through the Revise Early Warning & Analysis System (REWAS) initiative. The system provides credible early warning information on drought risks and coordinates action across sectors and agencies at all stages of the drought cycle, at both national and county level. The NDMA publishes monthly bulletins communicating current drought status to government departments and relevant humanitarian agencies. This service helps planning activities across the entire value chain.

Additionally, the NDMA carries out a food security assessment on the basis of weather patterns (long and short rains). The aim is to determine the population's vulnerability based on agricultural performance during the seasons. The report is then used by government and non-government actors to design interventions that support vulnerable populations.

In response to climatic threats, farmers have formed groups/cooperatives to facilitate the acquisition of inputs, improve on-farm activities, transmit value-adding information and support marketing. These groups also help provide access to extension services, enabling farmers to prepare for risks. This is evident in the case of poultry farmers, cassava and chilli farmers. The cooperatives are also engaged in bulking the commodities in order to seek better market prices for the farmers. For instance, KALRO has been providing and facilitating the use of drought-tolerant cassava varieties in Kilifi County.

As an alternative option, farmers have been seeking off-farm employment opportunities such as fishing or business or move to urban centres in search of jobs to mitigate the climate variability risks. Kilifi with its ocean shoreline has opportunities in the tourism sector for the local population.

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

Cassava

	Provision of seeds and other inputs 	On-Farm production 	Harvesting storage and processing 	Product marketing 
Floods	Lack of access to clean and improved planting cuttings; scarcity of planting cuttings; planting cuttings and not materials	water logging; delay in planting calendar	Minimal or no harvest; destroyed storage facilities; increased incidence of rotting at storage	Increased root demand and low supply; flooded markets leading to less market activities; increased market price
Magnitude of impact	Severe	Severe	Severe	Severe-Moderate
Farmers' current strategies to cope with the risks	Use of local (traditional) roots varieties; use of traditional pest control inputs (ash/oil)	Terracing and furrows; formation of women groups to provide pooled labour; intercropping; crop rotation; enterprise diversification	Farm gate sale of roots; use of roots as livestock feed; post-harvest value addition (drying to reduce perishability)	Low quantity and quality of marketed roots; low market prices; reduced market/marketing activities by traders; market scarcity (leading to market abandonment)
Other potential options to increase farmers' adaptive capacity	Local seed bulking; germplasm maintenance	Construction of dams to control floods; upscale of household/community tuber planting (increase acreage); awareness campaigns on crop's importance to food security	Community storage centres; traditional household post-harvest value addition and conservation practices (flour making)	Formation of producer groups (facilitate market pricing and marketing activities)
Droughts	Drying of planting materials; scarce labour and increased labor costs	Soil degradation (hardening of soils); drying of planting material; increased labour cost; delayed planting ;poor stand establishment and poor crop vigor; increased incidences of pests	Poor quality and reduced quantity of harvested roots; increased incidence of storage pests; drying of stored roots	Increased prices; reduced market activities; lack of potential buyers due to inconsistent supply
Magnitude of impact	Severe	Severe	Severe	Severe
Farmers' current strategies to cope with the risks	Recycling of planting materials or cuttings; pooled labor; access to inputs (seed, fertilizer and extension services) through development/aid agencies; farmer grouping (facilitate access to inputs/extension services)	Early land preparation; early/staggered planting; planting clean and certified tubers; use of ash (prevents ants); tree planting (provide shade); intercropping; crop rotation; mulching (with crop residues); water harvesting and storage, mapping soils for suitability of growing cassava	Use of household labor (harvesting); use of cereal stores; divert root harvest to household consumption; sale of root at farm gate to avoid storage	Low quantity and quality of marketed tubers; low sale prices by farmers; loss of market/marketing activities by traders; market scarcity (leading to market abandonment); improve and strengthen market information on markets and prices, formation of processing groups
Other potential options to increase farmers' adaptive capacity	New drought and pest tolerant tuber varieties; local root nurseries; conservation of cassava germplasm	Use of s oil rippers (break hardpans); enterprise diversification (to grow other crops); access to affordable pesticides/insecticides; promote water conservation structures (dams/pans)	Community storage centres; traditional household post-harvest value addition and conservation practices (drying/flour making)	Formation of producer groups (facilitate market pricing and marketing activities); establishment of collection and storage centres to stabilize prices

