

## Climate Risk Profile Kajiado County

### Highlights

- Kajiado County is predominantly semi-arid. Livestock rearing and crop farming are the main economic activities in the county. Crop farming is mainly in the southern and western parts of the county along rivers and springs. The agricultural sector employs 75% of the total population and provides nearly 40% of the county's food requirements.
- The main climatic challenge facing the agricultural sector in Kajiado is drought. The frequency and severity of droughts in the county have resulted in crop failure and livestock losses and triggered severe food shortages in the past. In 2009 crop failure in the county reported at more than 90%, while livestock losses were in excess of 70% in most areas within the county.
- Current adaptation strategies include planting of drought-tolerant grasses/pastures, fodder conservation, irrigation, mass vaccination, livestock migrations, and rearing of livestock types adapted to drought.
- Stakeholders such as the Kenya Meteorological Department (KMD), National Drought Management Authority (NDMA) and the Ministry of Agriculture, Livestock and Fisheries (MoALF) offer off-farm services such as early warning and extension services. However, the low population density typical of pastoral areas combined with a lack of access roads makes the delivery of extension services difficult.
- Low literacy rates coupled with high poverty levels further compound the challenges brought about by climate change and variability; more than 53% of the population live below the poverty line. The high level of illiteracy among pastoralists of Kajiado County also hinders access to information, speed of recovery from climatic events, and constrains options for livelihood diversification.
- The successful implementation of adaptation strategies requires systematic strengthening of the input supply - farmers require viable and quality seed at the right time. In addition, farmers also need better cooling and storage facilities in order to reduce post-harvest losses occasioned by increases in temperature. Adequate plans for water harvesting in mega dams as the terrain is suitable for dam construction and the few torrential downpours recorded in the year can yield storm water to fill the dams.
- In spite of agriculture being a devolved function, partnerships are still crucial in maximizing benefits of climate change adaptation and responding to drought in the county. The county has received support from research organizations such as KALRO, donor-funded projects such as the Regional Pastoral Livelihoods Resilience Project (RPLRP), as well as Non-Governmental Organization such as the Food and Agriculture Organization (FAO).
- Lack of a forum, which would bring together all the players in the agricultural sector for the joint planning of activities, is among the major gaps identified. Adequate planning and preparation are required to respond to potential calamities such as drought. Coordination of activities by all stakeholders in agricultural production and climate change ensure coherence in implementation.

## List of acronyms

<b>AFFA</b>	Agriculture, Fisheries and Food Authority
<b>ASAL</b>	Arid and Semi-Arid Lands
<b>ASDSP</b>	Agricultural Sector Development Support Programme
<b>CEAP</b>	County Environment Action Plan
<b>CIDP</b>	County Integrated Development Plan
<b>CSG</b>	County Steering Group
<b>ERA</b>	Economic Review of Agriculture
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>FGD</b>	Focus Group Discussion
<b>HCDA</b>	Horticultural Crops Development Authority
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>KALRO</b>	Kenya Agricultural and Livestock Research Organization
<b>KCSAP</b>	Kenya Climate-Smart Agriculture Project
<b>KFS</b>	Kenya Forest Service
<b>KMD</b>	Kenya Meteorological Department
<b>KNBS</b>	Kenya National Bureau of Statistics
<b>NDMA</b>	National Drought Management Authority
<b>NEMA</b>	National Environment Management Authority
<b>NGO</b>	Non-Governmental Organization
<b>PSP</b>	Participatory Scenario Planning
<b>RPLRP</b>	Regional Pastoral Livelihoods Resilience Project
<b>SEAG</b>	Small East African Goat
<b>SID</b>	Society for International Development
<b>VCC</b>	Value Chain Commodity



# Foreword

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

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

This document presents the Climate Risk Profile for Kajiado County, which is modestly vulnerable to climate change (vulnerability index of 0.426) in the country (GoK, 2013). Climate hazards are common in Kajiado, with a history of devastating droughts since the 1900s. The frequency of drought has increased over time to about every 2-3 years. In the 2000s there

were drought events in 2000, 2003, 2004, 2007, 2008 and 2011; two of them being extreme. The drought events have resulted in the drying up of water sources with an associated increase in the distance to watering points in the pastoral livelihood zone, loss of livestock, crop failures, school dropouts and escalated human wildlife conflicts; factors that have made the county dependent on food relief. The mortality rate for cattle, sheep and goats (shoats) during the 1999-2001 droughts was 50% and 20% respectively (Huhu and Kosonoi, 2014). More than 11,000 livestock died while on transit to Mount Kenya in search of water and pastures (Matthews, 2006). In 2014, approximately 50,000 families were affected and at least 100,000 livestock died (The Star, 2014). In response to the above, there has been implementation of various programs to manage the effects of droughts and alleviate food insecurity. For example, in early 2017, KES 100 million was set aside for averting hunger in the county, in addition to other ongoing food interventions such as the General Food Distribution and the Home Grown School Meals Programme. These events are an impetus for a paradigm shift from emergency response to integrated agricultural development interventions that bolster resilience and enhance agricultural productivity in the county.

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



# Agricultural context

## Economic relevance of farming

Kajiado County is located in the Rift Valley towards the southern part of Kenya. The county borders the Republic of Tanzania to the southwest, Taita Taveta County to the southeast, Machakos and Makueni counties to the east, Nairobi County to the northeast, Kiambu to the north and Narok County to the west. The county covers an area of 21,900.9km<sup>2</sup> with 2,344.2 km of road network which include 300 km of tarmac roads, 932.3 km of gravel roads and 1,111.9 km of earth roads (GoK, 2013). The county divides into five administrative sub-counties namely: Kajiado Central, Kajiado East, Kajiado West, Kajiado North and Kajiado South with 25 wards. The most densely populated is Kajiado North with a density of 1,369 persons per km<sup>2</sup>. The density projects to reach 2,087 persons per km<sup>2</sup> by 2017. This is due to presence of highly populated areas of Rongai, Ngong, Kitengela and Kiserian which are residential areas serving the Nairobi City. Kajiado West has a lowest density of 14 persons per km<sup>2</sup> due to its vast area attributed to harsh climatic conditions unfavorable for farming and settlement (GoK, 2013).

The main physical features of Kajiado County are plains, valleys and occasional volcanic hills ranging from an altitude of 500 meters above sea level at Lake Magadi to 2500 meters above sea level in Ngong Hills. The lake has substantial deposits of commercially exploited. Soda ash. Approximately 720,000 tons of soda ash are harvested per year in Magadi and this makes it the largest producer both in the country and in Africa (ASDSP, 2014). The county's soils include well drained, shallow to moderately deep, brown to dark brown, firm and slightly smeary, strongly calcareous, stony to gravelly clay loam; in many places saline and/or sodic soils and with inclusions of lava fields (Ando-calcaric Regosols, partly lithic phase) (National Accelerated Agricultural Inputs Access Program, 2014). It also consists of three geological regions: quaternary volcanic, Pleistocene and basement rock soils<sup>1</sup>.

The county has a bi-modal rainfall pattern. The short rains fall between October and December while the long rains fall between March and May. The long rains (March to May) are more pronounced in the western part of the County while the short rains (October to December) are heavier in the eastern part. The rainfall amount ranges from as low as 300mm in the Amboseli

basin to as high as 1250mm in the Ngong hills and the slopes of Mt. Kilimanjaro. Temperatures vary both with altitude and season. With the highest temperatures (34°C) recorded around Lake Magadi while the lowest (10°C) at Oloitokitok on the eastern slopes of Mt. Kilimanjaro. The coolest period is between July and August, while the hottest months are from November to April. Most of Kajiado County lies in semi-arid and arid zones V and VI characterized as livestock production zones with only 8% of having potential for rain fed cropping (zone IV).

The county is predominantly semi-arid with livestock rearing and crop growing as the main economic activities. The agriculture and livestock development sector is the most important sector in the county. The sector employs 75% of the total population and provides nearly 40% of the county's food requirements. According to the ASDSP Baseline report of 2014 (GoK, 2014), at least 78% of households were employed and derived their income from on-farm (crop, livestock sales and fishing activities). Average annual on-farm income earned the households KES 193,533 with crop sources contributing the largest portion of this income.

Livestock production is the predominant economic activity in the county through nomadic pastoralism. The main cattle breeds are Sahiwal, Boran, Simmental and Friesians. The main goat breeds are crosses of Small East African Goat (SEAG) and the Galla (74.3%), while the sheep breeds are Red Maasai crossed with Dorper (Gitonga et al., 2016). Approximately 1,055ha of land is cultivated with food crops such as maize, sorghum, finger millet, beans, cowpea, green grams, tomatoes, bulb onions amongst others. According to the ASDSP Agribusiness Baseline Survey Report of 2014, commercial farming of onions and tomatoes is throughout the county though some are in small quantities. Horticulture is also gaining popularity through irrigation schemes mainly in Isinya sub-county and Kajiado North. Most people have small-irrigated farms, in productive areas of Oloitokitok, Kajiado East Sub-county and Ngong. Tomato production is majorly in Kajiado South in Kimana, Rombo and Oloitokitok under small-scale mixed farming. Large farms of more than 50 acres are mostly for rain fed agriculture although this is slowly becoming unpopular because of irregular rainfall patterns. The 2015 statistics show that tomato production in the county was worth about KES 989,740,000. In 2016, the value of bean production was at KES. 391,177,000 while that of maize was KES 240,587,000.

<sup>1</sup> Other soils include Alluvia soils, Quaternary Volcanic soil in the Rift Valley and Basement System Rocks that comprise various gneisses, cists, quartzite and crystalline limestone, along the river valleys and some parts of the plains. Pleistocene soils are in the inland drainage lake system around Lake Amboseli. Quarrying of building materials is also within the county

In terms of gender, adult males were more involved in livestock and livestock product trading than women and youth. Female-headed households (FHH) were more involved in self-employment compared to male-headed households (MHH) and youth-headed households (YHH)<sup>2</sup>. Provision of hired labor is mainly by the youth. Overall, 79% of adult male-headed households, 60% of adult female-headed and 79% of youth-headed households derived their income from on-farm activities. On a money value basis at household level, crop income represented 48% of all on-farm income compared to livestock's contribution of 28% and 14% from fishing and 8% from other sources.

## People and livelihoods

The county population as per the 2009 population census was 687,312 (345,146 males and 342,166 females). The county's growth rate is 5.5% bringing the 2017 population to 999,819 (502,077 males and 497,742 females). There are high levels of poverty in the county with more than 53% of the population living below the poverty line (GoK, 2011). Kajiado North has the highest number (94, 923) of poor people (GoK, 2013). Major causes of poverty include illiteracy, frequent droughts, poor infrastructure and inadequate water resources. In 2012, the number of rural poor was 461,507 where 230,426 were female and 231,082 male (GoK, 2013), Kajiado North has the highest number (80,020) of the rural poor.

