

# Climate Risk Profile Taita Taveta County

## Highlights

- Taita Taveta has been experiencing changes and variabilities in climate for the last four decades. The long-term environmental changes include soil degradation, reduction of water volumes in rivers, landslides, deforestation, drying of wells and rivers, and increased human wildlife conflicts.
- Agriculture is the main source of livelihood in Taita Taveta. It contributes about 95% of the household incomes and more than 80% of employment. Absolute poverty stands at 57% while 48% of the population experience food poverty.
- The agriculture sector is greatly affected by droughts, floods, unpredictable and unreliable rainfall, and high temperatures brought about by climate change. These effects of climate change are compounded by low use of inputs, poor infrastructure, and high levels of poverty and illiteracy. Moreover, only 40% of households own title deeds. A need therefore exists to increase the number of title deed holders so as to enhance investment in agriculture.
- Farmers adapt to climate change by planting trees, practising soil and water conservation, water harvesting, staggered cropping, and pasture conservation, and changing crop and livestock types. However, the adaptive capacity of farmers remains low. Therefore, there is need to support adoption of strategies such as agricultural insurance, increased irrigation, and mechanization.
- Available off-farm services that help increase crop farmers' and livestock keepers' climate adaptive capacity include extension services and training, fodder conservation, credit, storage, value addition, early-warning information, and production inputs.
- Several government, non-governmental, community-based, and private organizations support climate change adaptation efforts in the County through alternative channels such as extension services, delivery of inputs, and policy-making. Local beneficiaries are generally involved in the planning phases of various interventions, but are often absent from subsequent phases including implementation, monitoring, and evaluation. The capacity of these organisations to deliver accurate, easy-to-understand, and timely information to farmers is limited by inadequate financial, technical, and human resources. This leads to unequal coverage of farms in the County. The organisations also need to improve coordination in addressing climate vulnerabilities.
- Successful implementation of climate adaptation strategies will require strengthening the institutional and financial capacity of key actors. In turn, farmers must have the information and tools to respond to climate change. Appropriate adaptation will depend upon farmers' ability to access crucial extension services in a systematic way.
- It is imperative to mainstream climate change in the County development plans and budgets by introducing a County climate adaptation fund and implementing climate risk reduction and social protection programmes.

## List of acronyms

AI	Artificial Insemination
AMS	Agricultural Mechanization Services
ASDSP	Agricultural Sector Development Support Programme
ATC	Agricultural Training Centre
CAADP	Comprehensive African Agricultural Development Programme
CIAT	International Center for Tropical Agriculture
CIG	Community Interest Group
CIP	International Potato Centre
EAAPP	Eastern Africa Agricultural Productivity Project
EWS	Early Warning Systems
FAO	Food and Agriculture Organization
GEF	Global Environmental Facility
IPM	Integrated Pest Management
ITK	Indigenous Traditional Knowledge
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research Organization
KAPAP	Kenya Agricultural Productivity and Agribusiness Programme
KAPSLM	Kenya Agricultural Productivity Project and Sustainable Land Management Project
KCB	Kenya Commercial Bank
KDB	Kenya Dairy Board
KES	Kenya Shillings
KFS	Kenya Forestry Service
KMD	Kenya Meteorological Department
KRCS	Kenya Red Cross Society
KVD	Kenya Veterinary Department
KWS	Kenya Wildlife Service
MLND	Maize Lethal Necrosis Disease
NAAIAP	National Agricultural Accelerated Input Access Programme
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NCPB	National Cereals and Produce Board
NDT	Nguamlambo Development Trust
NEMA	National Environmental Management Authority
NGO	Non Governmental Organization
NMK	Njaa Marufuku Kenya
PPP	Public Private Partnership
SCCF	Special Climate Change Fund
TEI	Taita Environmental Initiative
THVC	Traditional High Value Crops Promotion
VCC	Value Chain Commodity
WB	World Bank
WFP	World Food Programme



# 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 (NCCAP) in 2012. The focus of these initiatives has been the national level. As the country shifts towards County governance and focus, there is a need to mainstream climate change perspectives in programmes and development plans at the County level.

In support of efforts to strengthen local capacities of stakeholders to reduce the near-, medium- and long-term vulnerability to current and future climate change and 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, 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.

Presented here is the County Climate Risk Profile for Taita-Taveta County, a County where climate variability has been accompanied by a significant increase in risks, as often reported in national news. In the past five

years alone, Taita-Taveta residents have been among the hardest hit by intermittent cycles of drought and floods. In 2012, 2014, and 2015, the County suffered acute drought that destroyed crops and livestock and left many dependent on food aid. An estimated 87,000 people were affected by famine caused by drought, forest fires and the subsequent invasion by wild animals that destroyed surviving food crops in 2012. Three years later, approximately 81,000 people were reportedly starving due to acute water shortages that affected agricultural production and access to drinking water throughout the County but especially in Maktau, Kishushe, Mbololo, Kasighau, and Maungu<sup>1</sup>. The years 2013 and 2015 experienced torrential rainfall that caused flash flooding; the floods killed several people and hundreds of heads of cattle and destroyed thousands of acres of cropland<sup>2</sup>. The disastrous nature of extreme weather makes identification of impending climate risks urgent. Considering how practices that help citizens become more resilient in the face of imminent threats to their health, safety, and livelihoods is equally urgent.

This 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 text 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 Taita Taveta. In the next section, the main climate hazards are identified based on 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 As reported by the Star online newspaper (The Star 2015a, 2012).

2 As reported by online newspapers Floodlist (2013) and Citizen Digital (2015).

## Economic relevance of farming

Taita Taveta is one of the six counties in the coastal region of Kenya. It borders Tana River, Kitui and Makueni Counties to the North, Kwale and Kilifi Counties to the East, Kajiado County to the North-West, and the Republic of Tanzania to the South and South-west. It is located approximately 200 km North-West of the coastal city of Mombasa and 360 km South-East of Nairobi, the capital city of Kenya. The County covers 17,084.1 km<sup>2</sup> and lies between latitudes 2°46' South and 4°10' South and longitude 37°03' East and 30°14' East (GoK, 2013). Administratively, the County is divided into four sub-County units namely: Wundanyi, Mwatate, Voi, and Taveta<sup>3</sup>. The County headquarters is in Mwatate.

Topographically, the County is divided into three major zones. The upper zone comprises Taita, Mwambirwa, and Sagalla hills regions with altitudes ranging between 304 and 2,208 m. The lower zone consists of plains while the third zone is the volcanic foothills zone covering Taveta region. There are two lakes, Jipe and Challa, both found in Taveta area and served by springs emanating from Mt. Kilimanjaro. The main rivers are the Tsavo, Lumi, and Voi. There are also springs like Mzima springs and other small springs and streams including Njukini, Njoro kubwa, Kitobo, Sanite, Maji Wadeni, Humas and Lemonya springs.

The climate in Taita Taveta County is strongly influenced by the South-Easterly winds. The County is largely dry except for the Taita hills which are wetter. The hilly areas have ideal conditions for condensation of moisture, which results in relief rainfall. There are two rainy seasons - the Long rains between March and May and the Short rains between October and December. Rainfall distribution is uneven, with the highlands receiving higher rainfall than the lowlands. During the Long rains, on average the highlands record 265 mm while the Lowlands record 157 mm. Mean rainfall during the Short rains is 1,200 and 341 mm for the highlands and the lowlands respectively. The annual mean rainfall is 650 mm. The average temperature is 23°C; it falls to 18.2°C in the hilly areas of Taita, Mwambirwa, and Sagalla, and rises to about 25°C in the lower zones (GoK, 2013).

The County is divided into eight Agroecological Zones (AEZs) (Jaetzold et al. 2010). These are:

- The lower highland zone (LH2), found in Wundanyi at altitudes above 1680 m, receives more than 1,200 mm of mean annual rainfall.
- The upper midland zone 3 (UM3), found in Wundanyi at altitudes between 1,370 and 1,680 m, receives around 900 – 1,200 mm of mean annual rainfall.
- The upper midland zone 4 (UM4), found in Wundanyi at altitudes between 1,220 and 1,520 m, receives 700 - 900 mm of mean annual rainfall.
- The low midland zone 4 (LM4), including Wundanyi, Mwatate and Taveta at altitudes between 910 and 1220 m, receives 600 - 800 mm of mean annual rainfall.
- The low midland zone 5 (LM5), including Wundanyi, Mwatate, Taveta and Voi, is situated at altitudes between 790 and 980 m and receives 480 - 700 mm of mean annual rainfall.
- The low midland zone 6 (LM6), is located in Taveta National Park, Mwatate and Voi at altitudes below 790 m; it receives bimodal rainfall<sup>4</sup>
- The lowland zone 5 (L5) found in Mwatate, Taveta and Voi at altitudes between 610 and 790 m, receives 480 - 680 mm of mean annual rainfall.
- The lowland zone 6 (L6) found in Tsavo National Park and Voi at altitudes below 610 m; it receives bimodal rainfall.

Arable land constitutes about 205,500 ha or 12% of the total land area in the County and 3.7% of the national arable land. The larger part of the County is the two national parks, Tsavo East and West National Parks which cover approximately 1,065,000 ha, representing 62% of the total land area. Forest parcels gazetted as forests cover 1,489.8 ha while non-gazetted forests cover approximately 9,000 ha (GoK, 2013). Agroforestry is widely practised in the County.

The forests provide key ecological services including protection of water catchments, and serving as carbon sinks and wildlife habitats. The forests and wildlife play a critical role in ecotourism in the County. The forests also produce timber, fencing poles, wood fuel, herbal medicine, tubers, latex, gum, wild fruits, and honey. Charcoal is produced from ranches and private farms.