African Bird Eye Chili

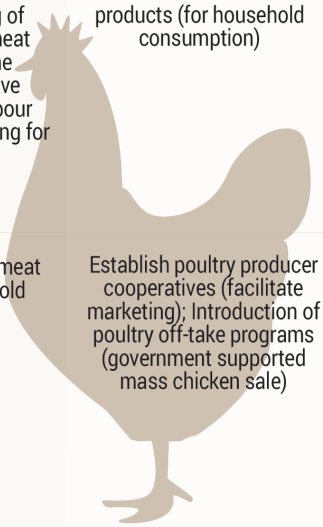
	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
Floods	Increased incidence for seed loss at nursery stage (rotting, wiping away); scarcity of labour and inputs (access challenges due to damaged roads)	Water logging of seedlings at planting; deteroriated soil quality (poor germination/seed rotting); loss of applied inputs (ferilizers/chemicals); low stand establishment; loss of crop vigor; increased disease incidence	Poor quality of harvested chillies; increased storage durations (collection hampered by lack of access to farms); increased labor (sorting and grading)	Low market prices (Low quality chillies); loss of markets/marketing opportunities; shift in market focus
Magnitude of impact	Severe	Severe	Severe	Severe
Farmers' current strategies to cope with the risks	Pooled labour (formation of women groups to provide cheap labour); establish farmer owned nurseries; use of pesticides/insecticides	Construction of raised seed beds; use of greenhouses; contruction of water drainage controls (terraces, canal, furrows); use of chemicals for pest and disease control; enterprise diversification (to holticulture; banana farming): intercropping (with cereal/tuber crops);	Use of bad quality chilli as poultry medicine; disposal of rotting chilli; use of family labor for sorting and grading; crop abandonment in case of severe crop failure; use of chilli solar driers	Low market prices; farm gate sales (to avoid storage expenses); sale to local markets (traders/hotels/institutions)
Other potential options to increase farmers' adaptive capacity	Research on moisture torelant chilli varieties; county support in giving input aid during floods; offering access to extension services	County support in construction of water drainage /conservation structures (dams/canals); use of improved pesticides/insecticides; Training on enterprise diversification (poultry keeping/bussiness)	Offering IPM technonologies (pest and disease control); capacity building on chilli value-addition technologies (as poultry drugs); access to improved storage materials (canvass and wooden crates)	Formation of farmer groups (facilitate contracting); contracted farming (supporting producers in input provision/storage/negotiated prices)
Droughts	Increased nursery seed loss; labour scarcity; lack of water	Low seed germination; poor stand establishment; loss of crop vigor; Loss of soil quality (hardening); Increased labor needs; wilting/drying of planted crop	Poor quality and low quantities of harvest produce; increased labour needs for sorting and grading; increased incidence of storage pests(weevils); loss of flavor (overdrying)	Reduced market supply (high demand); Increased market prices
Magnitude of impact	Major	Major	Major	Severe
Farmers' current strategies to cope with the risks	Use of drip irrigation kits; growing seeds in nurseries (before transplanting); pooled labor (through farmer groups); access inputs (pest and disease control); use of traditional pest control (herb sprays); farmers dry the chillies to get their own seeds rather than being given free of charge	Replanting/ staggered planting; mulching (cereal crop residues); drip irrigation (after establishment); crop rotation; planting trees (shade/windbreak); enterprise diversification (poultry/cereal production); intergrated pest management (pest control kits from ICIPE) intercropping (mangoes and pawpaws); sunken beds, water holes of water harvesting	Use of manual (household) labor at sorting and grading; construction of drying and storage sheds; storage in gunny bags and traditional sisal vessels (reduce loss of flavor)	Sale to local markets; produce offered free of charge to neighbours/friends
Other potential options to increase farmers' adaptive capacity	Research (to improve drought torelance); acess to modern pesticides; access to greenhouses (materials/structures); acess to irrigation equipment; access to extension services	Widespread access and use of drip irrigation kits; research on improved crop rotation practices; IPM practices; continued support from research agents (for pest control and management)	Improved access to storage facilities; farmer capacity building on best practives for chilli storage (preventing loss of flavor)	Producer groups (facilitating production, marketing, pricing); Contract farming with external buyers; support in external market access

Dairy (cattle)