Over 75% of the population depends on agriculture for their livelihoods, and pastoralism dominates crop production for majority of rural households in the county. The main livestock types are sheep, goat, beef and dairy cattle, exotic commercial chicken, indigenous chicken, donkeys, pigs and camel. Some of the crops grown are maize, beans, tomatoes, Irish potatoes and kales. Adult males make main decisions on the type of crop however; women are the main decision makers (63%) in production of kales. Adult males (60%) are the primary decision makers in production of beans, maize, Irish potato and tomato followed by adult females (25%). (GoK, 2014).

Out of 173,464 households, only 39.8% have access to electricity. For cooking, 38.5% of the households use firewood while 39.8% use electricity for lighting. Firewood is the most common cooking fuel by gender with 35% of male-headed households and 53% in female-headed households using it (KNBS and SID, 2013). The households using improved sources of water e.g. boreholes, protected springs and piped water account for 66% of the households, while the rest rely

on unimproved sources such as ponds, dams, stream/river, unprotected spring, unprotected well and water vendors. Use of improved sources varies by gender with 68% of male-headed households and 63% in female-headed households using it (Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID), 2013). Households with access to potable water are 172,139. The mean distance to a water source is 10km from their homesteads (GoK, 2013). The Drought Early Warning Bulletin prepared by NDMA in February 2017, stated that the temporary water sources including pans recharge from off-season rains. This led to slight improvement in access to water by livestock in January 2017.

On average, the 79% of households in the county are food insecure. About 80% male- and 86% female-headed households were food insecure compared to 75% youth-headed households. A Joint Report by the Kenya Food Security Steering Group and the Kajiado County Steering Group on the 2016 Short Rains Food Security Assessment (Kenya Food Security Steering Group and the Kajiado County Steering Group, 2017) states that factors affecting food security include: late onset and low amounts of rainfall which negatively affected water and forage situation thus triggering early livestock migration hence a decline in household milk production and consumption.

Twenty eight percent of Kajiado County residents have secondary level of education or higher. Kajiado North constituency has the highest share of residents with secondary level of education or above at 49%. On the other hand, 42% of Kajiado County residents have primary level of education only. Kajiado South constituency has the highest share of residents with primary level of education at 47%. Kajiado West constituency at 38% has the lowest share of residents with a primary level of education only. Some 31% of Kajiado County residents have no formal education. Kajiado Central constituency has the highest share of residents with no formal education at 48%. According to the 2014 Kenya Demographic and Health Survey, 18.2% of children in the county are stunted. The cause of stunted growth is due to poor diversification of food sources among households.

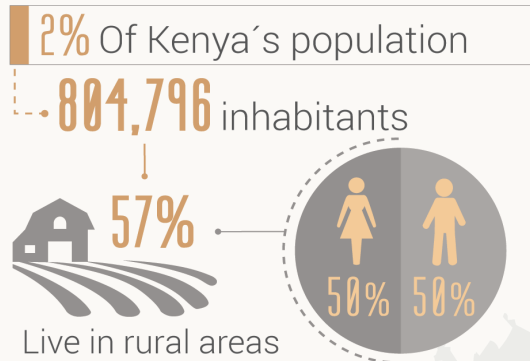
## Agricultural activities

The dry-land conditions in the county make the production of nomadic pastoralism possible. However, there is a significant change in land use in the urban areas where industrial and commercial use is gaining momentum. The arable land in the county is 3468.4 km<sup>2</sup> that represent 15.8% of the total land area. The area

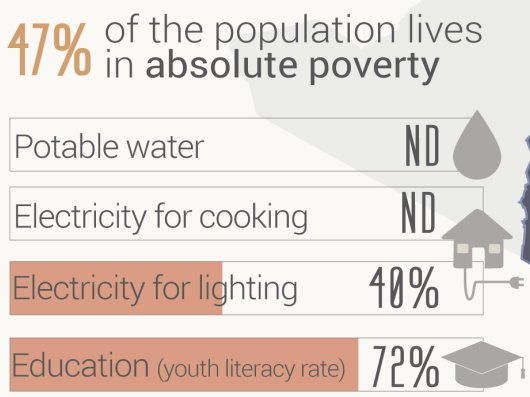
2 YHH - refers to any female or male aged between 18-35 years who is the main decision maker in the household.

# Livelihoods and agriculture in Kajiado

## Demographics



## Access to basic needs



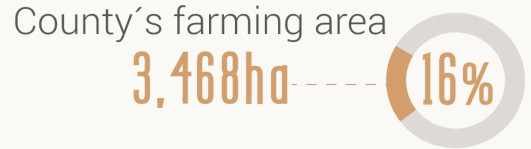
## Food security



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

## Farming

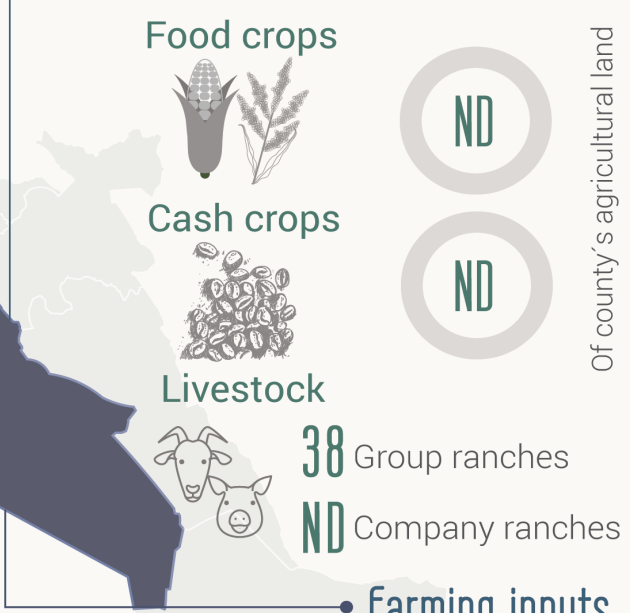


43% of the population employed in agriculture production

50% of farmers have title deeds

ND are women

## Farming activities

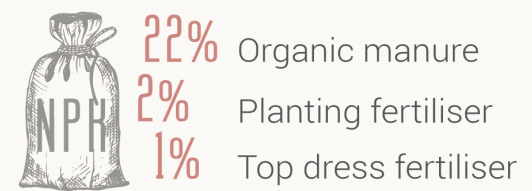


## Farming inputs

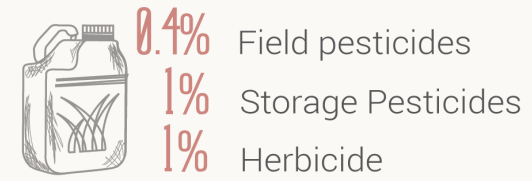
### Water uses



### Fertilizer types (% of households)



### Pesticide types (% of households)



under cultivation is about 88,000 hectares or 25.3% of the total acreage of arable land (Costa *et al.*, 2013). On average, small-scale land sizes are approximately 9ha while large scale ones are 70ha. About 66% of households hold title deeds; with more male-headed households (70%), having title deeds compared to both the female- and youth-headed households (68% and 66% respectively). Nevertheless, more youth-headed households (approximately 31%) have access to communal land relative to the male- and female-headed households (26% and 23% respectively) (GoK, 2014). Most of the rural land is without title deeds compared to the urban areas due to lack of awareness of the importance of titled land ownership also most land is communally or privately owned group ranches. In 2014, a draft County Land Policy was developed in light of the transformation of pastoral land for urban use and decline of pastoralism, which is the main source of livelihood in Kajiado County. Fortunately, this land policy, amongst other things, would control development and overstocking due to reduced land carrying capacity and now industrial uses.

In the southern part of the county, crop production is mainly rain fed agriculture benefitting from the rainfall on the windward side of Mt Kilimanjaro. Horticulture, in particular is produced using irrigation from existing springs and rivers. The main areas for irrigated cropping are along the Ngong Hills, along the Nolturesh River in the Kimana area, in the Kilimanjaro foothills and around Namanga. The perennial Tsavo River with its main tributaries Nolturesh, Magoine and Rombo, which flows from the eastern slopes of Mt. Kilimanjaro, provides water to Kajiado South Sub-County. Springs from Nkuruman escarpments provide water for irrigation in the area. During the dry season, no tomatoes grow in these areas because the rivers dry up.

The low use of inputs such as certified seeds and fertilizer is attributable to high input prices and distances to input markets that causes low agricultural productivity in the county (CIDP, 2013). For instance, only 29% and 28% of all the farmer households use improved seeds and organic manure respectively whereas barely 1% of the households use herbicides, foliar feed and field pesticides, and only less than 2% use basal and top dressing fertilizer and storage pests (GoK, 2014).

## Agricultural value chain commodities

A broad diversity of agricultural commodities are grown in the county. Of these commodities, various value chains have been prioritized as being strategic for the county as indicated in the County Integrated Development Plan (CIDP) and the Agriculture Sector Development Support Programme (ASDSP) as well as by government institutions such as the Kenya Agricultural and Livestock Research Organization (KALRO). For the development of this County Climate Risk Profile, four major value chain commodities (VCC) were selected for in-depth analysis based on: prioritization in County frameworks and programs; economic value (KES/bag or KES/livestock or KES/unit livestock product)<sup>3</sup>; resilience to current weather variability and future climate change<sup>4</sup>; and number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor<sup>5</sup>). The selected VCC were Cattle (milk), Cattle (meat), tomatoes and shoats (meat).

### Cattle (milk)

The county produces an average of 30,241,491 liters of milk every year valued at KES 907,244,730. Between 61-80% of the population are involved in milk production, predominantly in rural areas and by women even though men own the cow. About 54% of households sell cow milk, among them 52% are male-headed, 41% female-headed and 48% youth-headed households (GoK, 2014). Women and youth are particularly important in the value chain engaging in milking, selling and production. The milk is sold to consumers in major towns such as Kitengela. There are both private and public small-scale service providers providing feed and veterinary services in the county. To support on-farm production of milk, there are few service providers supplying ploughing services, labor (e.g. for milking and pasture management) and spraying services. There are also a limited number of enterprises providing hay-harvesting services. However, a few cooperatives offer milk cooling services and transportation of the milk to the market. These cooperatives also carry out value addition services to products such as fermented milk 'mala' and yoghurt

3 As stated in the 2015 Economic Review of Agriculture (ERA)

4 Resilience is as defined in IPCC (2012); where we consider the general risks posed by climate change in the county. Value chains which are perceived to survive the local conditions under the current production systems holding other things constant (including variations in technology adoption rates among farmers/pastoralists) are considered more resilient. <sup>15</sup> In the study, the concept of resilience follows the definition set in IPCC (2012), taking into account the climate change risks that the County is exposed to. The resilience of value chains is given by their ability to recover from climate shocks, holding constant aspects related to variations in adoption rates of technologies among farmers/ pastoralists.