3 Constituencies follow the same boundaries as sub-counties hence go by the same names. County further divided into 32 and 90 locations and sub-locations respectively

4 Rainfall bimodal and area not suitable for rainfed agriculture except under irrigation.



Mining is a major activity in the County; major minerals include gemstones and industrial minerals such as iron ore, limestone, marble, magnetite, asbestos, graphite, kaolin clay, and mica. Other mining-related activities are quarrying for building stones, murrum, ballast, and sand harvesting.

Farming is the main occupation in the County, and plays a critical role in provision of food and employment creation<sup>5</sup>. It is the main source of food for households and provides raw materials to agro-based industries. The agricultural sector comprises both subsistence and large-scale commercial farming.

Agriculture contributes 95% of household income (GoK, 2013). Income sources are not diversified within the agriculture sector where over 83% of the households depend on a single income source (GoK, 2014). Crop- and livestock-related activities contribute 26 and 15% respectively. Eighty-six percent of female-headed households and 42 and 21% of male- and youth-headed households respectively depend on income from crop-related activities. Thirty-two percent of male-headed households and 14 and 10% of female- and youth-headed households respectively depend on livestock-related activities (GoK, 2014). Agriculture employs about 80% of the County's workforce.

The average farm size for small-scale farmers is about 0.4, 1.3, and 4.8 ha respectively in the highlands, midlands, and lowlands. Large-scale farms (mostly sisal estates<sup>6</sup>) occupy 7,400 ha each on average. The total acreage under food crops is 18,125 ha and that under horticulture<sup>7</sup> is 3,296 ha. Ranching is practised mostly in the lowlands. There are 28 ranches<sup>8</sup> with an average of 12,762.5 ha, covering a total of 77,350 ha. However, only 40% of the households have title deeds (GoK, 2013).

A survey by Agricultural Sector Development Support Programme in 2014 indicated that the primary occupation of the households was crop and livestock production. Over 90% of the total households grow maize; 46% grow beans and 31% grow cowpeas<sup>9</sup> (GoK, 2014). Drought-tolerant crops including sorghum, millet, pigeon peas, green grams, and cowpeas are grown in the lowland areas, where ranching and sisal growing are also practised. In Taita Hills, tomatoes and

cabbages are the most important horticultural crops. In Taveta, cultivation of tomatoes, onions and bananas is dominant.

## People and livelihoods

The population of Taita Taveta County was 329,383 in 2015. With a population growth rate<sup>10</sup> of 1.6% per annum, the population is projected to increase to 345,800 in 2017 assuming constant rates of mortality and fertility. The rural population is estimated to be 75%, while the urban population is 25% (GoK, 2013).

The absolute poverty in the County is 57%<sup>11</sup>. Food poverty stands at 48%, implying that the County is not self-sufficient in food; it is 52 and 48% in urban and rural areas respectively. The nutritional status of children based on the indicators: stunting, wasting, and underweight is 34, 11.2, and 28.5% respectively<sup>12</sup>. About 79% of the population aged 15 years and above are able to read and write, while 15% are not able to read and write.

The high level of poverty in the County is attributable to a number of factors including: erratic and inadequate rainfall especially in areas dependent on rain-fed agriculture; insufficient water for irrigation in the lowlands; poor agricultural practices; wildlife destruction especially in areas that border the Tsavo National Parks; population increase and hence large family sizes; and high rates of unemployment. The economic and social challenges posed by HIV/AIDS have also contributed to the state of poverty in the County. Those most affected by overall poverty include the aged, the disabled, small farm holders (with less than 0.05 ha), landless, and squatters, children, and female-headed households. Poverty pockets are concentrated in areas with marginal agricultural potential in the County<sup>13</sup>.

Firewood and charcoal continue to be the main sources of cooking fuel at 69% and 24% respectively. The main lighting fuel is paraffin (81%), followed by electricity (15%) and solar energy (2%). The major sources of water are piped water and streams accessed by about 60 and 23% of the households respectively.

5 However, the budget allocated to agriculture was 3% in the financial year 2014/2015.

6 There are three sisal estates

7 Excludes sisal estates

8 The ranches are either Kenya Government or private owned. The County is a major livestock rearing zone partly due to these ranches. Beef cattle mainly produced in the ranches.

9 Participants in the County workshops rated the proportion of households engaged in maize production as 81-100%

10 Against the national average estimated at 3% (KNBS, 2009)

11 Absolute poverty refers to population living by less than KES 1,562 per month.

12 Stunting - height for age; wasting - weight for height; underweight - weight for age.

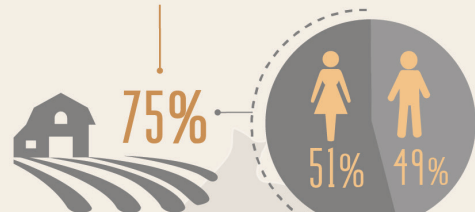
13 Marginal farming refers to the subsistence system that largely depend on rainfed agriculture.

# Livelihoods and agriculture in Taita Taveta

## Demographics

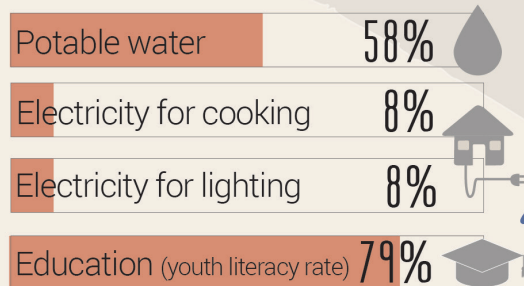
0.7% Of Kenya's population

329,383 inhabitants



## Access to basic needs

57% of the population lives in absolute poverty



## Food security

48% 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)

County's farming area

205,500ha

12%

40% of the population employed in agriculture production

40% of farmers have title deeds ND% are women

## Farming activities

Food crops



9%

Cash crops



2%

Livestock



6 Group ranches

Of country's agricultural land

## Farming inputs

Water uses



Fertilizer types (% of households)



20% Organic manure

16% Planting fertiliser

8% Top dress fertiliser

Pesticide types (% of households)



8% Field pesticides

19% Storage Pesticides

6% Herbicide

## Agricultural activities

Arable land in Taita Taveta constitutes only 12% while National Parks constitute 62% of the land. Rainfed agriculture is the dominant activity practised by most households as a subsistence or economic undertaking. Agriculture is practised in all AEZs except in LM6 and L6 which largely fall in the Tsavo National Park, a protected area. Mixed farming is common in LH2, LM3, LM4, and LM4 while livestock production is practised mostly in LM5, LM6, L5, and L6. Maize and beans are the main food crops; however, most end up in markets. Other crops are green grams, sorghum, cowpeas, pigeon peas, cassava, and sweet potatoes.

Livestock is also an important activity in the County. The main types of livestock include beef cattle, dairy cow, sheep, goat, camel, pig, and poultry. Chicken is the main livestock reared, although some farmers practise beekeeping while others rear guinea fowl and rabbits. At the ranches, the livestock reared includes goats, sheep, camels, and cattle. Fish farming<sup>14</sup> is mainly undertaken in Taveta and Wundanyi, with Tilapia, Claria, Eel, Crayfish, and Sardines as the main species.

Crop and livestock farmers in Taita Taveta use relatively low levels of agricultural inputs mainly due to high input prices and the general tendency in the County to practise low-input production; farmers frequently

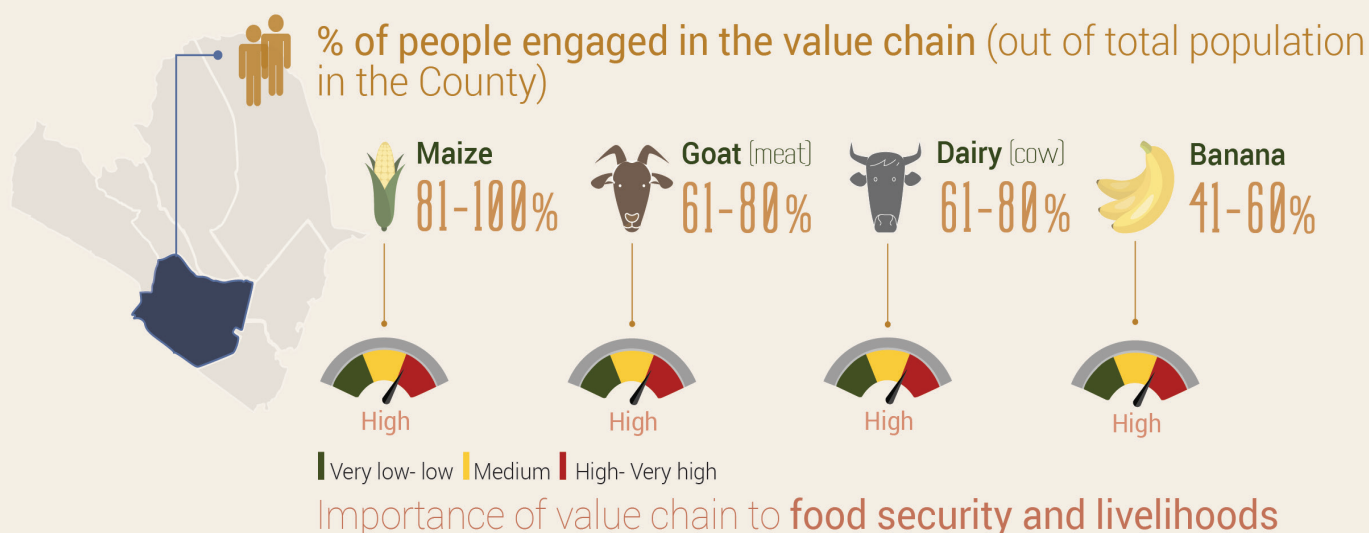
utilize local and recycled seeds. Field pesticides are used by 8% of the farmers, storage pesticides by 19%, and herbicides by 9%. Male-headed households tend to use more inputs compared to female- and youth-headed households.