	Provision of inputs	On-Farm production	Harvesting storage and processing	Product marketing
Floods	Limited access to extension services; reduced feeds (fodder,pasture) reserves; increased cost of veterinary services and dairy inputs (feeds, drugs, vaccines)	Low breeding success rate; poor feeding (result to malnutrition); increased pests and disease incidence; increased animal production cost (feeding, deworming); high mortality rates	Poor milking regimes (inaccessibility to milking pens); poor milk storage (damaged storage structures); manual milking (damage to mechanical milking equipment); milk storage in metal and plastic cans	Milk scarcity on the market and increased demand; increased consumer prices; reduced market activity (road inacessibility; l oss of marketing opportunities)
Magnitude of impact	Moderate	Severe	Major	Severe-Major
Farmers' current strategies to cope with the risks	Feed (fodder) conservation; water harvesting (floodwater harvest for fodder production); regular mass vaccinations	Construction of on-farm water drainage structures (tunnels, furrows) for pasture establishment; synchronized cattle breeding; increased drugs and vaccines use; increased production costs (feeding/houshing/breedig)	Low quantity and reduced milk quantity; poor storage facilities leading t milk contamination; increased milk spoilage (store in cans/metal tins); milk for household consumption	Poor milk quality (low sale prices); milk scarcity and increased demand external milk imports by traders/processors reduced market and marketing opportunities
Other potential options to increase farmers' adaptive capacity	County support in introduction of new water harvesting techniques/structures (dykes, canals); use of cost-effective oil-based vaccines; support (government/aid agents); provision of dairy input as relief; access to improved animal breed varieties; improved access to extension services; mechanization of fodder conservation and construction of mega multi-purpose dams	Capacity building on feed conservation techniques (hay/silos); access to alternative feed supplements (crop biomass); acess to improved/modern vaccines; animal insurance schemes	Access to small-scale and community-based refrigeration/cooling facilities; capacity building small scale farmers on cottage milk processing (cheese, yorghut); continued capacity building (on propoer husbandry practices milking	Formation and support of dairy farmer groups/cooperatives (marketing and milk pricing activities)
Droughts	Reduced feed availability (fodder); high demand and increased costs of veterinary services; Increased demand of extension services; unavailability of breeding stock	Malnutrition; decreased growth rate; increased cost of feeding; low breeding rates; increased mortality rate; Increased incidence of animal pests (ticks)	Reduced milk quality and quantity; increased milk and meat contamination (dust/dirt); low milk and carcase quantity; Increased cost of milk storage and packaging; milk spoilage and short shelf-life	Reduced market and meat market availability; increased market prices (High demand/ low supply); high cost of milk distribution
Magnitude of impact	Severe	Severe	Severe	
Farmers' current strategies to cope with the risks	Water conservation techniques for pasture establishments (Zai pits); fodder purchase (locally and externally); rearing drought resistant animal breeds; crossbreeding exotic/indigenous cattle; farmer grouping (facilitate access to inputs/extension services)	Pasture conservation (hay/silage) and use of cattle feeding regimes; feed supplementation (minerals/licks) ; tethering/herding of animals; keeping drought tolerant breeds; use of cop residues (animal feeds); access to advisories from early warning systems	Lowered capacity for milk processing (e.g. powder milk) by agroprocessors; milk consumed at household level; storage in locally available plastic/metal containers; household milk processing (fermentation products)	Milk scarcity and increased demand; external milk imports (local traders/processors): market price exploitattion due to poor milk quality; reduced market and marketing opportunities
Other potential options to increase farmers' adaptive capacity	Feed bulking; reseeding of natural pasture lands; use of hydroponics to grow animal feeds; increase artificial insemination services	Selection of efficient feed converting animals (breeding herd); access to livestock insurance schemes (cushion loss of livestock at household); training on enterprise diversification (cereal production/poultry keeping); Construction fo hay storage structures and mechanization of hay storage harvesting; proper demarcation of grazing land.	Use of renewable energy sources (reduce storage costs); construction of community operated milk processing plants; increased processing of value-added products (milk powder)	Dairy farmer groups/cooperatives (milk pricing)