5 Categorization of "poor" people was based on workshop participant perceptions and not on any standard index normally used to measure poverty.

while the Kenya Dairy Board is the main marketer of milk and milk products.

There is also a shift towards migration in search of pasture. Previously, the pastoralists would migrate with the entire livestock including lactating livestock. However, attitudes of the community are also changing where the lactating herd are for domestic consumption and additional income for the women. This significantly contributes to domestic food security and provides additional income for the family. Some women have reported having income of up to KES 10,000 from milk sales every month (The Review, 2015).

The dominant breed in Kajiado, Zebu, is upgraded with the dual-purpose Sahiwal breed and with improved Borana breed in an attempt to increase milk and beef production. There are initiatives by KALRO to improve breed productivity by having crosses of the predominant Zebu cows with the more productive Borana cow that produces more milk per animal. Milk production in exotic cattle is three times higher than in cross breed cattle (GoK, 2014), indicating that livestock improvement programs have the potential of increasing productivity.

Zero grazing is predominant for milk production under commercial mixed-farming system. The main areas where milk production is under this system are Ongata Rongai, Kiserian, Bulbul and Matasia. Small-scale agro pastoral milk production is in the southern parts of the county namely Kimana, Oloitokitok, Ilasit and Rombo. The majority of milk produced in the county is large scale (above 100 heads) under pastoral free-range system.

### Cattle (beef)

In Kajiado County, 61-80% of the population is involved in beef production mostly in rural areas. The major farming system across the county is the free-range commercial system. There are pockets of small-scale commercial farming (less than 100 heads) in Ongata Rongai, Ngong, Matasia and Kiserian. Mixed commercial beef production is in Kajiado South particularly in Kimana, Eldoinyo, Oloitokitok, Rombo, Kuku, Olou and Iltilal. Limited production is also in Mashuru and Kibini in Kajiado East. There is also fattening of steers and the youth are mainly involved in cattle fattening enterprises.

An average number of veterinary and extension services exist to support the value chain that practiced

by majority of households in the county. There are a few slaughterhouses such as Keekonyokie Slaughter House located in Kiserian and the others located in Bisil and Imbirikani. The latter is the first export abattoir in the county (The Standard, 2014). Women's role in beef production is mostly in on-farm production while the youth are involved in the slaughter' transportation and run the butcheries at the market.

The average beef production per year is 16,831,950kg bringing in an estimated KES 4,376,307,000. Similar to the milk VC above, production of cattle has remained high even with the prevailing climate changes. This is attributable to pastoralism, and the transhumance nature of beef production<sup>6</sup>. The local Zebu are able to survive and reproduce despite the climatic changes experienced in the county that result to a remarkable increase in temperature and a moderate increase in number of moisture stress days. Zebu are indigenous to the county and are able to adapt by delaying their breeding during prolonged dry seasons. This breed is the most preferred breed due to their superior adaptive capacity to environmental stresses and resistance to diseases and parasites.

The management of livestock pests and diseases has improved with regular surveillance and advisory services from sub-county teams. There is also enhanced response to disease and pests outbreaks with the support from FAO and the national government. Extension advisory services for breed improvement such as crosses of Zebu and Boran species is being done to ensure higher carcass weight that leads to better prices for beef at the market. The crosses also mature faster reducing the age between birth and market. Planting fodder and conserving hay for use as livestock, feed during prolonged dry spells is one of the more promising adaptation options. KALRO is also providing three types of grasses to increase pasture availability. These grasses are *Eragrostus superba* (Maasai love grass), *Cenchrus ciliaris* (foxtail grass), and *Enteropogon macrostachyus* (Rye grass).

Continuous capacity building of pastoralists in pasture management and recommended stocking rates is also contributing to better management of livestock and an increase in the size and value of the livestock herd. Initiatives by development partners in the county such as KALRO have contributed towards reseeding of grasslands and planting of fodder for better feeding and restoration of the rangelands.

6 Transhumance is the regular movement of herds among fixed points in order to exploit the seasonal availability of pastures. (Definition FAO)

## Shoats (meat)

Sheep and goats (Shoats) are a combined value chain because of their similarity in management and production practices. Shoats are next to cattle concerning importance of livestock to the communities in Kajiado County. Shoats represent a significant composition of pastoralist livestock herds. Their small body size, rapid rate of reproduction and low market price make them easy to sell and buy when compared to cattle and camels (Gitonga et al., 2016). The income from such sales is able to cater for 60% of household basic needs to include grain, medical and education expenses (Behnke and Muthama, 2011).

There are large numbers of shoats kept along the Kaptein slopes (Kaputiei plains) (from Isinya to Kiboko) in the county. Stakeholders described two main shoats farming system: small scale, where a household has less than 300 heads and large scale with above 300 heads.

Between 61-80% of the population are engaged in this value chain especially in the central, western, and southern parts of the county. The main sheep breeds are the East African fat tailed sheep of which the Red Maasai are a representative group (Audho et al., 2015) and the Dorper breed. On the other hand, the main goat breeds include crosses of Small East African Goat (SEAG) and Galla (Gitonga et al., 2016).

A substantial number of dairy goats are present in Kajiado North. Inaccessibility to rural areas has made technical support from the county difficult. Farmers deworm their sheep and goats on-farm.

Strategic markets are available in Ilbisi Shompole and Kimana but processors of shoaat meats are lacking in the county. Sheep and goat hides business is prevalent in Kajiado. Currently hides exports are in a semi-processed form referred to as wet blue<sup>7, 8</sup>. A tanning factory is under construction in Isinya as part of the Kenya vision 2030-flagship projects, has earmarked a leather city for development in the county at Kinama, Athi River.

## Tomatoes

About 41-60% of the population is engaged in tomato production mainly in Kajiado South and East. Greenhouse tomato production is common in Kajiado East and North while irrigated tomatoes are in Kajiado West and South and according to the Horticultural Crops Development Authority (HCDA) Report 2014; Kajiado County is the second highest tomato-producing county after Kirinyaga accounting for 9.1% of total production. In 2013, 1,603ha of land were under tomato cultivation with a value of KES. 921 million, increasing to an acreage of 1,680ha valued at KES. 1.624 billion 2014 (AFFA, 2014).

Kajiado South Sub-County produces tomatoes under four farming systems: Small-scale commercial, large-scale commercial, small-scale mixed farming and small-scale mono farming/ cropping. Value chain actors include input suppliers and other, service providers and operate at small to medium scales. The value chain challenges are mainly at the post-harvest stage as the county lacks storage and processing facilities that can add value to the produce and increase the shelf life. The construction of a tomato processing plant had been initiated at Namelok in Kajiado South but work has stalled. Middle persons who go directly to the farms with set prices and purchase the tomato do the marketing of tomatoes. The farmers would improve their market by establishing themselves into cooperatives that would enable them access the market directly and achieve a higher bargaining power.

Women are significant actors of this value chain with high and active involvement in the production and marketing activities. However, the youth's low engagement in the inputs and marketing stages is attributable to the high presence of middle persons who buy and hire vehicles to transport the produce to the market.

7 Wet blue is the bluish coloration of the chrome tanning process of semi-finished leather

8 The Kenya leather council highlights the need to move the country's leather exports from wet blue to more processed products

# Agricultural value chain commodities in Kajiado<sup>8</sup>



Provision of seeds and other inputs



On-farm production

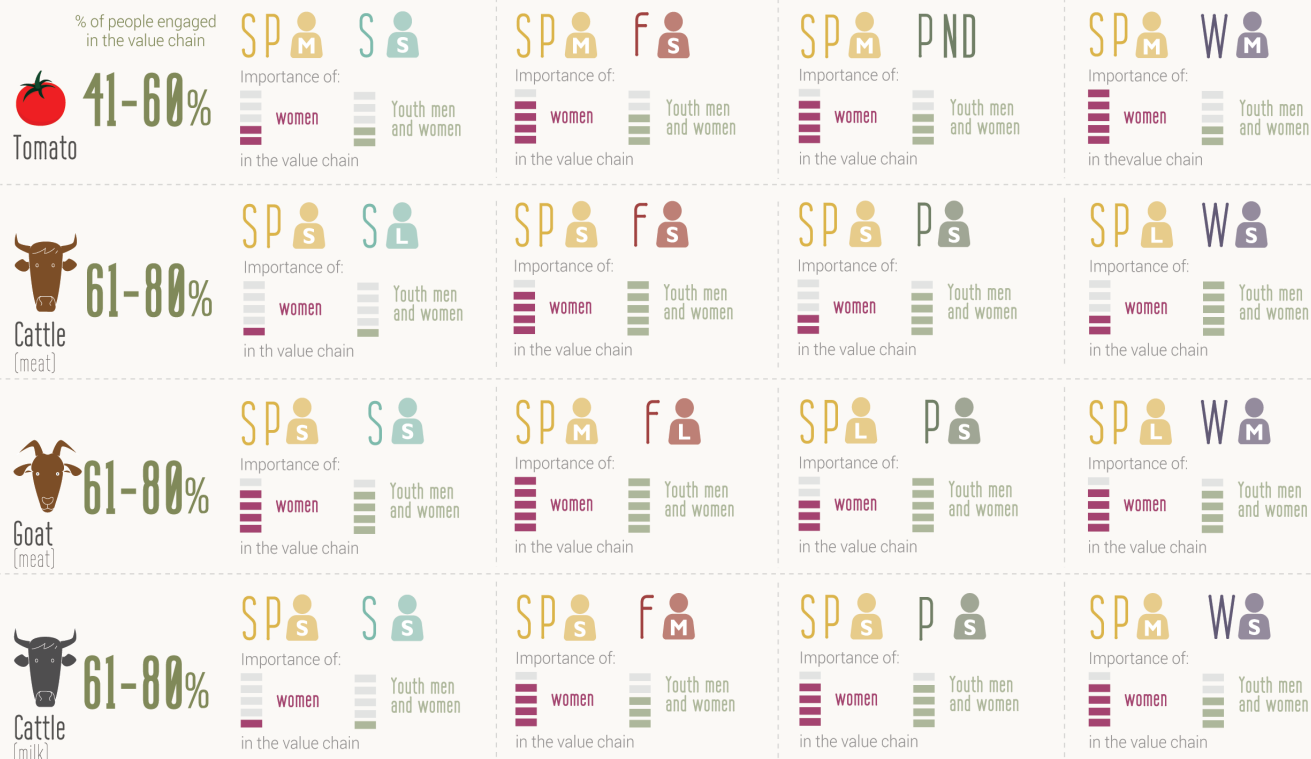


Harvesting storage and processing



Product marketing

## Types of actors engaged in Value Chain



### Conventions

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

<sub>S</sub> small-scale <sub>M</sub> medium-scale <sub>L</sub> large-scale

ND: No data

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

## Agricultural sector challenges

Climate change affects the agriculture sector adversely and Kajiado has started experiencing these changes through decreasing rains in the year and increased drought especially in the first season. Evidenced by a moderate increase in mean temperature, remarkable increase in heat stress days, high variability and slight decrease in precipitation and an increase in flooding risk. Overall, the second season has increasing rains

and decrease in starting of growing period. A slight decrease in mean temperature and reduction in crop cycle, moderate increase in rains since 2000, and high variability in flooding risk and remarkable decrease in starting of growing season manifest this. The long periods of drought have affected livestock production in terms of health condition and sometimes leads to deaths due to lack of sufficient feeds and water.