The main storage facilities used by most households are improved granaries, traditional stores, and living houses. However, these facilities are not sufficient and farmers are sometimes forced to sell their produce at low prices to avoid post-harvest losses due to spoilage.

## Agricultural value chain commodities

Taita Taveta County has a broad diversity of agricultural production systems; crops, livestock, and fisheries comprise the value chain commodities (VCCs) that have been identified and prioritized for development interventions by different government organizations and programmes. These include the Ministry of Agriculture, Agricultural Sector Development Support Programme (ASDSP), the Kenya Agricultural and Livestock Research Organization (KALRO) and University of Nairobi survey, and the Kenya Agricultural Productivity Programme (KAPP). For the development of this County Climate Risk Profile, four major value chain commodities were selected for in-depth analysis, based on their contribution to food security, productivity characteristics, and importance to the

### Agricultural value chain commodities in Taita Taveta



<sup>14</sup> Fish farmers, 181, with about 795 fish ponds

economy. These VCCs have been selected from a list compiled from the available literature, interviews with various County experts, and a validation workshop. The indicators used for prioritization include: harvested area (hectares), production (90-kg bags), variation in production in the past 5 years, value of production (KES), dietary energy consumption (Kcal/capita/day), protein content (g of protein/100 g of product), iron content (mg of iron/100 g of product), zinc content (mg of zinc/100 g of product), and Vitamin A content (IU Vitamin A/100 g of product).

Thus the VCCs selected were: maize, banana, dairy cow, and meat goat. The major indicators for prioritization were: indicator for maize - production and food security; bananas – economic and food security; dairy cow – production and economic security; while goat (meat) – production and economic security. Maize is grown in almost all the AEZs but mainly in UM3, UM4, and LM4. Banana is grown in AEZs UM3 and UM4. Dairy farming is practised mostly in UM3, UM4, and LM5 while meat goats are reared mostly in LM4, LM5, LM6, L5, and L6.

## Dairy farming

Dairy farming, practised throughout the entire County, is important for food security and income generation. The major breeds kept are local, cross, and exotic breeds comprising Friesian, Jersey, Ayrshire, and Guernsey. In 2014, the dairy cow population was approximately 27,472 animals and the milk produced was about 17.2 million kg valued at KES 758 million. The dairy sector employs 61-80% of the population and all gender types own dairy animals and are involved in production activities. According to the ASDSP survey of 2013, male-headed households own on average three local and exotic breed cows while female- and youth-headed households own one to two on average. Productivity varies with gender of household head. For local breeds, it is 4.5, 2.5, and 1.6 litres/animal/day for youth-, male-, and female-headed households respectively. For exotic breeds, productivity is 12.0, 10.0, 8.0 litres/animal/day respectively for female-, youth-, and male-headed households. Feeding and milking are mostly the responsibility of female family members and the youth. The youth also provide most of the farm labour. For most households, men own the cows and control income from milk. Majority of the input suppliers are small and medium agrovets.

The main value addition activities are boiling and fermenting, practised by about 60% of dairy farmers. Other activities in very small scale include

cooling, bulking, and transporting. However, about 80% of farmers sell raw milk. This is largely due to farmers' low financial capacity and limited knowhow on value addition. Value addition can be increased through training and provision of electricity. The major marketing channels include local markets and cooperatives, which sell to processors and middlemen.

The major challenges to the dairy sector include poor feeding, poor breeding, poor record keeping, unreliable input supply, lack of organized marketing structures for milk products, poor housing, and poor calf rearing. Diseases also pose a major challenge, especially tick-borne diseases and mastitis. The poor road network makes marketing more difficult, especially during the wet season.

## Maize

Maize is a key staple food and a major contributor to livelihoods; it is grown in the entire County mostly as a rainfed crop. Between 61 and 80% of the County's population is engaged in maize production mostly at small-scale level<sup>15</sup>. Twenty-nine percent, 11, and 6% respectively of male-, female-, and youth-headed households engage in maize production. In 2014, the County produced 9,142 bags of maize valued at KES 30 million, at an average production of 12.8 bags/ha<sup>16</sup>.

Despite the ever increasing acreage under maize production, maize yields have continuously declined over the years due to climate change amongst other factors. In the vast rain fed crop production zones where most farmers grow maize, the crop starts showing moisture stress at tussling stage and eventually dries off thus significantly affecting the yields. Average productivity is 487, 178, and 168 kg/ha respectively for male-, female- and youth-headed households. The differences in production levels are attributable to differentials in access to services that support production. For instance, access to extension services is 80, 13, and 7% respectively for male-, female-, and youth-headed households. Overall productivity is very low, hence there is a need to adopt better farming technologies and drought-tolerant varieties.

Despite the ever increasing acreage under maize production, maize yields have continuously declined over the years due to climate change amongst other factors. In the vast rain fed crop production zones where most farmers grow maize, the crop starts showing moisture stress at tussling stage and eventually dries off thus significantly affecting the yields. Persistent crop failure due to inadequate rains calls for introduction of more drought tolerant varieties.

<sup>15</sup> The average area under maize is 2 - 3 acres at household level

<sup>16</sup> A bag equivalent to 90Kgs. National average in 2014 was 7.4 bags per acre (GoK,2015)



More youth-headed households are likely to adopt new technologies compared to male- and female-headed households. These include herbicides, basal fertiliser, organic manure, and storage pesticides. For instance, basal fertiliser use was 20% in youth-headed households compared to 17 and 15% in male- and female headed households.

Farmers are involved in production activities and related services such as land preparation, weeding, harvesting and storing. The main value addition activities mostly undertaken by farmers are sorting and sometimes transporting the maize to the local markets.

Challenges encountered in the maize value chain include: changing onset of the seasons, poor road network, high input prices, low farm gate prices, pests and diseases such as the Maize Lethal Necrosis Disease [MLND]).

### Meat (goat)

About 61 - 80% of the County's households keep goats for meat since they can survive harsher climatic conditions compared to other livestock types. In 2014, there were about 172,450 meat goats in Taita Taveta, producing roughly 159,000 kg of meat valued at KES 464 million (GoK,2015).

The goat meat value chain in the County is dominated by medium- and small-scale service providers at input supply, production, and processing stages. The major stakeholders in the value chain are the farmers, who keep the animals, and the livestock production department, which provides extension services on input utilization and practices such as breeding. Others are NGOs such as Mazido which provides technical advice on water harvesting. The veterinary department and the National Drought Management Authority (NDMA) play an important role in the value chain as they help with disease control through vaccinations. Brokers are the major marketing channel but farmers are forming cooperatives that have outlets (butcheries) to sell their goats. Some of the goats are sold to local butcherries and others to abattoirs outside the County. Main value addition activities undertaken by the farmers include drying and salting.

### Banana

Banana is an important crop engaging about 41-60% of the population. It is produced across the County at small- scale level (average 0.2 – 0.6 ha). Sixty-three percent, 29, and 8% of male-, female-, and youth-headed households respectively grow the crop. Productivity is 1415, 778, and 669 kg/ha respectively

for female-, youth-, and male-headed households. In 2014, a total of 129,736 metric tonnes valued at KES 1.2 billion were produced (GoK, 2015).

Inputs such as fertiliser are supplied by small-scale traders normally found in local market centres. Improved banana seeds inputs such as tissue cultured seeds are not available in the local market but sourced from outside the county making it more costly to acquire.

Bananas are aggregated at local market centres by small-scale retailers; they are then sold to wholesalers who transport them to Nairobi. Some of the produce finds its way into the local markets where the vendors are normally small-scale women traders. To tap into the increasing banana production in the County, cooperatives are developing value addition activities such as making crisps and juice.

### Agricultural sector challenges

The County is home to one of the largest national parks in the world, the Tsavo National Park, so wildlife population is exceptionally high. This, coupled with the fact that the park does not have an electric perimeter fence, has aggravated human wildlife conflicts. The animals destroy crops and harm, even kill people. This results in loss of livelihoods and food insecurity. Over the years, residents have suffered huge losses occasioned by herds of marauding elephants that invade farmlands destroying crops, besides causing injuries and death to humans. Some of the areas affected by the human wildlife conflict include Maktau, Mwachabo, Bura, Ghazi, Mbulia, Kishushe, Marapu, Birikani, Miasenyi, Kasigau, Challa, Ndara, and Jipe.

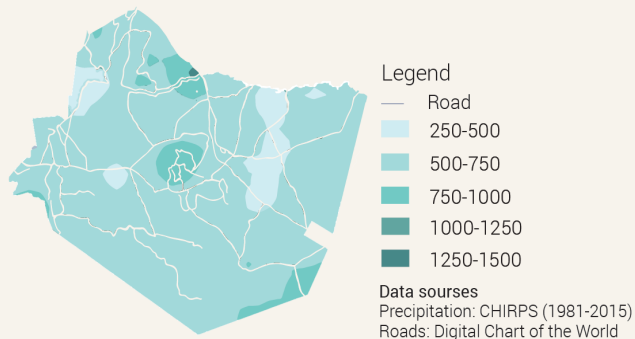
The County is very favourable for livestock production; it has ranches that constitute about 22% of the total land area and are designated as disease-free zones. The ranches attract "commercial" grazers - livestock traders from outside the County who come and rent grazing grounds for a period. As a result, there is a two-way conflict with grazers taking their livestock to the parks and wildlife interfering with livestock in ranches and on farms. The farmers have to endure cases of livestock predation especially by lions. Thus there is need for measures to control the wildlife/livestock movements including: erection of an electric fence around the park perimeter, construction of water pans to hold water for use during dry seasons, and surveillance to monitor animal movements.