Poultry

	Provision of inputs	On-Farm production	Harvesting storage and processing	Product marketing
Floods	Poor feed quality (Rotting); Feed scarcity; High vaccines demand; High maintainance cost of poultry houses	Increased incidence of diseases and outbreaks; high mortality rate; poor growth rates; increased use of drugs and vaccines	Reduced meat quality and low weight of poultry products; poor storage facilities	Low supply of local chicken (by farmers); high poultry products demand and low market supply; decreased market activity; poor infrastructure (drainage and roads for transportation) to market sale points
Magnitude of impact	Major	Major	Moderate	Severe
Farmers' current strategies to cope with the risks	Use of alternative feed supplements (kitchen waste/holticultural afterharvest products)	Use of modern and traditional drugs for disease control; mass vaccinations (disease outbreaks)	Household slaughter/dressing of poultry carcases; meat storage (polythene bags); manual labour (slaughtering)	Low market prices (by farmers); high poultry products demand and low market supply; decreased market activity; poor transportation (products contamination by moisture/dirt)
Other potential options to increase farmers' adaptive capacity	Capacity building/training on alternative feed sources; feed formulation; feed conservation; provision of improved chicken breeds/chicken cross breeds	Enforcement of vaccination (disease outbreaks); enterprise diversification (to crop farming/employment)	Provision of improved meat storage structures (moisture free and cold storage); government support to access to small scale refrigirators; community access to modern slaughter equipment; farmer training on chicken poultry standards (feedinhg/slaughter/ storage)	Establish poultry producer cooperatives (facilitate marketing); introduction of poultry off-take programs (government supported mass chicken sale); country support to explore external markets; establishment of specific local chicken auctions
Droughts	Feed scarcity; Increased feed/Input prices; increased disease incidence; increased used of vaccines; high maintainance cost	Poor productivity; reduced feeding (malnutrition); increased disease incidence; high mortality rate; increased use of drugs/ vaccines/ supplements; increased water intake	Low quantity and reduced meat quality; low egg production; poor storage facilities; reduced weight; spoilage of bird carcases	Low market prices; high market demand and low supply; decrease in market activities and opportnities; poor transportation (product contamination by dust); high transport cost; live birds die due to dust and heat stress
Magnitude of impact	Moderate	Moderate	Moderate	Moderate
Farmers' current strategies to cope with the risks	Use of feed supplements; alternative feed strategies (drought-tolerant crops); use of thermo-stable vaccines; farmer grouping (facilitate access to inputs/extension services); birds are allowed to scavenge for food	Water harvesting and conservation practices (to establish poultry feeds); regular poultry vaccination; free foraging flocks; access to advisories from early warning systems; enterprise diversification (fishing/employment)	Household slaughter/dressing of poultry carcases; meat storage (polythene bags/hanging above ground); manual labour (slaughtering/searching for layed eggs)	Divertion of chicken products (for household consumption)
Other potential options to increase farmers' adaptive capacity	Capacity Building/Training on alternative feed sources/feed suplementation (local resources); Research on alternative vaccines (traditional herbs); Use of modern poultry vaccines (support by the county); Provide impoved chicken breeds	Introduction of insurance products (Cushion againist drought-related risks; Promotion / upscale of water harvesting/conservation; enforcement of disease control measure during outbreaks; improved access to extension services	Provision of improved meat storage structures (cold storage)	Establish poultry producer cooperatives (facilitate marketing); Introduction of poultry off-take programs (government supported mass chicken sale)



Policies and Programmes

discussed below and summarized in Annex 3.
Currently, Kilifi County is in the process of creating or adopting climate risk management policies that can address some of the major challenges faced by farmers and some of the informational, institutional, and resource shortcomings that compromise their ability to respond to these challenges.

The National Livestock Policy (2008) seeks to create a favourable environment for the private sector to thrive by creating mechanisms for capacity building, supervision, regulation and improved access to market information. This policy prioritizes actions such as breeding, nutrition and feeding, value addition and marketing, disease control, and research and extension. Additionally, it provides good opportunities for encouraging the adoption of climate adaptation practices, for example through breeding programmes that share information about animal genetic resources including those better adapted to climate conditions. Already there are efforts on the ground in the County to support the conservation of feed, the improvement of local breeds through selective breeding, and the establishment of pastures through pasture re-seeding.

The Arid and Semi-Arid Lands Policy - ASALs (2007) aims to revitalise ASALs by sporting livelihood opportunities in the drylands. The policy acknowledges pastoralism as a legitimate and productive livelihood and aims for the coherent development of the ASALs through the provision of basic services (health, education, and infrastructure) and the decentralization of strategic planning on livelihood diversification, community participation, and drought early warning systems. ASALs are the most vulnerable to impacts of climate change and variability, thus the policy works to provide ASAL-specific linkages between adaptation and development agendas.

The National Irrigation Policy - draft (2014) aims to: expand land under irrigation; increase agricultural water harvesting and storage capacities; promote water harvesting, use of wastewater, and exploitation of groundwater for irrigation; build capacity for the generation and utilization of irrigation research, innovation, and technology, and; promote and adopt an integrated approach to sustainable commercial irrigation farming. Under this policy, there have been concerted efforts to promote drip irrigation and various forms of water harvesting such as establishment of water pans, Negarims, roof water harvesting and storage tanks.