Unpredictable climate patterns also multiply the existing challenges that originated from the sale of communal lands resulting to an increase in economic and social instability for the local communities (Rozen, 2016). Conflicts emerge when livestock trespass into privately owned land in search of water and pasture. Climate variability has resulted to an increase in Trans boundary livestock pests and diseases such as Contagious Caprine Pleuropneumonia<sup>9</sup>, Rift valley Fever<sup>10</sup>, Lumpy Skin Disease, East Coast Fever<sup>11</sup>, and Trypanosomiasis especially due to human migration movements in search of pasture and water. This has reduced resilience in livestock production systems causing significant losses to farmers consequently affecting their food and nutritional security. Through active and passive surveillance, the Veterinary Department is able to identify and respond to disease outbreaks in the county by vaccination and/ or control. Of the vectors. The invasion by undesirable plant species such as *Prosopis juliflora*<sup>12</sup> also known as “*Mathenge*” and *Ipomoea spp*<sup>13</sup> are the biggest challenges facing productivity of pasturelands in Kajiado County. In particular *Ipomoea spp*, has colonized Kajiado East and Central and spreads rapidly especially after the rainy season. The plant has infested up to 60-80% of pasture fields (Kidake et al., 2015) and is mainly in disturbed or degraded sites. The degree of invasion in crop fields is low at 10% because of the comparatively small amount of crop farming in the county. The poor road network in the county has hampered access to some areas of the county. This also exacerbates the insufficient financial amounts available to support the county staff in their activities. Poor infrastructure in the county has led to poor market access resulting in limited access to accurate and timely market information. Limited access to farm inputs such as certified seeds and fertilizer resulting from high costs is attributable to poor infrastructure and distribution network. There are no reliable marketing channels to assist farmers market their agricultural produce most of which is sold at throwaway prices in the local markets. The situation becomes worse due to lack of storage and processing facilities particularly for tomatoes. The county’s poor and inadequate infrastructure (road, water supply, electricity, and telecommunications/ICT among others) has led to high cost of doing business and hindered harnessing of local potential and access to markets. During rainy season most of the earth

roads are impassable, which hampers movement of persons and goods’ (CIDP, 2013).

A growing level of land speculation in the urban areas of the county has led to excessive subdivision of land to small and sometimes uneconomical plots. Proximity of the county to Nairobi City and indeed location within the Metropolitan area is a recipe for increased demand for land for purposes of investments in various sectors such as housing, agriculture, commerce, educational, industrial among others. This has occasioned haphazard development patterns, subdivision of land to accommodate urban developments, diminishing agricultural and pastoral land, demeaning land values and encroachment on ecologically fragile areas such as wetlands, hilltops, water resources and forests. Zoning plans are developed but enforcement is weak and this increases conflicts of land use.

## Climate change-related risks and vulnerabilities

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

Kajiado County has a cool dry climate with mean annual temperatures over most of the county being around 21°C; although the northwestern corner near Lake Magadi has higher mean annual temperatures of 23°C to 25°C. Annual average rainfall ranges from as low as 300mm in the Amboseli basin to as high as 1250mm in the Ngong Hills and the slopes of Mt. Kilimanjaro, although most of the county receives an average of between 500mm and 750mm annually. Drought is the main agricultural hazard in the county, commonly resulting in a reduction in the availability of water and pasture availability and quality. This in return causes crop losses, livestock emaciation, conflict between agro pastoralists and escalated human-wildlife conflict. In early 2017 for example severe drought resulted in , failure of maize crops and a drastic decline in household milk production (to less than 1 liter per day) with households reportedly reducing the frequency and size of meals being eaten each day as a coping strategy<sup>14</sup>. Despite drought being the major agricultural risk in the county, flash floods

9 A fatal disease that occurs in goats with high morbidity (80-100%) and mortality rates.

10 A viral zoonosis that primarily affects animals and causes serious economic losses due to livestock deaths and abortion among RVF-infected cattle.

11 A tick borne corridor disease transmitted from wild animals such as buffalo to cattle during migration through the Amboseli National Park.

12 This species spreads in the dry degraded grasslands of the county with erratic rainfall due to its hardiness and versatility. It was introduced in the early 1990s and begun to suppress the other vegetation types following the 2006 and 2009 droughts (Kyuma et al., 2016). It is dominant and competitive owing to its superior adaptive capacity to arid conditions. The invasion of the *Prosopis* has reduced the available grazing land, and has led to the decline of pastureland. It is predominantly found in Kajiado West.

13 The plant is an annual creeping herb which is unpalatable and toxic to livestock in addition to outcompeting existing grass and forage species for nutrients and water from the soil. *Ipomoea spp* produces many seeds that remain dormant in the dry season only sprout at the onset of the rains that are dispersed over the season at the end of the rains. Control efforts include uprooting of the mature *Ipomea spp* plants as well as the young seedlings. These efforts have been moderately effective.

14 <http://reliefweb.int/report/kenya/kajiado-county-drought-early-warning-bulletin-march-2017>

also occur in the county resulting in displacement of people and livestock.

Analysis of historical temperature trends in the county over 25 years (1981 to 2005), indicate that mean first season temperatures have increased by approximately 0.5°C, while second season temperatures decreased slightly  $\leq 0.1^\circ\text{C}$ . Analysis of precipitation trends over a 35-year period (1981-2015) showed that average first season rainfall had decreased moderately, while that of second season had increased by more than 50mm particularly since 2000. Because of these changes in temperature and rainfall, first season has experienced a large increase in the number of heat stress days<sup>15</sup>, while flood risk in both seasons has increased. The farmers perceive that a rise in temperatures, moisture stress and flood risk as the main agricultural hazards in the county. Potential climate hazard scenarios hazards include moderate decrease in temperature/ reduction in crop cycle for the two seasons and decreased drought spell length in both seasons.

Looking ahead to the future, climate projections for the period 2021-2065 based on two representative concentration pathways (RCPs<sup>16</sup>) indicate that under the low emissions scenario mean temperatures will decrease moderately. However, under the high emissions scenario temperatures increase significantly. Under both scenarios, flood risk<sup>17</sup> is expected to increase in both seasons, however erosion risk<sup>18</sup> is not expected to change significantly. The Ministry of Agriculture has instituted Sustainable Land Management practices to prevent erosion across the county. These include soil conservation structures such as gabions and terraces, conservation agriculture technologies, tree planting and agro forestry. Of particular concern is a projection of an increase in moisture stress<sup>19</sup> in both the first and second half of the year by at least 25 days each. This could have a significant impact on water availability and needs for crop and livestock production. Despite the increase in moisture stress, drought stress on the other hand is not expected to change significantly and may reduce slightly in both seasons regardless of the emissions levels. Therefore, different changes in the weather and climate of Kajiado County can be expected depending on the emissions scenario. However regardless of the scenario there is need to take adaptive action to safeguard agricultural production in the county.

## Climate Perceptions by the farmers

Over the years pastoralist communities have had different ways of understanding changing weather patterns and even developed traditional ways (behavior of certain insects and birds) to predict natural hazards such as drought and floods. With time, they have devised local strategies to adapt to the ever-changing climate in an effort to protect their livelihood securities and in particular pastoralism.

Farmers' participants in a focus group discussion in Naretoi, Kimana, corroborated this reality concurring that indeed climate is changing and increasing the risk of drought incidences in the county. According to their understanding, climate change manifests through changing weather patterns, which they conclude has become unpredictable. They perceived that the amount of rainfall has reduced considerably over time forcing them to reduce their herd size, which poses serious constraints on their pastoral economy, an important livelihood in their county. Bobadoye (2016) established that pastoralists' communities often interpret drought as the ability of rainfall to maintain pasture availability throughout the season hence a reduction in number of rain days usually leads to dry periods. Invasive species such as *Ipomoea spp* weed was due to increased climate variability as it invaded and spread rapidly soon after the 1997/8 *El Niño* rains. This species is the most undesirable forage species for grazing livestock that multiplies and spreads immediately after the rains have started. It has caused many livestock deaths because of its toxic characteristics.

The local communities have extensive knowledge on adapting to climate change that has sustained them from their dry ecosystems for ages (Kameri-Mbote and Nyukuri, 2013) which includes stacking hay for future use. Some farmers even confirmed to matching their herding stock to available pastures through selling off their livestock heads to reduce impact of extreme climatic events.

15 Total number of days with maximum temperature  $\geq 35^\circ\text{C}$

16 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

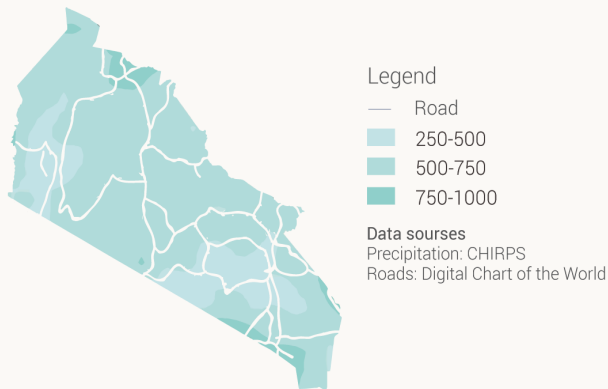
17 Indicated by the maximum 5-day running average precipitation (mm/day).