Inadequate storage facilities at the farm forces farmers to sell their produce at low prices to avoid post-harvest losses. This may lead to food shortages especially after

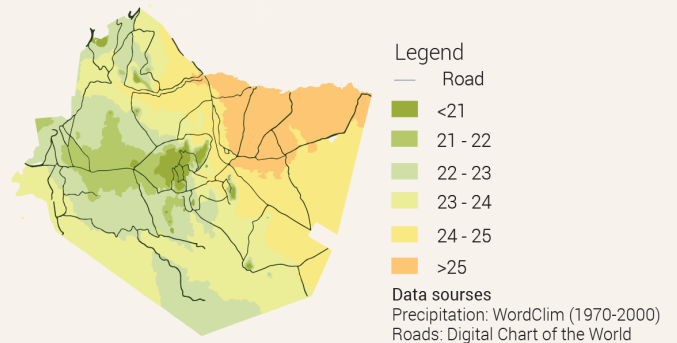


# Past and future impacts of climate hazards in Taita Taveta

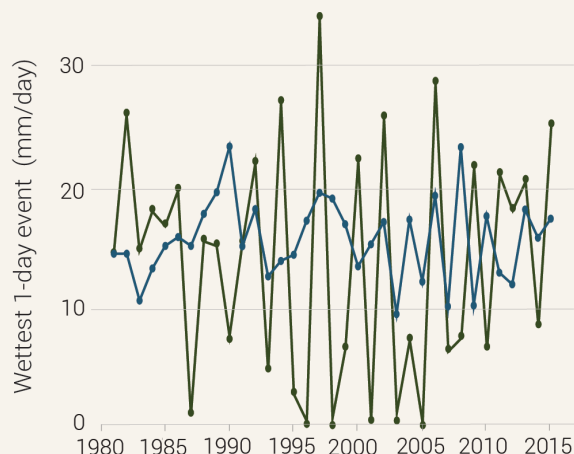
## Historical annual mean precipitation (mm/year)



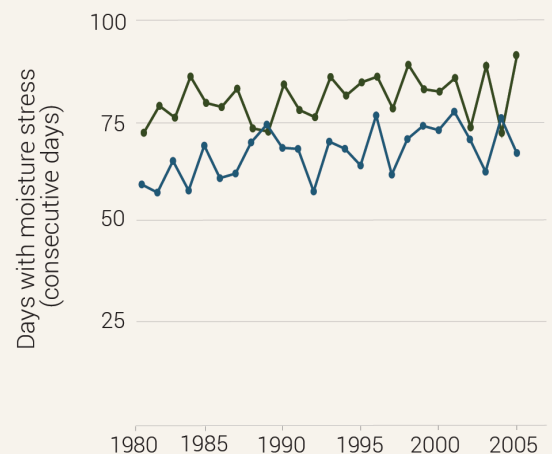
## Historical annual mean temperature (°C)



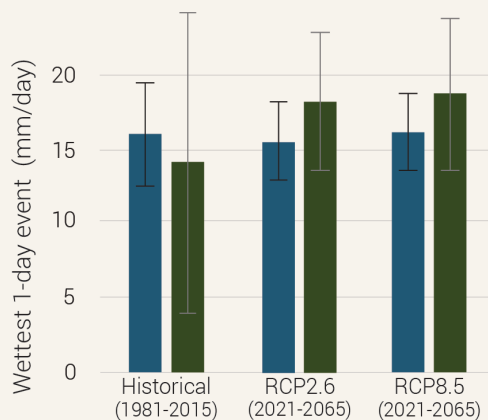
## Historical extreme flood events



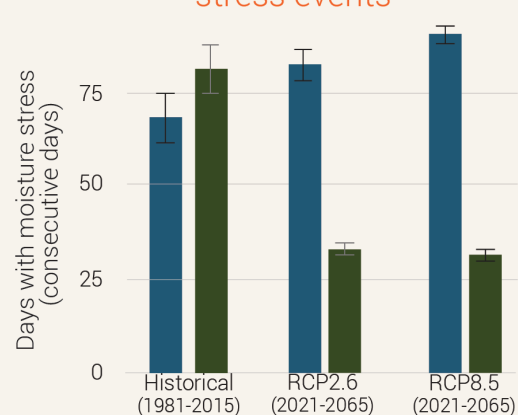
## Historical drought stress events



## Historical and expected extreme flood events



## Historical and expected drought stress events



■ January - June ■ July - December

a prolonged dry season. The main storage facilities used by most households are improved granaries, traditional stores, and living houses. The marketing system is poor, due to poor infrastructure especially the road network across the County, lack of accurate and timely market information, and post-harvest handling facilities.

Poverty is related to environmental degradation. Massive destruction of forests occurs in the County, for firewood, charcoal, and agricultural production. Due to high poverty levels, farmers lack the capacity to access certified seeds, fertiliser, irrigation, technology, and other necessities. Consequently, poverty creates a cycle of low productivity in the following season as the farmers have limited alternative sources of income.

Reliance on rainfed agriculture remains a challenge especially with climate change. Only 10% of households have adopted irrigation (GoK, 2014). Effects of climate change include unreliable and erratic rainfall patterns with shifts in planting time, moisture stress during the crop growing periods and heavy rains during harvesting, leading to increased post-harvest losses. Temperature fluctuations lead to increased incidences and emergence of new pests and diseases. This affects both the quantity and quality of produce. Lack of capacity to undertake value addition, coupled with limited storage facilities compel farmers to sell their produce at low prices, leading to low returns in the sector.

Poor infrastructure in some parts of the County is an important challenge to the agricultural sector. In 2013, the County had 199 km of bitumen surface roads, 138 km of murrum surface roads, and 1251 km of earth surface roads (GoK, 2013). During the rainy season, the roads without bitumen surface, which are common in the rural areas, become impassable. This leads to post-harvest losses and delayed land preparation.

The budgetary allocation for the agricultural sector in the County is very low (3% in 2014/2015) compared to the minimum of 10% suggested by the Comprehensive African Agricultural Development Programme (CAADP). This might be the cause of the inadequate service provision to farmers; for instance, the County has only one extension staff for over 600 farmers. Farmers reported that the extension service was inadequate; the extension personnel admitted that inadequacy of resources limited facilitation of extension services.

Poor access to local and international markets, coupled with unreliable data and information management remains a constraint in both crop and livestock sectors. In addition, with minimal or no value addition at the farm level, the farmers receive lower incomes as they are often exploited by the middlemen.

Agricultural productivity and output are low, due largely to low adoption of appropriate technologies such as high-yielding crop varieties, fertiliser and manure, and efficient tillage and cultivation methods.

Access to farm inputs is low; this is brought about by the high cost of inputs which in turn results from the poor distribution network across the County. Most farmers use non-certified seeds and other planting materials. Access to credit remains low, reducing the potential to increase production.

## Adaptation to climate change and variability

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

Throughout Taita Taveta County, the climate is fairly hot (21-23°C) and moist (1,000-1,750 mm precipitation annually). There is some variation in precipitation throughout the County, with the hills around Wundanyi, among a few other places in the central to northern portions of the country providing cooler and slightly wetter conditions. The temperature is about 1.0 to 1.5°C warmer during the First rainy season (January-June) as compared to the Second season (July-December). Average precipitation is fairly consistent throughout the year, although the First wet season receives much more consistent rain, whereas the Second wet season is much more variable year-to-year. Due to the fairly hot and dry conditions, dry spells and heat stress are both hazards that contribute to agricultural risk in the County.

Historic analysis of weather in Taita Taveta County shows that both dry spells and extreme precipitation are hazards in the County. Dry spells are on average slightly longer during the second wet season with around 70-80 consecutive days of moisture stress, whereas moisture stress is experienced for 55-80 days during the first season. Extreme precipitation and flood risks<sup>17</sup> are moderate to low in both seasons, with most years receiving between 10 and 25 mm of precipitation on the wettest day<sup>18</sup>.

<sup>17</sup> Refers to the wettest 1-day event (mm/day) indicator in the infographic.

<sup>18</sup> Note that this is 20 mm on average over the entire County, so specific parts of the County will have experienced greater than this (possibly much greater), whereas other parts will have experienced less.

Climate has already been observed to change slightly in the County. Since 1981, the First wet season - the predominant rains of the year, have experienced a 1.5°C increase in mean temperature. This increase has been associated with a reduction in crop cycle, and a slight (<10%) decrease in precipitation on average. In contrast, the Second wet season experienced little change in climate. The combination of increased temperatures and decreased precipitation make for an increase in drought risk.

Temperature is projected to increase by 0.4°C in the period 2021-2065, with the First wet season projected to experience even greater changes. By that time, precipitation is projected to increase by 0.8 % in the First wet season, and 6 % in the Second. Prolonged moisture stress is projected to occur in the First season of the year, whereas intense precipitation is expected to change little in either season. Consecutive days of moisture stress are projected to increase from 70 to around 85-90. In contrast, moisture stress in the Second wet season is projected to decrease from 80 consecutive days to approximately 30. These projections under the two climate scenarios - RCP 2.6 and RCP 8.5<sup>19</sup>, show some small differences, but generally the same future projections, suggesting that climate change impacts will be fairly similar during this time frame regardless of the greenhouse gas emissions that occur.

## Climate from the farmers' perspective

From the farmers' perspective, there has been observable variation in climatic conditions in Taita Taveta County over the years. Weather patterns have become more unpredictable compared to the past. The effects are in terms of soil degradation, reduction of water volumes in the rivers, landslides, deforestation, and drying of wells and rivers. The farmers relate this phenomenon to human destructive activities on the environment such as deforestation, poor land use, and pollution by industries.

The onset of seasons has changed. Moreover, the rains have become more unpredictable and unreliable, causing shifts in planting time, moisture stress during the crop growing period and heavy rains during harvesting; the rains lead to increased post-harvest losses; they fall in portions in such a manner that even within a small area there can be rain in one portion and no rain at all in another. Intense rains occur in the highlands, causing flooding in the lower areas; this

leads to destruction of the road infrastructure and loss of biodiversity.