Based on the vulnerability assessments mentioned previously, the NMDA is implementing the Cash for Assets program, which entails the transfer of cash to most vulnerable farmers who, in return, establish an asset that is used to mitigate climate change risks. NMDA also provides support to the vulnerable farmers participating in this Cash for Assets program in terms of non-food items such as wheelbarrows and mattocks that are used in the establishment of the assets. This program is also aimed to address water by facilitating the establishment of water pans, zai pits, sunken beds and Negarims for crop production. Challenges to this intervention are linked to limited human and financial capacity to ensure full coverage within the County.

KACCAL has introduced interventions (technologies) within the beekeeping, Local poultry, dairy cow and ABEC value chains to increase resilience to climate change effects. KACCAL provided inputs and extension services for demonstrating the various technologies. It is mostly the small-scale farmers with limited alternative income-generating options that benefit from these interventions. Some farmers also tend to develop dependency syndrome whereby they expect to be given all the time rather than working towards being independent of the donors in terms of being supplied with things like inputs every now and then. The Kenya Cereals Enhancement Programme - Climate Resilient Agricultural livelihoods Window (KCEP-CRAL) is a new initiative by the government aimed at increasing rural households' resilience to climate change and thus help reduce poverty and food insecurity.

The programme is expected to benefit Small-holder farmers including women-headed households and young people whose livelihoods depend on maize, sorghum, millet and associated cereals. Another initiative is farming the Gods way led by the Anglican services of Kenya. This is a church based initiative dedicated to conservation and restoration of biodiversity with agriculture being one of the critical sectors of interest. Agricultural productivity is declining due to climate change among other factors causing food insecurity and environmental degradation. This is done through organizing farmers training that seek to address biodiversity conservation and increase food production. Forums are organized for sharing various experiences the different communities have undergone.

The Kipepeo project is a forest butterfly farming initiative which aims to provide alternative to farmers who raise butterfly pupae for export. This deters the farmers from clearing the forest for farmland.

Governance and institutional resources

Climate risk management and adaptation strategies in Kilifi are implemented mainly through the collaboration between various actors, both state and non-state. Amongst the most influential are the state actors, including the line ministries and departments such as; the Agriculture, Livestock and Fisheries Department; the Kenya Meteorological Department (KMD); Kenya Agriculture and Livestock Research Organization (KALRO); the Kenya Forestry Service (KFS), together with its research arm the Kenya Forestry Research Institute (KEFRI); Water Department; ASDSP; Academic institutions such as Pwani University; and government parastatals such as NDMA and the National Environmental Management Authority (NEMA).

The non-state actors and non-governmental organizations (NGOs) include WV, KRC, the UN's World Food Programme (WFP), Kilifi Charcoal Burners Association and FAO. Government departments mainly provide technical support and policy direction while non-state actors provide the research, funding, and implementation for the adaptations. The collaboration is largely coordinated through a stakeholder's forum that is responsible for planning climate risk management.

In Kilifi County, NDMA is the key player that spearheads climate risk management by serving as convener of the stakeholders' meetings and bringing together key state and non-state actors. The main mission of the NDMA is to ensure that drought does not bring about famine in its areas of operation in the arid and semi-arid lands of Kenya. This is accomplished through a number of strategies, but most importantly by providing early warning systems. At the stakeholders' meetings, the convened actors assess the County's situation based on the early warning system provided by the NDMA. They then decide upon the best course of action to bring about the desired solutions and apportion each actor a task to perform based on their capacity and the financial resources at their disposal. The assessment is done for both the long and the short rains and in case of any other emergency. The NGOs have a great deal of influence in the implementation process due their financial muscle. Community-based organizations are normally incorporated in implementation phase of adaptation since they are grassroots organizations that are more able to influence the farmers within their mandate.

Even with preparatory stakeholder meetings, the great majority of the climate risk management in the County is reactive as opposed to proactive; actions are taken to reduce damages incurred instead of looking ahead to prevent them. Government departments have neither climate risk management sub-departments nor specific budgets assigned to climate risk management, even though most of their activities play an important role in addressing climate threats and hazards. As for the NGOs, their activities are often prescribed by their project or program plans, which are often locked-in and not easily modified or altered throughout the longevity of their implementation. Inclusion of climate risk management must be included from the start of the project, or it is unlikely to be added to any real extent until the periodic assessment phases, if at all.