18 Indicated by the 95th percentile of daily precipitation.

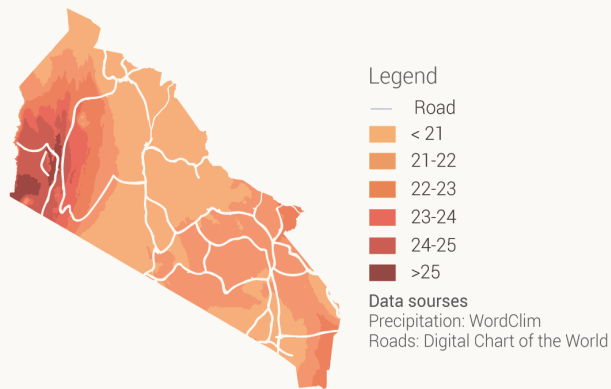
19 Number of days with ratio of actual to potential evapotranspiration ratio below 0.5

# Past and future impacts of climate hazards in Kajiado

Historical annual mean precipitation (mm/year)



Historical annual mean temperature (°C)

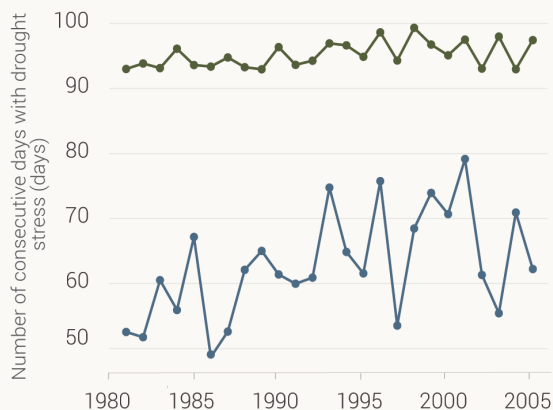


## Moisture stress hazards

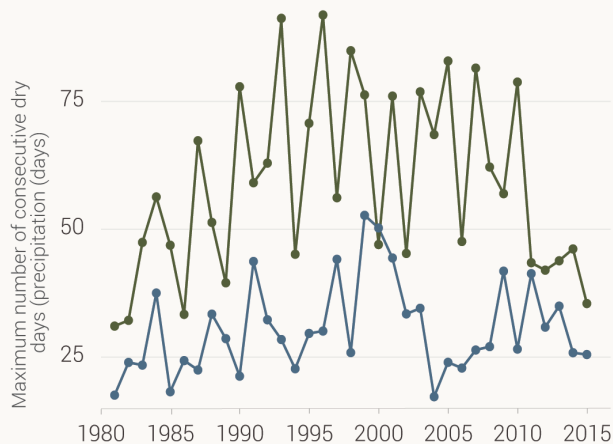


## Drought hazards

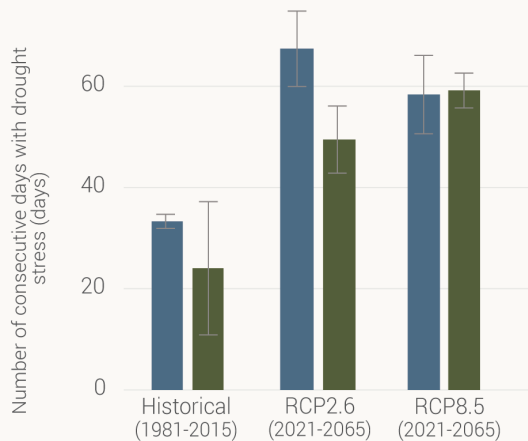
Historical extreme moisture stress events



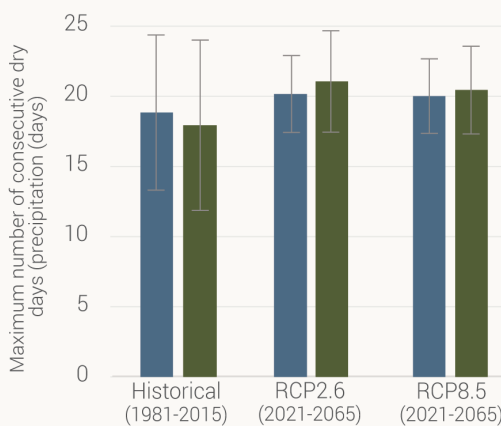
Historical drought stress events



Historical and expected extreme moisture stress events



Historical and expected drought stress events



■ January - June ■ July - December

## Climate vulnerabilities across agriculture value chain commodities

The most significant climate hazards facing key value chains identified in this report (dairy, beef, tomatoes and shoats) were drought, increased temperatures, moisture stress and flooding. These hazards affect the VCCs in various ways as discussed below:

### Shoats (meat)

Intensity of rainfall with moderate risk of flooding in both seasons and less intense rains for both seasons are important climatic hazards in the sheep and goats value chain development.

Consequences of less intense rainfall ranged from moderate to severe across the value chain. With less rainfall available, there is reduced availability of quality pasture resulting in poor nutritional status of the shoats. The latter presents challenges in transportation of emaciated animals because of the high risk of injury and/ or death. There is also increased need for more vaccination and treatments against secondary infections and nutritional disorders. Due to the high cost of animal health treatment, some farm practices such as deworming are foregone. Traders are also less willing to purchase animals, which are not in good condition since they lower the quality mutton as well as the byproducts leading to lowering the tradable volumes. Decline in market demand of shoats' results to low incomes for the farmers. As animals migrate in search of pasture, there is high risk of losses through theft and death. The animals also have a low resistance to diseases during migration.

More intense rainfall and flooding contributes to deterioration of pastures and hence the poor nutritional status of the shoats. Wetter conditions favor increase in vector population hence the high risk of increase in zoonotic diseases (Rift Valley Fever, Anthrax, etc.) which lower animal productivity by reducing or delaying the fertility in females due to abortion or fever, and temporary or permanent infertility in males. Abortion also leads to quarantine of the entire herd to establish the cause of the problem and rule out zoonotic diseases. Floods also cause a delay in the breeding season because of the abortions. Quarantines on movement are imposed to control the spread of diseases and vectors, reducing the tradable volumes...

Farmers' response to these hazards is determined by the access to timely and adequate information from extension agents. Those with higher income levels have a higher purchasing power when marketing is limited due to flooding. They can restock the animals

that they lost due to flooding much faster. Those with higher education levels have an advantage in seeking information at the onset of the hazard and respond faster. Those with higher income and education levels also recover better from the hazard because they have a higher resource base, which they can fall back on.

Extension services demand increases during floods because of livestock diseases and abortions. All stakeholders in this VC are encouraged to form producer-marketing groups to manage the hazards affecting them. Transporting the shoats to market is in vehicles that are not fit for their transportation resulting in to severe overcrowding. Constructing more slaughterhouses in addition to capacity building on over stocking and destocking as well as advice on meat production process are proposed adaptation options.

### Cattle (milk)

Moderate increase in the number of days with moisture stress and remarkable increase in temperature are climatic hazards critical in this value chain development.

With the increase in temperature, the animal does not come on heat, which further reduces the need for artificial insemination service. The major consequence of this hazard is an increase in diseases such as Trypanosomiasis, Anaplasmosis and Babesiosis thereby increasing the need for veterinary services. High temperatures limit movement therefore less feeding for animals. The consequence of this is low production of milk. Another major consequence is the increased movement of animals in search of pasture and water. This mostly affects the youth, as they are the ones involved in herding. This further leads to increased levels of illiteracy in the county as families migrate and children abscond schooling. Fewer animals are milked during the migration. Another important consequence of moisture stress and increase in temperature is that there is a reduction in the frequency of dipping services. Weak animals are not dipped which leads to increased disease incidence or death. Increased temperatures affect the farmer in that s/he reduces the hay harvesting activity leading to reduced amounts of conserved hay. High temperatures increase microbial activity in milk, which affects its keeping quality. Therefore cooling is required to store the milk when the temperatures are high.

Temperature and moisture stress affects milk production due to low pasture productivity that in turn leads to low milk availability for sale/cooling and/ or storage. The quality of milk produced is also low. Increase in temperature hardens pastures thereby

reducing its quality. Heat stress slows down the milk process by affecting the milk let down hence low production. Heat stress hardens pastures reducing their quality and negatively affecting the quality of milk. The low volumes of milk are given to children rather than for sale. By effect, this reduces the amount of income accruing to the women. High temperatures reduce the movement of animals and therefore less feeding for the animals. The consequence of this is low/no milk production. Heat stress causes body heat stress in the animal slowing down the milk let down process reducing the amount of milk produced. As part of vector and disease control, the high temperatures increase the amount of acaricides absorbed through the skin affecting normal body functioning. High temperatures increase microbial activity in milk thereby affecting its keeping quality with is a major source of concern. Women are most affected as they depend on milk as an additional source of income for the household. It also forms a major part of the diet of children.

### Cattle (meat)

Less intense rains for both seasons and increased temperature are climatic hazards with the potential to produce negative impacts on livestock. High temperatures reduce available soil moisture content hence low fodder production. Animals which are forced to trek longer distances without proper watering will suffer heat stress which contributes to anaphylactic shock. Incidence of new pests and diseases because of rising temperatures leads to emaciated carcasses and affects the keeping quality of meat. Low fodder availability triggers massive movement of cattle in search of pasture and being vulnerable to pests and diseases. The men are away from the home for longer as they have to go further with the animals disrupting normal tradition of living. The farmers will be dissuaded from attending training programs because of the high temperatures. There is severe reduction in availability of pastures because of the high temperatures and contributes to infertility of the cow.

Less intense rains minimizes both pasture and animal production since sufficient amount of water is required for the establishment of productive pasture. This leads to greater water demands and pastoralists are forced to adjust grazing time, reduce their animals or choose livestock types/pasture varieties that are best suited for the conditions. More pests and diseases due to hot and wet conditions emerge contributing to many deaths and resulting in major economic losses. Poverty, lack of critical livelihoods resources such as land, access to services and infrastructure are some

of the underlying factors contributing to vulnerability of pastoral communities to climate change. Women are the most vulnerable due to the existing gender inequalities where men continue to control income despite the heavy involvement of women at the production stages.

### Tomatoes

Moisture stress and an increase in intense rainfall occurrences are critical climatic hazards in the production of tomatoes. Specifically, intense rainfall disrupts the planting programs and leads to poor plant growth. Heavy rains damage infrastructure such as roads consequently affecting the amount of produce reaching the market. Rain disrupts the timing of operations, leads to rapid growth of weeds, poor germination and causes a high prevalence of pests and diseases. Intense rainfall hinders the harvesting activities and causes rotting of the tomatoes while they are still in the field.