Significant temperature variation has also been observed by the farmers. They say it is now warmer, and crops like maize now have a shorter crop cycle. Bean farming is now favoured by the increased temperatures where areas that used to be very cold are warmer. However, the increased temperatures are also associated with higher incidences of pests and diseases which affect productivity both in crops and livestock. Extreme cold is responsible for frost experienced in the County.

Climate fluctuations have had important economic and social consequences. Rains during harvesting often lead to post harvest losses as the crop is destroyed. Infrastructure is damaged, thus reducing access to markets. Farmers earn less and are unable to meet their needs. When temperatures rise, agricultural output is affected. Dairy animals yield less milk due to heat stress. Heat and moisture stress may lead to crop failure, exposing the farmers to food insecurity. Irrigation becomes necessary due to high evaporation rates, but the water in the County is too little to sustain serious irrigation. All these factors together contribute to high production costs and thus make agriculture less viable to many locals. During drought, women spend more time looking for water. Migration to urban areas in search of employment increases due to decreased incomes from agriculture. This reduces labour available for agricultural activities.

## Climate Vulnerabilities across Agriculture Value Chain.

Across the County, future climate change and variability pose serious threats to the value chains identified in this work. Increased precipitation, long dry spells, moisture stress, reduced rainfall, and heat stress are the major climatic hazards identified by farmers and local experts in the County. The following section highlights the hazards and impact on the value chains.

### Maize

Maize is a sensitive crop to climatic fluctuations. Moisture and heat stress were identified as major hazards for the crop. The entire value chain is affected by these hazards. Low yields are experienced and sometimes crop failure occurs due to moisture and/or heat stress. Low productivity from previous seasons

<sup>19</sup> 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.

reduces farmers' ability to purchase inputs such as fertilisers and improved seeds. The cycle of low productivity and food insecurity therefore continues, especially for subsistence crop farmers.

Drought in a previous season reduces availability of seed at the input supply stage of a subsequent season. Yields from a previous drought season would have been low and all of it consumed and/or sold by the farmer due to scarcity of food. Thus the capacity of the farmer to purchase inputs would be low. Extension services during dry periods are low as extension workers neglect crops during such periods. Maize planted during a dry spell grows poorly. The ground is hard and difficult to plough manually, germination is poor and the crop ripens early. These factors increase the susceptibility of the grains to storage pests such as weevils, a situation worsened by lack of good storage facilities. Moreover, poverty and low levels of education reduce the capacity of farmers to adapt to risks by, for instance, building water dams or using climate information in day-to-day decision making on the farm.

### Banana

The workshop participants identified increased rainfall in some seasons and decreased rainfall in others as the most serious hazards for the banana value chain. Their effects become more serious as the weather becomes more unpredictable. Increased precipitation causes delays in land preparation as some parts are flooded and working on the farm is delayed as most land preparation is manual. More time is required for hardening, the demand for manual planting increases, and risks of pests and diseases are high. These factors reduce yields, and consequently the farmers reduce the area prepared for the crop in the subsequent season, reducing overall production. Reduced precipitation results in poor hardening of the seedlings and of course low yields. Utilisation of pesticides is limited since the chemicals scorch the crop during this period.

Severity of intense rain is high in the banana value chain; the hazard increases both production and marketing risks. Production inputs such as fertilisers and pesticides become expensive due to high demand and impassable roads. Poor distribution of subsidy fertilisers exacerbates the problem. On-farm production also becomes a challenge as activities such as land preparation, weeding, and harvesting are greatly impaired.

Production costs are highest during the wet season. Many production-related activities are hampered

during both seasons. Labour requirements on activities such as land preparation, weeding, and harvesting increase significantly. Farmers are also required to use more inputs during the rain season since the fertilisers and pesticides are washed away. The soils have not only been degraded due to erosion but have also become more acidic due to continued leaching; this reduces productivity.

Destruction of roads during the rainy seasons exacerbates the marketing challenges. Gravel and earth roads are the most affected during such seasons. Farmers are therefore unable to transport their produce to the markets, especially in view of the bulkiness of bananas. Lack of capacity to undertake value addition mainly due to lack of funds, high power costs and scarcity of appropriate storage facilities for bananas such as cold rooms make the farmers very vulnerable. Poor farmer organization is also a contributing factor to the low adaptive capacity to the climate risks.

At the farm level, the poor, uneducated farmers are the most affected. Resource limitation and low education make it difficult for them to recover. Similarly, labour becomes expensive during the rainy season as demand rises beyond supply. High temperatures lead to high costs of labour as the working hours decline when temperatures are high. The women are the most affected as they are the ones who provide most labour on the farm, especially during planting, weeding, harvesting, and sorting. Transport is provided mostly by men who consequently are affected by the climatic hazards.

### Dairy (cow)

The dairy cow is sensitive to drought associated with long dry spells and heat stress, as water and feed become scarce. During such periods, most fodder crops wilt and water sources dry up. Commercial feeds are prohibitively expensive for most small-scale farmers. The resulting poor nutrition leads to low fertility. Diseases such as Foot and Mouth, Lump Skin disease, and Rift Valley Fever become common due to suppression of immunity. All these factors culminate in a reduction in milk production and hence farm incomes.

Input suppliers are affected since the reduced purchasing power of the farmers translates into reduced incomes for the suppliers.



## Meat goat

Long dry spells and heat stress were identified by farmers as major climatic hazards that affect the meat goat value chain. Effects of long dry spells are severe. They include inadequate availability of feed, which compels farmers to travel long distances in search of pastures. The animals become emaciated and some die. The rotation system is disrupted and collapses while the prevalence of pests and diseases increases, hence farmers have to spend more money and time on vaccination. Poor feeding, heat stress due to high temperatures and increased movement reduce meat production. Accessing markets at this period also becomes difficult due to the large number of poor-quality goats, which attract very low prices. Livestock keepers, livestock traders and consumers are impacted by the long dry spells.

Heat stress has been associated with a disruption in grazing time, affected rotational timing, and increases in disease prevalence. The risk of losing livestock significantly increases especially during feeding and transporting. Demand for value added goat meat products during this season limits market access for the pastoralists who lack the capacity to add value to their meat. Both these hazards translate to low farm incomes. Poorer members of communities with smaller livestock holdings and less-developed social support networks are in general more affected by droughts and heat stress.

## Adaptation to climate change and variability

Farmers in Taita Taveta County have adopted various strategies to cope with variability changes in climate conditions that affect agricultural production and food security. Consultations during this work coupled with literature available such as the ASDSP survey of 2013 show that over 80% of all farmers experienced climate hazards in their agricultural production activities (GoK, 2014). Consequently, the farmers have adopted strategies aimed at mitigating the effects of the climate hazard. However, their adaptation options are limited by factors such as lack of resources, low technology, and social constraints. Some of the adaptations are specific to certain value chains while others cut across the value chains.

The underlying factors for the consequences of climatic hazards spread across socioeconomic

and geographical issues. Poverty and low levels of education limit the ability of the farmers to adapt to technologies easily. Resource-constrained farmers are not able to adopt the strategies that can reduce the impact of climatic hazards such as water harvesting by constructing dams requiring huge financial investments. Women are the ones that provide most household labour and also support the households through other activities such as child care, hence the time available for productive activities is reduced. Communities are becoming increasingly sedentary. They are therefore more vulnerable as they do not migrate in search of pastures and water when hazards like drought occur. The available processors are small scale so they are also impacted severely by the climatic hazards, making the farmers more vulnerable. Absence of a livestock marketing policy coupled with inadequate market structures and funds is also a challenge that affects the farmers. Inadequate investments in the infrastructure, including road networks and processing plants is obstructing farmers' opportunity to access markets and add value to their products so that they can receive better prices and improve incomes.

At the institutional level, inadequacy of resources allocated to agricultural activities reduces access to services such as extension, which farmers would have received from various organizations including the County government. In addition, poor farmer organization limits collective production and marketing as a strategy for reducing transport costs and increasing bargaining power. The negative perception towards financial institutions makes farmers avoid credit which they would have used to mitigate climatic hazards by constructing dams and water pans, for instance.

In spite of these challenges, farmers in Taita Taveta, with the support of various stakeholders, have adopted a number of strategies to cope with climate hazards that affect agricultural production and food security. The County Government has supported climate change initiatives including promotion of drought tolerant crops, promotion of rain water harvesting techniques, tree growing among others. Other stakeholders include Community Interest Groups (CIGs) formed by the farmers and supported by organizations like Kenya Agricultural Productivity and Agribusiness Programme (KAPAP), transporters, processors, government organizations such as Kenya Forest Service (KFS), National Disaster Management Authority (NDMA), cooperatives, and NGOs such as World Vision for crop farmers.



## On-farm adaptation practices

In responding to the various climatic challenges, farmers use various on-farm adaptation practices. Over 80% of the farmers have adopted several on-farm and off-farm adaptation strategies. More male headed households respond to climatic hazards compared to female- and youth- headed households (GoK,2014). This was confirmed by workshop participants during consultations for this work. Male-headed households are more likely to apply climate change adaptation strategies on their farms, given their higher access to productive resources, extension and training, and due to their higher decision-making power on household resource utilization compared to women and youth. Some adaptations are specific to certain value chains whereas others cut across the value chains.

For the maize value chain, the strategies adapted currently include use of extension services, manual land preparation, oxen and tractor ploughing, selecting seeds from previous harvest, capacity building on organized markets, adoption of *zai-pits* technology<sup>20</sup>, farmer linkages to buyers, promotion by farmers and traders, improved seed varieties, diversification of crops, and use of indigenous traditional knowledge (ITK). The potential options raised by the farmers include more support to enhance crop rotation through provision of seeds for example, seeking weather data in advance, improving organized farmer groups, increasing irrigation uptake, increasing use of tractors, engaging in more contract farming, adopting farm mechanization and crop insurance, improving linkages to microfinance institutions for credit, increasing access to certified seed, formation of strong farmer cooperatives, increasing dissemination of market information, increasing access to agricultural mechanization services for land preparation, improving organization and support for bulking and storage facilities, insurance, using standardized measurements for price determination and enhanced product promotion by the farmer organizations.