Even though there is a good deal of collaboration among the various stakeholders mentioned above, currently, there is not an institutionalized framework for structuring and organizing the collaborations between actors. This lack of structured interaction contributes to a lack of accountability on the part of the actors. The integration of climate risk management efforts in Kilifi is further complicated by the ongoing process of domesticating national policies and adapting them for the county level, as is happening nation-wide. Inadequate funding and limited human capacity are the bane of climate risk management: these factors affect each phase of intervention, from planning to implementation, and thus should be considered core issues when addressing climate adaptation efforts.

Crucially, the various organizations involved in climate risk management must share information with one another to avoid the duplication of efforts and improve efficiency in the delivery and implementation of initiatives. Relatedly, the various stakeholders involved in climate risk management should receive in-depth training on the topic, including training and capacity building across institutions to mutually reinforce one another's skills, to enhance their skills in analysing and strategizing adaptations. There is also need for adequate monitoring and evaluation of the interventions that are underway and planned in order to improve the efficiency of implementation and ensure that future project build on the existing successes and avoid the common pitfalls of previous interventions. These types of collaborations, knowledge sharing, and reflection should be carried out through inclusive processes such as forums that bring together relevant actors and interactions with climate risk management actors in other sectors or counties to support the cross-pollination of ideas and potentially the disbursement of funds and resources.

Synthesis and Outlook

Drought and flooding incidences are already visible and are projected to increase in the near future in Kilifi and therefore it is imperative that the farmers' capacity to cope with these conditions is enhanced. This calls for both short-term and long-term adaptations that target value chains that are key for the population's food security and livelihoods for both livestock and crop systems.

Various measures to increase the resilience of farmers in Kilifi are ongoing. This include on-farm practices such as planting drought-tolerant varieties, crop diversification, construction of water pans, Zai pits, Negarims, sunken beds aiming at water and soil conservation, drip irrigation, mulching, crop rotations, agroforestry systems, drought-resilient animal breeds. To complement the on-farm services, there are off-farm activities such as the early warning information and extension services to prepare and advise farmers on how to manage the risks. Other farmers have formed groups that provide cheap agricultural labour to each other.

As farmers continue to implement the on-farm initiatives, taking cognizance of the entire value chain activities is crucial since all activities are affected by climate change and variability. Farmers cannot produce without having the recommended inputs at the required time and therefore timely access of inputs is vital. Equally important is the handling of the produce after harvesting and subsequent marketing. Farmers have been known to get bumper harvests only for the same farmers to incur heavy post-harvest losses occasioned by excessive rains during harvesting and poor storage. Recommended inputs should be made available at the right time through availability of more input outlets. Extension services are essential for supporting farmers in investing in technologies that improve crop and livestock productivity and prevent post-harvest loses.

Improvements in road infrastructure are also key to ensure that the produce reaches the market timely and in good quality. Moreover, most of the agricultural produce is sold in raw form and have a degree of perishability and therefore value addition will come in handy to reduce losses, increase shelf-life and increase the income earned from the produce.

The River Sabaki creates a high irrigation potential in the County, offering opportunities for the expansion of the agricultural sector. In the case of livestock, practices related to fodder (hay) production and storage, which can ensure a sustainable and stable supply, have proven effective, and could be complemented with improved productivity-oriented practices (such as livestock crossbreeding), to ensure maximization of benefits. Added to these, timely and accurate weather forecasts would help actors along value chains take informed decisions in their effort to adapt to changing climate conditions.

Apart from these measures, the study highlights the need to address the underlying factors that increase farmers´ vulnerability to climate change and variability. Investments in the provision of basic amenities such as availability of and access to electricity, water and education are required to empower farmers and helping them take informed decisions on their farm (use of inputs, interpreting weather information, etc.). Moreover, basic services provide the population with avenues to venture into other income-generating activities that lift them out of poverty and enable them to undertake longer-term investments in agriculture. Alternative sources of income will curtail the involvement of the populations in environmental-degrading activities such as charcoal burning that decimate the tree cover and contribute to climate variability.

In terms of an enabling policy and institutional environment, there is a need to scale-down national policies to the County level, tailoring them to local needs and resources available, so as to address institutional and financial inadequacies that hinder effective climate risk management.

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For further information and access to the annexes, visit https://cgspace.cgiar.org/handle/10568/80452

Annex 1: Crop and Livestock/Animal Production in Kilifi County
Annex 2: Climate analysis
Annex 3: On-farm adaptation strategies

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