Moisture stress causes increased cases of pests and diseases presenting good conditions for the proliferation of fungal diseases such as powdery mildew, bacterial wilt and early and late blight. Weeding and spraying cannot be carried out when there is moisture stress. Fewer seedlings will germinate that leads to reduced plant population. Those that germinate and mature are few and produce small sizes of tomatoes that fetch lower prices at the market. There are increased costs on land preparation because of repeated land preparation for replanting.

## Adaptation to climate change and variability

Despite climatic hazards, farmers in Kajiado County have adopted various strategies to cope with the changing conditions in climate that affect agricultural production and food security.

### On-farm adaptation practices

Pastoralism is highly vulnerable to climate change due to its heavy dependence on rain fed conditions. The majority of farmers agree that there are increased incidences of drought and that annual rainfall has been reduced each season (Bobadoye, 2016) hence the adoption of various practices to cope with climate change aimed at ensuring their food security, livelihood and future well-being. According to the ASDSP Household Report, the main adaptation strategies employed by farmers were water harvesting (33%), value addition (14%), increased soil and water

conservation (14%) and tree planting (12%). This shows there is need to support capacity building on climate change for all stakeholders and farmers to increase communities' adaptive capacity.

In livestock production systems adaptation strategies include the production of fodder and hay conservation to help maintain the body condition of livestock during the prolonged dry spell. Even with improved livestock breeds, the adoption of such breeds is low at 12% and feed conservation 6% (GoK 2014a). Pests and disease management is carried out by farmers in collaboration with veterinary services providers including the County veterinary officials through spraying the animals in the morning and/or evening when the temperatures are cooler since increased temperatures cause increased absorption of acaricides through the skin of the animals which interferes with normal body functioning. Farmers practice uncontrolled cross breeding among their Households herds and limit movement of their livestock to reduce rate of infections. The roles of community Animal Disease Reporters and their importance in surveillance of diseases and in capacity building of farmers needs better recognition and support. These reporters also need further capacity building on the importance of animal diseases to livelihoods in the county.

Further capacity building of farmers is needed towards the ongoing breed improvement program through Assisted Reproduction Technology (ART) (e.g. Artificial Insemination) such as the successful multiplication of Sahiwal cattle by KALRO. Increased sensitization on the need for proper calf management should be practiced to maximize milk production and improve livestock husbandry for dairy cattle. Farmers are advised to take up pasture management measures that involve planting of improved varieties of pasture, to replace the native grasses with higher yielding and more digestible forages, including perennial fodders, pastures and legumes. Among these are drought resilient superior *Brachiaria* grass accessions (K1, L1 & B1); Sorghum varieties (E6518, Ikinyaruka, E1291, and BM30) drought resilient and dual-purpose sorghum (can be utilized as human food).

On-farm, feed conservation of Napier with legume forage, hay bulking<sup>20</sup> as well as using improved fodder and supplementary feed provides energy sources for dry season feeding. Additional capacity building would be required on production of maize and sorghum for silage making as well as the use of leguminous fodder shrubs, which have a high nutritive value, can improve ruminants' diets, sequester carbon, as well as improve

soil fertility. Concentrates can be replaced through the forages from fodder shrubs that contribute increase in milk production. On animal health management, vaccinating cattle in Kajiado can sustainably control Transboundary Animal Disease (TAD)s e.g. Foot and mouth Disease (FMD) and vector borne diseases e.g. ECF and reduce deaths of cattle from as high as 80% to 10%. Improvements in feeding should also include use of Molasses Urea Mineral Blocks (MUMBs, which are rich in proteins, and minerals that improve digestibility of roughages contributing to rapid weight gain. On animal health management, vaccinating cattle can sustainably control ECF and reduce deaths of cattle from as high as 80% to 10%.

In tomato production there is need to promote pro-poor strategies to reduce the impact of key pests, and improve yield and quality of the tomato crops produced. Pests and diseases remain the greatest challenge in this production and their proper identification is critical to the control strategies that include practicing crop rotation, planting resistant/tolerant varieties, field hygiene, using proper agronomic/ crop production practices, irrigation management and regular crop scouting for pest and disease as well as weed and nutrient deficiencies.

## Off-farm adaptation practices

Capacity building offered by different players is key to addressing vulnerabilities faced by farmers in Kajiado County. Farmers have been trained on on-farm cooling technologies for their milk. A tomato processing plant that will greatly reduce post-harvest losses is under construction in Kajiado South sub-county. Additional capacity building is required on value addition of the VCs. Reseeding of pasture lands is also ongoing using drought resistant species such as *Eragrostus superba* (Maasai love grass), *Cenchrus ciliaris* (foxtail grass), and *Enteropogon macrostachyus* (Rye grass). Pastoralist Field Schools are also held periodically where farmers are able to learn and raise emerging concerns with extension staff.

Participatory scenario planning (PSP), a tool used by the Kenya Meteorological Department to enable communities explore potential future changes and their associated impacts has been done. It is an innovative and inclusive way of communicating seasonal forecasts to communities. It has assisted farmers to plan their activities and advise on when and how to plant across the seasons.

<sup>20</sup> Annual rather than perennial grasses make better hay if harvested early in the dry season. Seed pods, especially those of *Acacia tortilis* and *Prosopis* can be harvested and used as feed supplements.

Extension advisory services for breed improvement are also offered. When adopted, the improved breeds have a faster growth rate and fetch better prices at the market. Women empowerment programs are also ongoing to increase women decision making at the family level. Upcoming new technologies such as managing cattle health via computerized detection e.g. Anthelmintic Resistance in animals could increase disease control in livestock production and hence should be made easily available for farmers use. Milk contamination surveillance for cattle will go a long way in preventing contamination of milk. The surveillance teams look for drug residues, contaminants and antibiotic resistance. Teams can use a rapid diagnostic kit for detecting aflatoxin, antibiotics and drug residues in milk for dairy cattle. They can conduct a rapid serum agglutination test for ruminants and use a tool for detecting antibiotic resistance in cattle. This is ongoing whereby samples are collected and sent to the Central Veterinary Investigation Laboratory at Kabete. Efforts should be made towards building and equipping the county with a lab to conduct simple laboratory tests. Improved animal breeds that include the superior Boran<sup>21</sup> breed have been promoted in most ASAL counties. Multiplication through assisted reproductive technologies such as artificial insemination is necessary.

Degraded natural pasture can also be fenced off and reseeded with selected grasses and micro catchments such as furrows made by use of oxen plough or pits at the onset of short rains. Use of micro catchments contributes to better pasture establishment by using more than one grass species to spread the risks. Utilization of such grasses should start at the end of second growing season. Such fodder supports livestock during drought periods, reduces goats' mortality and fattens livestock for markets.

21 The Boran is a dual purpose breed for production of high quality meat and milk. It is tolerant to high ambient temperatures; high feed conversion efficiency thus high growth rate. With better feed conversion there is less methane emission and lower demand for feed.

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

## Cattle (milk)

Provision of seeds and other inputs

On-Farm production

Harvesting, storage and processing

Product marketing



Animal breeding cycle is affected hence less Artificial Insemination (A.I.) services; reduced participation in extension activities; low pasture/fodder productivity

Increased disease incidences and animal mortality; fewer animals are milked since most animals have migrated looking for pasture and water  
Increased calving interval

Less pasture harvesting leads to less conserved pasture; low milk availability for cooling/storage

Increased transportation cost; poor-quality milk fetches low market prices

Magnitude of impact

Moderate

Major

Major

Major

Farmers' current strategies to cope with the risks

Conservation of hay during rainy season; Conservation Agriculture technologies; increased shelter for animals; use of pastoral school approach

Farmers spraying and dipping individually at farm level; increased pasture conservation, fencing and paddocking to retain animals for milking. Hay procurement by farmers

Hay conservation; enhanced Olopololi(fenced area next to homestead); county investment in coolers for milk

Milking and delivering immediately to avoid spoilage; pooling transport of milk (motorbike); sales to middlemen

Other potential options to increase farmers' adaptive capacity

Promote pasture/seed conservation and conservation agriculture; use of drought-resistant pasture varieties; strengthen pastoral field school approach

Promote communal dips introduce on farm feed formulation for supplementation; promote water harvesting, run off harvesting and irrigated pasture; silvopastoral systems; live fences to confine animals

Encourage farmers to engage in commercial hay production; strategic hay reserve at individual and communal level; promote efficient hay conservation and storage techniques

Capacity building on low cost farm cooling methods; optimize the use of coolers; Market access through adoption of modern technologies e.g. internet, mobile phones etc. Formation of farmer marketing groups to enjoy economies of scale



Reduced pasture quality; reduced length and intensity of oestrous; increased incidence of diseases thus increased costs of production

Animal physiology and welfare is affected; Low milk production; reduction of herd size; increased incidences of diseases

Decreased milk yield and quality; increased cooling requirement; rapid spoilage

Decreased milk quality and quantity; high transportation cost to available markets

Magnitude of impact

Major

Major

Moderate

Moderate

Farmers' current strategies to cope with the risks

Increased vaccination demand; use of selected breeding bulls; conservation of hay during rainy season to use for next season; harvesting hay early in the morning and late in the evening

Promote pastoral field schools; live fences as a restriction of animal movement; build shelters for milking; dipping/spraying animals early in the morning

Boiling milk for preservation; value addition to yoghurt and mala; milking early in the morning and delivering immediately

Contact middlemen to provide market linkages and networking; use of plastic containers for transportation of milk; Group selling to reduce costs

Other potential options to increase farmers' adaptive capacity

Upscale pastoral field school approach; capacity building on disease control(vaccinations) and breeding; Promote efficient hay conservation and storage techniques

Introduction of ECF vaccines; enhanced hay conservation techniques; promote silvopastoral systems; improved shelters and milking structures; improve capacity building on dipping and spraying

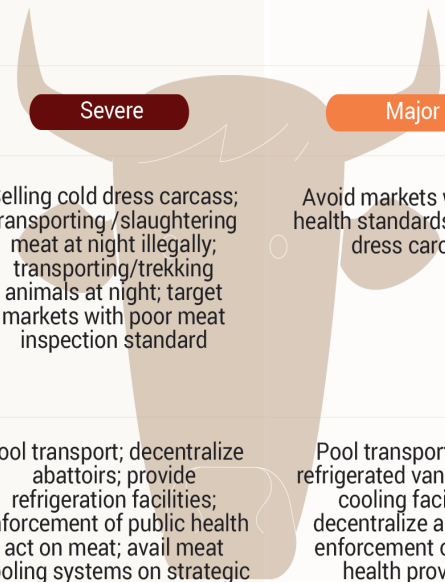
Training on milk pasteurization and milk value addition; mechanize hay harvesting and baling; promote low cost on farm cooling methods e.g. use solar powered cooling plants