For the banana value chain, the strategies adapted currently include use of extension services, manual land preparation, oxen and tractor ploughing, locally assembled facilities for hardening banana seedlings, bulking, formation of farmer groups to reach buyers, formation of aggregation centres, capacity building on organized markets, cottage industries for value addition, farmer linkages to buyers, promotion by farmers and

traders, improved varieties, diversification of crops, and use of indigenous traditional knowledge (ITK). The potential options raised by the farmers include private public partnerships (PPPs) on infrastructure such as banana hardening facilities, improving dissemination of weather information, improving on organized farmer groups, increasing irrigation uptake, increasing use of tractors, engaging in more contract farming, adoption of farm mechanization and crop insurance, improving linkage to microfinance institutions, developing hardening seedlings using greenhouse and tunnels, increasing access to certified seedlings, modern processing by farmers and cooperatives for value addition, formation of strong farmer cooperatives, increasing dissemination of market information, mechanization for land preparation, improving organization and support for bulking with shades and cooling facilities, arranging for organized transport with cold storage, using standardized measurements for price determination, and product promotion by the farmer organizations.

For the dairy cow value chain, farmers have adopted strategies including feed conservation (hay and silage making and preservation), extension services, supplementing the feed during dry periods when pasture is scarce, utilization of on-farm by-products such as stover and banana stems, sourcing of feed from the low lands (for farmers in the upper areas), pest control measures such as deworming, bulking of produce such as milk for affordable transport and marketing, selling raw produce to consumers, selling to buyers on cash basis, monitoring of animals for pests and diseases, use of traditional deworming methods, changing to alternative livelihoods such as vegetable production, selling at household level to avoid the high cost of transportation, and farmer-to-farmer exchange of knowledge within neighbourhoods. At the same time, the farmers recognize that there are potential strategies in responding to the climatic hazards. They include increased fodder and pasture production, construction of community hay stores for storing hay, adequate feeding to enhance animal health and production, satellite storage facilities for milk before transportation, training on animal husbandry and agricultural tours to motivate and expose farmers to value addition techniques, value addition on farm produce for higher returns, forming more farmer organizations, promotion of alternative livelihoods, contract farming and enforcement of contracts, construction of more bulking/collection centres,

<sup>20</sup> Zai pit technology involves harvesting rainwater for use by plants beyond the rain duration. Once a two to four feet in length, breadth and height pit is dug, it is filled with a compost of leaves and stems and then topped with manure. It holds water and the food is grown on top

increasing adoption of technologies such as Artificial Insemination, planting fodder trees at the household level and bulk purchases of drugs/vaccines by farmer groups to reduce costs.

For the meat goat value chain, farmers mentioned adapting various strategies including feed conservation (hay), extension services, supplementing the feed during dry periods when pasture is scarce, utilization of on-farm by-products such as stover, pest control such as deworming, selling to buyers on cash basis due to breach of contracts, monitoring of animals for pests and diseases, use of traditional deworming methods, changing to alternative livelihoods such as vegetable production, selling goats at farm gate to avoid the high cost of transportation, using traditional methods of slaughtering, keeping breeding animals longer on the farm for breeding purposes, grazing animals early in the morning during hot periods, individual purchase of drugs/vaccines at household level, controlling breeding during stress periods using methods like an Anti-Mating Apron<sup>21</sup>, seeking alternative markets for goats where prices are better, restocking and multiplication to increase volumes for market, and adopting farmer-to-farmer exchange of knowledge within neighbourhoods. The farmers also identify the following potential strategies as necessary in mitigating the impacts of climate change: Increased fodder and pasture production, regular deworming programmes, construction of community hay stores for storing hay, adequate feeding to enhance animal health and production, enhanced training on animal husbandry and agricultural tours to motivate and expose farmers to value addition techniques, forming more farmer organizations, promotion of alternative livelihoods, contract farming and enforcement of contracts, feedlots for fattening meat animals before selling to fetch higher returns, bulking/collection centres, slaughtering in approved abattoirs, enhancing planning of annual vaccinations, adoption of technologies such as Artificial Insemination for cattle and even goats, planting fodder trees at the household level, bulk purchases of drugs/vaccines by farmer groups to reduce costs, introducing buck camps and promoting use of Anti-Mating Aprons and measures for improved enforcement of contracts.

## Off-farm adaptation practices

Services accessible in the County include Off-farm adaptation options available in the County include early- warning information, financial services by banks, field days and input provision including Artificial Insemination, fodder conservation, financial services such as credit by banks, conservation agriculture, field days and workshops, input provision, and Artificial Insemination. The services are offered by government, non-government, private, faith- and community-based lead agencies.

Agricultural-related services (including extension, research, finance, artificial insemination services) and climate- related services are mainly accessed from the private sector (71%). This is contrary to service provision, where the Public Sector provides more services than the Private Sector (55% and 45% respectively). Extension services are offered by almost all the organizations where farmers are taught the importance of using good agricultural practices that promote soil and water conservation, high-yielding, early-maturing crop varieties and animal breeds, and value addition. In addition, the current demand-driven approach in extension marginalizes most farmers from accessing the services due to the high cost implications. Moreover, the vastness of the County coupled with insufficient human and financial resources, low technology adoption rates and poor infrastructure add to the limitations of access to the services. These services are offered by both the public and private Sectors.

Early-warning information which includes weather forecasts - mainly provided by the Kenya Meteorological Department (KMD) in collaboration with the MoALF and disease outbreak warnings - provided by the Kenya Veterinary Department (KVD) - informs farming plans and improves preparedness. The County is vast with few weather stations, limiting the accuracy of climate information. This has impacted the response of the farmers to early warning. However, in instances where farmers are ready to act on the early warnings, resource constraints deter them from taking the necessary precautionary measures.

Financial institutions such as insurance companies, micro finance, banks and the Agricultural Finance Corporation (AFC) offer credit services such as loans and insurance schemes to farmers. The loans enable farmers undertake adaptive measures such as water harvesting, value addition, and fodder conservation. However, perceptions of credit by farmers coupled with limited resources for collateral limits credit uptake.

21 Anti-Mating Apron method involves tying an apron made of leather or canvas around the body of a ram/buck to prevent mating with female (s).

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

Maize				
	Provision of seeds and other inputs 	On-Farm production 	Harvesting, storage and processing 	Product marketing 
 <b>Moisture stress</b>	Inadequate stocks in the agrovet (fertilisers and other agrochemicals); low availability of certified varieties; low manure quality for composting	Decreased germination rate after planting; reduced growth rates and plant vigour; increased use of pesticides/herbicides	Reduced transportation due to low production; challenges in timing for harvesting; low yield; poor quality of harvested produce	Increased market prices due to low produce supply; challenges in market linkages (low produce availability); loss of income by producers
<b>Magnitude of impact</b>	Minor-Major	Minor-Severe	Minor-Moderate	Minor-Major
<b>Farmers' current strategies to cope with the risks</b>	Use of indigenous technical know how; recycling of seeds (harvested seeds); use of Integrated Pest Management practices	Mulching, mechanized ploughing, ox ploughs, crop diversification	Increase acreage under production; group purchase of packaging materials	Sourcing of new market linkages; sourcing the product from others e.g. neighbours, counties
<b>Other potential options to increase farmers' adaptive capacity</b>	Seed bulking by farmers/organizing; KFA to stock appropriate seeds; more research on drought tolerant varieties; research on ICTs to enhance adaptability	Increase area under irrigation, increase use of tractors; Early Warning System; enhanced weather forecasting and delivery messages by the extension officer; capacity building on IPM practices	Introduction of modern and small scale storage facilities; awareness of quality standards (harvesting and storage); promotion of community-based grain aggregation centres	New market linkages to increase the product availability; improved NCPB delivery systems at local levels; regulated pricing through government grain pricing; linkage to external markets
 <b>Reduced rainfall</b>	High labour costs; reduced quality of planting material; increased costs of agro-chemicals	Challenges in land preparation (ploughing); delayed planting; reduced crop germination and establishment rate; low agronomic efficiency; increased pests incidence	Reduce produce quality and yield; transportation of produce will be reduced; increased risk of postharvest damage due to pests (rodents); reduced value addition and commercial processing opportunities	Reduced farmer prices (low quality); increased trader prices (scarcity); reduced demand for market linkages; household consumption; reduced household income
<b>Magnitude of impact</b>	Minor	Major	Major	Severe
<b>Farmers' current strategies to cope with the risks</b>	Use of indigenous traditional knowledge; use of conventional improved varieties	Enhanced cropping or varieties	Low storage and packaging due to low production	Aggregation of grains; farmers selling at farm gate
<b>Other potential options to increase farmers' adaptive capacity</b>	Adoption of rainwater harvesting structures; research and development of drought tolerant varieties	Crop rotation; Early Warning System; enhanced weather forecasting; cover crops; capacity building on IPM and weed control practices; conservation agriculture	Improved storage structures (pest free); promotion of community-based grain aggregation centres for bulking the grains	Associations to facilitate pricing/marketing; contract farming; improved rural access roads to improve supply to better markets; regulated grain pricing (through government policies)



# Goat



Provision of inputs



On-farm production



Harvesting, storage and processing



Product marketing



Long dry spell

Animals in poor body condition reducing selling price; increased expenditure on health drugs; few farmers will be reached