Access market information through modern technologies e.g. internet, mobile phones etc.; promote use of recommended food grade plastics and aluminum cans for transporting milk Milk ATMs with pasteurizer

# Cattle (meat)



	Provision of inputs	On-farm production	Harvesting storage and processing	Product marketing
<p><b>Less intense rains</b></p>	Lack of enough pasture due to decreased rainfall; High costs of purchasing seeds and services(tractor)	Stunted growth of pasture hence reduced fodder availability; increased pest, weeds and diseases outbreak	low quality meat and by products; animals diseases and insect pests affect meat quality; result to less biogas production	Fewer animals reach market place; reduced sales; poor-quality meat fetches low prices
<b>Magnitude of impact</b>	Major	Major	Major	Moderate
<b>Farmers' current strategies to cope with the risks</b>	use of supplement feeds; animal off-takes; farmers seeking advice from extension services	Weeding of invasive species (e.g. <i>Ipomoea</i> spp.);Animal migration; animal sales; hiring of private vet services; Disease control	Farmers trek animals to primary market at night; farmers; slaughter and transport of meat Slaughtering of shoats (diversification)	sourcing meat from outside the county; consumption of bush meat; pool transport to market; sale of cold dress weight
<b>Other potential options to increase farmers' adaptive capacity</b>	Seeding for bare grazing grounds; pasture conservation (paddock, creating storage facilities, irrigation; enhance livestock extension services; Research on invasive species e.g. <i>Ipomoea</i> spp., <i>Prosopis juliflora</i> (Mathenge) etc.; enhance farm forestry with fodder trees	Promote pasture conservation techniques; strategic pasture reserves e.g. creation of feed lots for fattening; engage more vet personnel; community based animal health workers; enhance disease surveillance systems; promote better livestock management practices to farmers	Create cooperative abattoirs in every sub-county; improve infrastructure; purchase refrigerated vans; enforcement of meat inspection	Pool transport to markets; create active cooperatives; opening up modern abattoirs across the county; improve market infrastructure
<p><b>Increase in temperature</b></p>	High cost of buying heat tolerant pasture varieties; higher demand for extension services based on weather forecasts	Stressed animals have poor growth pattern; lack of feed; long distance trekking; increased diseases and pests; animal weight loss or even death infertile dry soils	Poor meat quality and by products; increased meat preservation costs	High temperature accelerates meat spoilage; low quality; price fluctuations
<b>Magnitude of impact</b>	Severe	Major	Severe	Major
<b>Farmers' current strategies to cope with the risks</b>	Isolation of bulls from female; control mating; special feeding for the bulls; seeding of bare grazing grounds; pasture conservation; hay storage; farmers seeking extension services; farmers going for private vets	Farmers practice culling (disposing);diseases control through vaccination; spraying/dipping treatments; controlled movement; rearing of shoats (diversification); hand weeding of invasive species	Selling cold dress carcass; transporting /slaughtering meat at night illegally; transporting/trekking animals at night; target markets with poor meat inspection standard	Avoid markets with poor health standards; sell cold dress carcass
<b>Other potential options to increase farmers' adaptive capacity</b>	Create semen banks; strengthen extension services in animal husbandry; on farm training; strategic pasture reserves; increased of hay bans; reduce shoats rearing; decentralize extension services.; subsidized vaccines for disease control	Silvopastoral systems; timely vaccination services; well-planned calendar of events from veterinary services; decentralize vaccination services; afforestation; adopt sound land use technologies	Pool transport; decentralize abattoirs; provide refrigeration facilities; enforcement of public health act on meat; avail meat cooling systems on strategic points	Pool transport; use of refrigerated vans; availing cooling facilities; decentralize abattoirs; enforcement of public health provision



# Tomato



	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
<p><b>Intense rainfall/flooding</b></p>	<p>Delayed supply of fertilisers and pesticides; poor nursery development; transport of seeds/planting hampered by flooded roads; less demand for credit; unavailability of planting materials/seeds</p>	<p>Mechanized operations are not possible due to high levels of soil moisture; high cost of farm operations; flooding of nurseries, poor germination, prevalence of pests and diseases</p>	<p>Hindrance of harvesting activities and cause rotting of fruits; accessibility of farms is reduced due to destruction of road infrastructure; delayed collection and grading</p>	<p>Low volumes in the markets and quality is poor; poor market access; low market supply and high prices for the consumers</p>
<p><b>Magnitude of impact</b></p>	Moderate	Major	Major	Major
<p><b>Farmers' current strategies to cope with the risks</b></p>	<p>Lower lending rates; expansion of repayment periods; suspension of farming by farmers; early supplies of inputs; early purchases</p>	<p>Minimum/zero tillage; increased use of herbicides; increased frequency of farm operations; use of raised nursery beds</p>	<p>Manual delivery of produce to the most accessible area; suspend harvesting until rains stop; use of polythene sheets for covering the produce; suspend collection and grading (temporarily)</p>	<p>Producer will deliver produce manually to most accessible point; middlemen determines the product prices; combining of transport to collection centers</p>
<p><b>Other potential options to increase farmers' adaptive capacity</b></p>	<p>Loan products aimed at water harvesting technologies e.g. dams; creation of more input supply outlets at farm level e.g. mobile input supply; creation of more centers for supply of planting materials/seeds</p>	<p>Intensify use of minimum tillage practices; promotion of soil and water conservation structures e.g. cod, rod; intensify IPM practices; use of nursery beds, greenhouses and sheds</p>	<p>Improve access roads; construction of holding shades. ;acquisition of rain protective clothes e.g. gum boots, rain coats; construction of collection and grading shades at farm level</p>	<p>Improvement of access roads; market infrastructure development; formation of market groups; capacity building on value chain organization and market survey; linking producer to markets (e-markets)</p>
<p><b>Moisture stress</b></p>	<p>Reduced purchase of inputs; reduced access to credit/financial support; farmers who reduce the purchase of fertilizers and other agrochemicals</p>	<p>Delayed farm operations; increased cases of pests and diseases; poor seed germination; repeated land preparation and replanting increases labor and costs</p>	<p>Low quantity and quality of yields; high postharvest losses; low volumes of produce hence few transporters</p>	<p>Breaching of farming contracts; high market prices due to reduced yields and poor quality</p>
<p><b>Magnitude of impact</b></p>	Moderate	Severe	Major	Major
<p><b>Farmers' current strategies to cope with the risks</b></p>	<p>Provision of subsidized fertilizer by government; use of organic fertilizers; provision of subsidized irrigation and input packages; lowering of interest rates; spreading of repayment periods</p>	<p>Provision of sheds; mulching; lowering of seedbeds (cultural practice); limited reduced frequency of weeding, spraying; increased use of herbicides; reduced land operations (levelling)</p>	<p>Use of natural tree shades; use of combined transport; early harvesting or late harvesting using plastic containers; cover produce with glass or tree branches</p>	<p>Use of middlemen to link the producer to the market; middlemen determine the market prices; combining of transport to collection center</p>
<p><b>Other potential options to increase farmers' adaptive capacity</b></p>	<p>Soil fertility management e.g. composting, agroforestry, use of farm yard manure, cover crops; promotion of water harvesting technologies e.g. roof catchment, road/ roof runoff; kitchen gardening; review loan terms and expansion of loan products by the financial institutions</p>	<p>Promotion of seed trays; construction of seed multiplication centers; mulching; training on IPDM practices; promotion of water efficient technologies and water harvesting; promotion of conservation agriculture (minimum tillage)</p>	<p>Construction of collection and grading shades; establishment of cottage processing industries and cooled storage facilities; promotion of proper postharvest techniques (on farm cooling, cold storage facilities)</p>	<p>Formation of strong product value chain groups for marketing; capacity building on value chain groups (wholesalers and retailers). Conducting of market surveys</p>

# Shoats (meat)

Provision of seeds and other inputs 

On-farm production 

Harvesting storage and processing 

Product marketing 



Less rainfall

Increased demand of vaccinations, treatments against nutritional disorders and secondary infections hence high cost and demand for veterinary services

Decreased production and productivity; delayed breeding season; weak lambs and low fertility; low quality pastures resulting to poor nutritional status; increased mortality

Transportation risks and vulnerability due to animals emaciation; low quality and quantity of mutton and its by-products

Decreased bargaining power of the farmer; low trading volumes; reduction in quality and quantity of by-products hence low prices

Magnitude of impact

Major

Severe

Major

Moderate

Farmers' current strategies to cope with the risks

Purchase of hay and feed; use of private veterinary services; introduction of superior breeds; controlling inbreeding, castration of poor performing breeds

Paddock; pasture conservation and storage; inconsistent vector-borne diseases control

Producers are trading individually; producers are trading individually; small scale producers trek their animals to the livestock markets

Individual sales and sales to middlemen; limited value addition; livestock marketing committees (inactive)

Other potential options to increase farmers' adaptive capacity

Promote efficient pasture conservation and storage techniques; strengthen provision and coordination of extension services between the private and public sector; reliable sources of superior breeds; exchange program of breeding material to prevent inbreeding

Enhanced purchase of hay and feed; capacity building on paddocking and pasture conservation; capacity building on routine farm practices to farmers; integrated range management; IPM; increase awareness of the importance of vector-borne diseases control

Provision of adequate vehicles for animal transportation; enforce regulations on carrying capacity of vehicles; resting and providing watering points during trekking of animals; improving infrastructure on stock routes

Promote formation of producer marketing groups; development and implementation of market information systems; capacity building on the value of by-products



High temperature

increased cost of veterinary services; deterioration of pastures hence low fodder availability

Increase in diseases and vectors; poor nutritional status of animals

Animal overcrowding during transportation, vehicles not suitable for animal transportation

Individual sellers and middlemen dominate the market; low level of value addition; damage to infrastructure

Magnitude of impact

Moderate - Major

N/A

N/A

N/A

Farmers' current strategies to cope with the risks

Higher demand for vaccination services; limitation for inputs access

Migrate to higher and safe lands; inconsistent implementation of routine cultural practices; inconsistent vector-borne diseases control

Trekking of animals to livestock markets; offtake programs in small scale; individual slaughtering of animals

Currently there exists livestock market committees that need to strengthen their activity

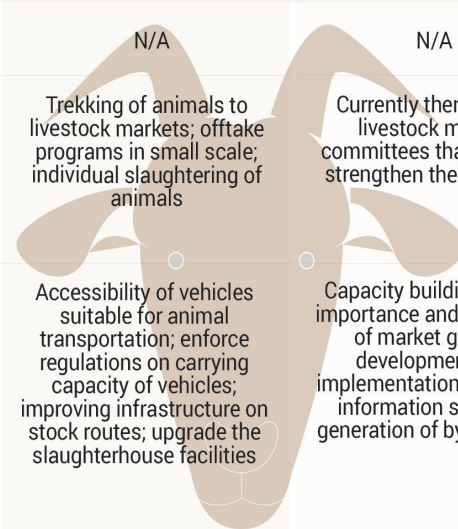
Other potential options to increase farmers' adaptive capacity

Creating awareness on prevalence of floods; afforestation and reforestation within riparian and flood prone areas; formation of producer associations to benefit from economies of scale; on time vaccination services

Develop Early Warning System briefs; feed supplementation for weak animals; rehabilitation of flooded areas; flood mitigation measures e.g. flood management structures; capacity building on routine farm practices to farmers; increase awareness of the importance of vector-borne diseases control

Accessibility of vehicles suitable for animal transportation; enforce regulations on carrying capacity of vehicles; improving infrastructure on stock routes; upgrade the slaughterhouse facilities

Capacity building on the importance and formation of market groups; development and implementation of market information systems; generation of by-products



## Policies and Programmes

Successful climate adaptation requires a holistic, coordinated policy approach with the aim to manage the challenges of everyday climatic hazards such as droughts and floods. Efforts by the National and County governments have seen various implementations of policies and development programs that support climate change adaptation, mitigation and governance.

The most recent, Climate Change Act of 2016 was created to deliver on the above-mentioned critical areas. It seeks to "... mainstream climate change responses into development planning, decision making and implementation; build resilience and enhance adaptive capacity to the impacts of climate change and reinforce climate change disaster risk reduction in strategies and actions of public and private entities. Counties are therefore obliged by the Act to report on action taken by respective counties to address the impacts of climate change. They are further mandated to update their County Integrated Development Plans and the County Sectoral Plans ensuring that climate change is mainstreamed therein. The Agriculture Sector Development Support Programme (ASDSP) funded jointly by the Government of Sweden and Government of Kenya uses the value chain approach in its interventions, identifying three priority value chains based on the ability of the value chain to commercialize; demand for the VCC; environmental friendliness and social inclusiveness. This program has engaged value chain actors and players through training sessions and has supported the registration of farmer groups into associations to enable easier access to funds. Phase 2 of the program's activities is scheduled to start in July 2017 continuing with the earlier identified value chains development. Considerable progress has been made through the Regional Pastoral Livelihoods Resilience Project (RPLRP) a 5-year (2015-2019) World Bank funded project that seeks to enhance livelihoods resilience of pastoralists and agro-pastoralists in the ASALs of Kenya, Ethiopia and Uganda. In Kajiado, the project promotes Natural Resource Management, contingency planning, risk profiling, community driven disaster risk reduction and early warning for drought. They have a market support system where they advise farmers on when to destock, restock, and provide information on when livestock prices are likely to be favorable. To increase availability of water during dry spells, the project constructs and renovates boreholes and water pans and rehabilitates selected rangelands to ensure increased pasture availability.

Historically, ASALs in Kenya have been neglected in terms of resource allocation, infrastructure development, social

service delivery and economic transformation even though they cover 80% of Kenya's land mass and hold 70% of Kenya's livestock but through the Arid and Semi-Arid Lands (ASALs) Policy (2015)<sup>22</sup> it has raised the profile and attention to Kenya's drylands and aims to strengthen the climate resilience of communities in the ASALs and ensure sustainable livelihoods.

The National Environment Management Authority (NEMA), among other things, coordinates environmental activities of various actors in the county by taking stock of the natural resources in Kajiado, their utilization and conservation. Coordinated by NEMA, the 5-year County Environment Action Plan (CEAP) identifies areas that need intervention and has recommendations on possible solutions to address environmental challenges. It is a blueprint for environmental activities in the county. NEMA prepares a State of the Environment report for the county detailing progress on implementation of the CEAP annually. The challenge facing the CEAP process in the county is the lack of sufficient funds to make the process of its development all-inclusive. The Animal Welfare Bill<sup>23</sup> that is before the county assembly for deliberation and eventual enactment into county legislation aims at, amongst other things, reducing losses during transportation.

Policy implementing ministries need to adopt inter-ministerial coordination and consultations to avoid contradictions in policies for example where some land policies indicate suitable areas for agriculture exist along river banks for irrigation purposes while the Environment Management and Coordination Act forbids cultivation along river banks because of erosion risk. Moreover, with the devolved system of governance it is essential that policies be structured to match the local contexts to cultivate local ownership and improve effectiveness.

## Governance, institutional resources, and capacity

Devolved governance through the Kenyan constitution 2010 moved key sectors such as agriculture, transport, health facilities, sanitation, trading licenses as well as responsibility to generate revenue from the central government to county governments. While this devolvement has enabled local stakeholders to set their own economic, social and political agendas, enhanced efficiency and performance is still lacking. There are challenges on resource mobilization and utilization, capacity building and strategic allocation of resources (Sinkeet, 2015). This has consequently affected

22 <http://www.devolutionplanning.go.ke/wp-content/uploads/2015/04/DRAFT%20ASAL%20POLICY.pdf>

23 This Bill, amongst other things, defines punishment for cruelty to animals; mandates animal owners to ensure that their animals have adequate food and water; adequate medical attention when wounded or ill; reasonable protection from injurious heat or cold; and not confined to an enclosure that significantly impairs the animal's health or well-being.

governance, institutional resources and human resource capacity.

Various stakeholders such as national and county government, non-governmental organizations, private sector and county line ministries<sup>24</sup> play major roles in climate change risk management and agriculture development in the county. More so by providing technical backstopping, extension services, policy review and advice as well as monitoring and evaluation of activities under their various thematic roles. They are the first point of call when a situation arises. Civil society actors<sup>25</sup> have also been actively engaged in advocacy and raising awareness on matters related to climate change.

All stakeholders mentioned above form part of the County Steering Group (CSG)<sup>26</sup> which holds meetings hosted by the NDMA to discuss the food security situation in the county. Despite its existence and important role in progress assessment, it is not formalized by the county assembly and hence has little allocation of resources.

The NDMA an agency of the Government of Kenya provides timely early warning bulletins on climate information to stakeholders to increase their adaptive capacity. Based on indicators such as rainfall, vegetation condition index using satellite imagery and number of livestock per household per day amongst other criteria it is able to classify the early warning messages into normal, alert, alarm, emergency and recovery. Depending on the classification, NDMA will work on resilience building activities as well as response programming. These include providing animal feed, supporting water infrastructure, providing fuel subsidies, vaccination and livestock off-take. The biggest consumers of these early warning messages are the county government, line ministries, universities, research organizations and NGOs. KALRO (a premier research organization) has been working to reduce the vulnerability caused by climate change in Kajiado County by promoting improved cattle breeds (local Zebu being upgraded with the dual purpose Sahiwal breed) that are climate resilient and have increased productivity. KALRO have provides grass and fodder seeds aimed at reseeded of grasslands and planting of fodder on-farm respectively, to increase the weight of the animals at the market.

Kenya Meteorological Department provides meteorological and climatological services to key sectors such as agriculture, forestry, water resources management and aviation for the better exploitation and utilization of natural resources for national development. They develop Climate Scenario Plans with farmers to enable the latter better plan

their activities with the weather in mind.

There exists some level of collaboration between the different agencies mentioned above but it is not well coordinated and there is no joint planning forum. It is recommended that a sector wide coordination forum is highly welcome and needs to be legislated at the county assembly. In so doing, the county government is obliged to provide financial support to this initiative and will ensure a harmonized forum for implementation of programs. Finances and allocation of available funds remains as the biggest challenge facing implementation of climate change risk activities in the county. Inadequate institution resources limit the number and location of interventions which is further exacerbated by risk emergencies such as drought.

## Synthesis and Outlook

Drought is projected to continue with increasing frequency in the county and this calls for increased resilience of farmers. Both short- and long-term adaptation measures are important for ensuring food security and agricultural production in general. Best-bet adaptation strategies in response to these climatic challenges include appropriate capacity building, livestock breed improvement, enacting appropriate legislation, and community willingness to adopt new technologies. These need to be up-scaled across the county especially in the sub-counties where production of a specific VC is high. More capacity building of farmers through early warning messages will also go a long way in this regard. Farmers will require quality and viable seed at the right time. In order to reduce post-harvest losses occasioned by increase in temperature and poor storage, it is recommended that extension services support farmers by developing low-cost technologies that reduce post-harvest losses. The county government also needs to invest in infrastructure that ensures that the produce reaches the market soon after its production as well as appropriate storage and processing facilities.

Even though agriculture is a devolved function, most of the targets are set at the national level and formalized in the performance contracts in respective departments. Planning by government institutions is done on a financial year basis even for donor-funded programs that have 5-year implementation periods such as ASDSP and the Regional Pastoral Livelihoods Resilience Project (RPLRP). However, the KMD does its planning per season after the development of the

24 Agriculture, Livestock and Fisheries; water, KALRO, Kenya Meteorological Department (KMD), Kenya Forest Service (KFS), ASDSP, National Drought Management Authority (NDMA) and NEMA.

25 They include Red Cross, German Agro Action, Technoserve, Arid Lands Information Network, Neighbors Initiative Alliance and Feed the Children.

26 CSG is the county equivalent of the Kenya Food Security Steering Group at the national level.

PSP. One of the gaps identified as far as coordination of activities was concerned was the lack of a forum, convened by the county administration, which would bring together all the players in the agricultural sector for joint planning of activities and sharing of resources. Adequate planning is also required to respond to calamities such as drought before they arise. Adequate financial resources and requisite human skills can further support this. County policies passed at the County Assembly are crucial to guarantee their implementation and allocation of funds for the same. Coordination of activities by all stakeholders in agricultural production and climate change is needed to ensure coherence in implementation.

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Women and youth play a significant role in Kajiado agricultural sector. However the existing gender gaps limits their affective participation and as there is need for more highly targeted interventions aimed at ensuring that they not only participate but also benefit from the incomes accrued from the various value chain. A gender responsive approach is recommended to effectively tailor these potential interventions to the needs of women and youth farmers and increase their participation in decision making both at the household and community level.

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