Inadequate availability of feed leading to long distances for grazing areas; emaciation leading to death; increased mortality rates (young/adult animals); disruption/collapse of rotation system; increased pests and diseases prevalence

Delayed training from extension services; transportation/processing affected by fluctuation in the availability of goats; low supply for bulking of goats at the dry spell begins

Low supply of goats that do not meet the market demand (low quality); non-fulfilment of contractual agreements due to varying volume of goats and fluctuating prices

Magnitude of impact

Severe

Major-Severe

Minor-Major

Severe

Farmers' current strategies to cope with the risks

Outreach of extension services

Feeds storing during the dry spell; farmers sell bucks who have stayed longer in the hard; regular spraying and deworming; carrying out vaccinations as provided by the government

Selling goats to immediate consumers and traders in small units; farmer to farmer exchange of knowledge within neighbourhoods

Restocking and multiplication to increase market supply; seeking alternative markets for goats, whose prices are better

Other potential options to increase farmers' adaptive capacity

Proper feeding with on-farm available feed (shrubs and twigs); increase extension services through farmer cooperatives; access to disease resistant breeding bucks; access to credit facilities (purchase drugs/breeding stock)

Promotion of equipment for harvesting fodder and storage; draw community goat breeding plan to enhance buck rotations; scheduled mass deworming-spraying and vaccinations campaigns; access to Early Warning Systems

Seek alternative sources of funds to carry out proper trainings; bulking of goats in large numbers to sell; promote holding facilities; seek funds to facilitate exchange tours to the best performing counties; community-based slaughterhouse

Restocking and multiplication to increase stock numbers for the market; legal enforcement of signed contracts between farmers and traders; organized cooperatives and groups; linkage of producers to external markets



Heat stress

Shortage of feeds and water; increased cost (purchasing animal health drugs); increased refrigeration and storage requirements for drugs; increased labour requirements

Disruption of grazing time; rotational timing is affected (inbreeding); increase in diseases prevalence; disease control becomes difficult due to disruptions in grazing time; low growth rates

Delayed trainings due to diversion of funds meant for training; transportation affected by decreased volumes of animals; reduced number of goats available for slaughter; delaying the acquisition of goats

Low supply of goats; insufficient goats that do not meet market demand; reduced market activities; dishonouring of contractual agreements; fluctuation in market prices

Magnitude of impact

Moderate-severe

Moderate-Major

Minor-Moderate

Major

Farmers' current strategies to cope with the risks

Use of a mating apron during stress period; individuals purchasing drugs/vaccines on their own; group trainings on modern animal husbandry technologies

Grazing early in the morning and bringing the goat late in the evening; buck is kept longer at the farm because rotation is being affected; withholding the goats during vaccination and deworming

Goats are sold at the household level; flaying meat cutting and hygiene is done in the traditional way

Brokers and livestock traders are bulking as they buy at the household level; farmers are selling their goats at slightly higher prices due to higher demand; selling to people they know/ nearby traders

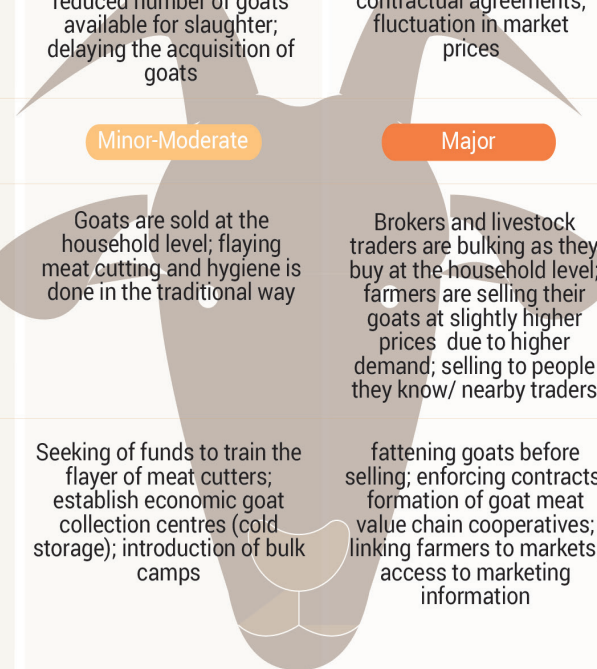
Other potential options to increase farmers' adaptive capacity

Bulk purchase of drugs and vaccines by community groups (livestock keepers/cooperatives); capacity building of more veterinary assistants

Planting browse trees such as acacia at the household level; introduce artificial insemination (meat goats); draw annual goat operational plan indicating schedules for deworming and vaccination; promoting use of aprons; water harvesting

Seeking of funds to train the flayer of meat cutters; establish economic goat collection centres (cold storage); introduction of bulk camps

fattening goats before selling; enforcing contracts; formation of goat meat value chain cooperatives; linking farmers to markets; access to marketing information



# Dairy (cow)

Provision  
of inputs



On-farm  
production



Harvesting,  
storage and  
processing



Product  
marketing



Long  
dry spell

Inadequate feeding leading to poor body condition and low productivity; increased diseases incidence and expenditure in their control; farm households-malnutrition

Reduced animal vigour and high pests and diseases susceptibility; low food availability; increased animal mortality; increased production costs (increased use of deworming drugs and vaccines)

Reduced milk volumes in transit; reduction in produce bulked against demand; increased production costs; processing facilities under utilisation

High market prices due to low production and milk scarcity; low profitability due to increased milk spoilage for processors

Magnitude of  
impact

Minor-Severe

Major-Severe

Major-Severe

Moderate

Farmers' current  
strategies to cope  
with the risks

Hay and silage making and preservation; use locally available materials; approach veterinary officers and extension workers

Intensive feed supplementation for nutrition purposes; utilisation of on-farm by products (maize stovers, banana stems); deworming exercises (youths); sourcing of feed stuff from low lands

Bulking milk for affordable transportation; selling the reduced volumes directly to consumers and other traders at farm gate

Selling directly to consumers; selling to high bidders (hawkers and processors); identified market linkages

Other potential  
options to  
increase farmers'  
adaptive capacity

Low cost pasture conservation techniques; provision of subsidized drugs and vaccines; development of early warning systems and advisories; enhanced extension and veterinary services to farmers

Veterinary services- disease centres especially for tsetse flies; regular deworming and vaccines; construction of community hay stores; agroforestry systems; adequate feeding with pasture and fodder to enhance milk production

Community satellite storage facilities for milk before transportation; establish more preservation facilities: small scale (on-farm) and community milk refrigeration structures

Increase investment in well defined market linkages; acquire value addition skills at farm level; farmers and buyers to draw contracts of agreement; conformation of farmers groups and cooperatives



Heat stress

Increased need of veterinary services; high production costs due to high costs of inputs (drugs; pastures)

Heat stress reduces animal appetite, hence low production; very low conception rate; high pests and diseases susceptibility; increased use of deworming drugs reducing economic benefits; reduced milk yields

"Low product volume transported and bulked; high demand/low supply; increased perishability; increased production costs due to high demand for cooling and refrigeration facilities

Low sales; increased costs of production; increased milk spoilage; price fluctuation

Magnitude of  
impact

Minor-Severe

Moderate-Major

Major

Major-Severe

Farmers' current  
strategies to cope  
with the risks

Enhanced mineral supplementation; close monitoring of animals; use of hormonal injections

Spending more time for feeding (use of on-farm crop residues such as maize stovers and banana stems; use of traditional deworming methods; buying of minerals and other feeds

Farmers aggregate milk production to share transport; sale of milk directly to consumers to avoid transportation; satellite bulking; selling small bulked volumes of raw milk

Due to low sales farmers implement alternative livelihoods (vegetables production, bee-keeping and poultry); most farmers rush to the highest bidder; market pricing regimes based on demand and supply

Other potential  
options to  
increase farmers'  
adaptive capacity

Enhanced mineral supplements; training farmers on heat detection; training on proper housing; subsidized drugs to farmers; commercial fodder growing and feed conservation

Training in feed conservation techniques and dietary supplements (silage and hay); planned deworming; development of Early Warning Systems; enhanced extension and veterinary services to increase the quality of milk for more income

Enhancement of satellite bulking (refrigerated) to reduce cost of transportation costs; train farmers on value addition at farm level; use of alternative energies (solar energy)

Form local marketing groups to improve on aggregation; provide financial support for investment in production infrastructure; value addition of cow milk



# Banana



Provision of seeds and other inputs



On-farm production



Harvesting storage and processing



Product marketing



Increased precipitation

Increased need for extension and advisory services; more labour and financial resources to mitigate flood effects (drainage canals, spraying)

Increased challenges on land preparation; increased cost and time invested on and preparation; high risks of pests and diseases incidence; high demand for manual planting

Challenges in product bulking the products in market centres due to increased damage in roads; high product losses; decline of demand and price of processed products; increased transportation costs decreased profits

Difficulty for famers to reach the consumers (limited market access due to bad road condition); reduced market activities; loss of income by producers

Magnitude of impact

Major-Severe

Major

Major-Severe

Major

Farmers' current strategies to cope with the risks

Access to public extension services; use of family labour

On-farm banana nurseries management using shade nets; planting new varieties

Aggregation by farmers; use of light farm vehicles; processing/ value addition at farm level

Formation of farmer groups to reach buyers; establishment of aggregation centres; capacity building on organised markets

Other potential options to increase farmers' adaptive capacity

Public-private partnerships; contracting organised farmer groups e.g. cooperatives; linkage to micro-finance institutions; continuous use of certified seedling (suckers) to enhance production

Use of greenhouse and tunnels for seedlings; tree planting; establish water runoff control structures (trenches, furrows); use of machines to complement labour; soil/land conservation structures

Established organized aggregative rights which are owned by farmer organisations; improve transport conditions (adequate vehicles) for farmer organisations; use of modern processing machines owned by farmer organisations and cooperative

Formation of strong farmer cooperatives and associations; dissemination of market information services; enhanced capacity building on marketing and value addition to produce; crop insurance



Reduced rainfall

High capital required; extension service advice on early maturing crop varieties; more time consumed for technical advice ; more labour required

Getting low yield from prepared land; reduction in the area under cultivation; reduced water availability for seedlings in the nurseries; stunted growth; low soil moisture for establishment; increased investment in land preparation; delayed planting

Produce scarcity; more collection centres will be required to meet buyer's target; increased transportation cost; better drying for value addition activities (flour making, crisps) but in low volumes to meet the market demands

More time required for buyers to reach farmers; limited trading volumes and low quality products; challenge in price determination; difficulty in selling low quality products; increased market competition hence low profit

Magnitude of impact

Moderate-Major

Major

Major

Major-Severe

Farmers' current strategies to cope with the risks

Access to public extension services; use of family labour

Use of shade nets; planting improved varieties

Implementation of precarious bulking structures; use of small farm vehicles; cottage industries

Farmer linkages to buyers; extension service provide institutional linkages; individual traders

Other potential options to increase farmers' adaptive capacity

Linkage with financial sources (banks); Public-private Partnerships in extension provision; supply of clean planting materials by research institutions

Mechanization for land preparation; standard manual planting; adopt improved banana production structures (greenhouses for seedling hardening) and irrigation facilities; cover crops

Organized bulking to specific sites with shades and cooling facilities; organised vehicles with cold storage; use of modern machineries for processing

Linkages to be carried out by coops and farmers associations; price determination using standardised measurements (e.g. weight); promotion of farmers' aggregation (e.g. cooperatives and farmer organisations

## Policies and Programmes

Although the awareness of policies and programmes related to climate change and adaptations is very limited among the farmers, several national and local policies and programmes have been put in place to broadly address problems related to the climate vulnerabilities discussed earlier.

The Agricultural Sector Development Support Programme (ASDSP), developed by the Kenyan and Swedish governments in 2010, has been targeting increasing agricultural production and productivity in rural households through capacity building. The programme has promoted Participatory Scenario Planning, where beneficiaries (farmers) of a certain intervention are given the chance to identify the most pertinent interventions as well as the most effective implementation strategies. Access to extension services which include knowledge sharing and transfer on crop selection, use of improved seeds and early-maturing varieties among others has been promoted through development of linkages between farmers and relevant stakeholders in the agricultural sector such as research organizations and input dealers.

With regard to crop farming, the Agriculture (Farm Forestry) Rules enacted under the Agriculture Act in 2009 encourage farmers to maintain a 10% tree cover to improve soil and water conservation (GoK, 2009). Different organizations including KFS and Nature Kenya support the tree planting initiative. Tree planting is crucial as there has been a lot of forest degradation for firewood and charcoal.

To tackle human-wildlife conflicts (most common during the dry spells as wild animals break into farms to look for pastures and human beings encroach on the protected areas), the Wildlife Conservation and Management Act developed in 2013 has been established to compensate any personal injury or destruction of property (livestock and crops) caused by wildlife (GoK, 2013b). However, inadequacy of wildlife monitoring mechanisms has compromised the effectiveness of this policy, since most of the compensation claims remained unsolved.

The Dairy Industry Act, Cap 336 of the Laws of Kenya has established the Kenya Dairy Board (KDB) after deregulation of milk prices. KDB's role in the dairy industry is to focus more on dairy regulation and development activities. The Board's main strategic objectives are to: improve the quality of Kenyan dairy produce; provide timely and accurate dairy information; stabilize milk production; promote milk production in non-traditional dairying areas; and enhance consumption of milk and milk products.

Programmes implemented in the County related to agriculture and climate change include: the Agricultural

Extension programme, which aims to support farmer and extension staff training; the Kenya Agriculture Productivity and Agri-business Project (KAPAP), facilitating farmers to form Community Interest Groups (CIGs) to increase productivity; Njaa Marufuku Kenya (NMK), which aims at capacity building and supporting farmers to access funds for income-generating activities; the National Agricultural Accelerated Input Access Programme (NAAIAP) assisting farmers to access inputs; Agricultural Sector Development Support Programme (ASDSP) assisting farmers increase productivity across identified value chains; Traditional High Value Crops (THVC) promoting traditional high value crops through bulking and establishment of seed multiplication units for food security and diversification of income sources. SHEP UP aims at farmer capacity building in Bomeni and Challa. SEDEMAN SAL for scheme rehabilitation and farmers training in Kasokoni scheme. 3G Irish Potato Project promoting potato commercial-oriented farming. E-extension to enhance efficiency and effectiveness in service delivery. Agricultural Training Centre to train both officers and farmers.

However, although some policies and programmes have recorded successes, there are challenges to full realization of programme objectives. Such challenges include insufficient funds to enable wider coverage, poor road network and insufficient staff. Some cultural practices such as continued maize production, low fertiliser use, high dependency syndrome compounded with high poverty levels impair success and ownership of most of the programmes by the farmers. In addition, it was reported that for some programmes, coordination is inadequate, hence there is duplication. Factors such as minimal involvement of all stakeholders at all programme/project phases and lacking policies were the reasons identified as contributing to poor coordination.

## Governance, institutional resources, and capacity

There are various government, non-government (NGOs), community-based, faith-based and private organizations in Taita Taveta County that directly or indirectly deal with climate risks. The government institutions at the County level include the Livestock Production Department, Agriculture Department, Irrigation Department, the Kenya Meteorological Department (KMD), the Agricultural Training Centre (ATC), the National Environmental Management Authority (NEMA), Kenya Forest Service, Kenya Wildlife Service, the National Cereals and Produce Board (NCPB), and the National Drought Management Authority (NDMA). The government departments and organizations mainly offer extension, input provision, and policy support. Specific interventions include extension and vaccination services by the veterinary department, and the design, implementation,

and mainstreaming of risk reduction strategies, as well as coordination of drought management infrastructure by the NDMA.

International organizations working in the County in areas related to addressing food security issues, supporting agricultural development and providing capacity building services include Kenya Red Cross Society (KRCS), the United Nations' World Food Programme (WFP), and World Vision. Non-governmental organizations (NGOs) focus mainly on advocacy and capacity building. The NGOs with the largest presence in the region that address issues related to climate change adaptation and food security include Mazido, Wildlife Works and Nature Kenya. Financial institutions like Kenya Commercial Bank (KCB) support environmental initiatives like tree planting. Private institutions like Total Kenya and hotels also support tree planting initiatives. Organizations such as Taita Taveta College, KALRO and Helsinki Campus are involved in research including on climate change. Community- Based Organizations like Nguamlambo Development Trust (NDT) and Taita Taveta Wildlife Forum mobilize communities to address issues such as human-wildlife conflict and environmental degradation.

For the government departments, influence mainly comes from the national offices. Nevertheless, when it comes to planning and implementation of development interventions, the government departments in the County and NGOs have significant influence on the choice of approach and location of interventions. Some donors also have specific objectives which may not allow for adjustments at the County level. The source of funding also influences operations in that some encompass a lot of bureaucracy hence delaying operations. Other than planning for development interventions, the government departments also take part in responding to emergencies that are within their mandate. Coordination among these previously mentioned organizations exists at some stages of intervention design and implementation. Collaboration was noted within the government departments. However, NGO-to-NGO collaboration and NGO-to-government department collaboration could be strengthened. This may be due to the fact that most of these NGOs are autonomous in operation.

## Synthesis and Outlook

Climate Change and resultant effects are foreseen to continue in Taita Taveta County. With agriculture as the main economic sector, and heavily impacted by climate change, there is need to increase the capacity of the stakeholders to mitigate the climatic hazards. Thus development and implementation of both short- and long-term adaptation measures are critical.

However, this study and literature available observe that there exist various mitigation measures in the County. These measures are initiated by the farmers and supported by institutions including government, NGOs, CBOs and institutions like banks and research institutes.

The strategies adopted currently include on-farm practices that target water and soil conservation and management, such as water pans, agroforestry systems, crop rotation, and drought-tolerant crops and animal varieties. Off-farm services are provided to facilitate the adaptation strategies including extension services, credit and insurance services, technical support, capacity building for farmers, and early warning systems. However, uptake of these services is affected by factors such as poverty, low levels of education, culture and geographical location of these farmers.

Therefore, it is imperative to adopt a multi-faceted approach in promoting adaptation to climate change. This involves ensuring that challenges along the various value chains are addressed if the interventions are to have impact. Thus without providing the necessary conditions for access to inputs, storage facilities and subsequent market facilitation, productivity in the value chain is affected and livelihoods and incomes of farmers remain at risk. To improve adaptation, measures such as ensuring inputs are available during the onset of rains; support for adoption of irrigation and farmer organizations can improve the preparedness of the farmers to cope with the climatic hazards.

Moreover, there is need to address the factors that continue to limit the capacity of farmers to respond adequately to the climatic hazards, that is, the underlying factors. These factors, including poverty and low levels of education, can be countered by a deliberate attempt to devote resources in the provision of utilities such as education, electricity, potable water, health, and security. Such investments will support livelihoods, increase productivity and curb environmental degradation such as deforestation.

There exist a number of policies that support climate change adaptations at the national level which are also applicable at the County level. However, awareness of these policies especially by farmers should be improved. Furthermore, implementation of the policies is not adequate and should be improved. The major challenge identified for the inadequate implementation of policies revolves around resources. Thus there is need to devote more resources both from public and private sources for agricultural activities and climate change response. These will enhance the institutional capacity to provide services such as extension and also provide subsidies where necessary. There is also need to build the capacity of farmers to form organizations that can improve their resilience such as cooperatives and CBOs.



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

**Annex 1:** Value chain selection indicators

**Annex 2:** Adaptation to climate change and variability

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