

Climate Risk Profile Laikipia County

Highlights

- In Laikipia County, agriculture and livestock are the main sources of livelihood. They contribute more than 75% of household incomes and employ more than 60% of the county's population. About 43% of the population are in absolute poverty while 27.2% rely on food aid during food shortages.
- Farmers in Laikipia County rely on rain fed agriculture and this makes them more vulnerable to climate variability especially during drought periods. Irrigation infrastructure is expensive and knowledge on diversification is inadequate. Rainwater harvesting through rooftops, water pans and dams will go a long way in providing water during dry spells for domestic, livestock and irrigation purposes.
- Several climatic hazards have been observed in the county e.g. drought, moisture stress and uncertainty in the onset and duration of seasons. These hazards pose a growing threat to the agricultural sector and often lead to significant crop and livestock production losses and food insecurity.
- Women and youth contribution to select value chains is high, therefore it is important to have highly targeted interventions that maximize on their involvement and increase their economic gains as well as decision-making powers.
- On-farm adaptation strategies include conservation agriculture, rainwater harvesting, fodder conservation, planting early maturing and drought tolerant crops, and drought resistant livestock and hybrid breeds.
- Off-farm adaptation strategies include education and research on climate smart practices, farmer/pastoralist field schools, early warning systems, sub-county specific climate based advisories, extension services, insurance, afforestation and re-afforestation. Kenya Meteorological Department (KMD), the Ministry of Agriculture, Livestock and Fisheries (MoALF) and the Kenya Forestry Service (KFS) amongst others offer these services.
- Poor coordination between different departments and institutions within the county has undermined the adaptive capacity of communities. There is little harmony and involvement of all the key players at the county level to have clear-cut roles and to enhance coordination. Conflicting programmes and policies, overlapping mandates between sectors also cripple adaptation efforts.
- The restructuring of community action groups (CBOs like WRUAS) and enhanced capacity on environmental protection and sustainable use of natural resources with support from relevant institutions such as NEMA, NDMA, WRMA, ENNDA, AWF, CETRAD, KFS, and other stakeholders involved in environmental issues is also a priority in the county. To improve the resilience of communities in climate risk management, collaboration and coordination by these institutions is key.

List of acronyms

AEZ	Agro-ecological Zone
ASAL	Arid and Semi-Arid Land
ASDSP	Agricultural Sector Development Support Programme
AWF	Africa Wildlife Forum
CIDP	County Integrated Development Plan
CA	Conservation Agriculture
EMCA	Environment Management Coordination Act
CA4FS	Conservation Agriculture for Food Security
ACT	African Conservation Tillage
KMD	Kenya Meteorological Department
NDMA	National Drought Management Authority
ERA	Economic Review of Agriculture
ESP	Economic Stimulus Programme
GoK	Government of Kenya
GHG	Greenhouse Gas
IEBC	Independent Electoral and Boundaries Commission
IPCC	Intergovernmental Panel on Climate Change
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Land
KALRO	Kenya Agricultural and Livestock Research Organization
KAVES	Kenya Agricultural Value Chain Enterprises
KNBS	Kenya National Bureau of Statistics
KEFRI	Kenya Forestry Research Institute
KES	Kenya Shillings
KFS	Kenya Forestry Service
MNLD	Maize Lethal Necrosis Disease
MoALF	Ministry of Agriculture, Livestock and Fisheries
LASEP	Laikipia Agricultural Sector Extension Programme
NALEP	National Agriculture and Livestock Extension Programme
NAWASCO	Nanyuki Water and Sanitation Company
NCCRS	National Climate Change Response Strategy
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
VCCs	Value Chain Commodities
WFP	World Food Programme
WRUAS	Water Resource User Association
WARMA	Water Resource Management Authority
NCCRS	National Climate Change Response Strategy
TIMPS	Technologies Innovations and Management Practices

Laikipia

Foreword

Climate change is becoming one of the most serious challenges to Kenya's achievement of its development goals as described under Vision 2030. Kenya is already highly susceptible to climate-related hazards, and in many areas extreme events and variability of weather are now the norm; rainfall is irregular and unpredictable; while droughts have become more frequent during the long rainy season and severe floods during the short rains. The arid and semi-arid areas are particularly hard hit by these climate hazards, thereby putting the lives and livelihoods of millions of households at risk.

In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS) which recognized the importance of climate change impacts on the country's development. This was followed by the National Climate Change Action Plan (NCCAP) in 2012 which provided a means for implementation of the NCCRS, highlighting a number of agricultural adaptation priorities. The focus of these initiatives has been at the national level, and there is need to mainstream climate change into county level policies, programmes, and development plans; therefore ensuring locally relevant, integrated adaptation responses with active involvement of local stakeholders.

The Government of Kenya (GoK) through the Ministry of Agriculture, Livestock and Fisheries (MALF), with funding by the International Development Agency (IDA-World Bank Group) is therefore implementing the Kenya Climate-Smart Agriculture Project (KCSAP). This 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 Laikipia County, which has a climate vulnerability index of 0.384¹. Historic climate data shows a decrease in precipitation and increasing temperatures. The

County continues to suffer extreme weather events especially droughts occurring every 2-3 years and occasional floods. Since the 1970s to 2009, the county experienced droughts in all years except for 1982, 1997/1998 (when there was the El Nino), 2002 and 2005; with the droughts in 2000 and 2009 being marked as severe . The mild drought of 1987 resulted in the death of more than 1,800 cattle and 3,000 goats and sheep in Mukogodo division³. The drought of 2000 resulted in the death of 5,300 cattle, 6460 sheep and 6970 goats whereas crop yields for maize and beans were reduced by 84% and 72% respectively. The anomalies in the weather have been associated with high malnutrition, due to crop failure and livestock losses, and inter-communal conflicts. For instance the conflict of 2017 resulted in the killing of 500 livestock among other losses⁴. In as much as there are deliberate efforts to reduce the impacts of extreme weather events, identification of long lasting strategies to build resilience to climate change is paramount in ensuring food security, sustainable development and minimization of the resource based conflicts common 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.

1 Source: GoK; UNDP (2013).

2 Source: FAO (2010).

3 Source: Huho et al. (2010)

4 <http://www.capitalfm.co.ke/news/2017/03/boinnet-denies-officers-killed-500-cows-laikipia/amp/capital/>

Agricultural context

Economic relevance of farming

Laikipia County covers 9,462 km² and is located in the former Rift Valley province. It is ranked as the 15th largest county in the Kenya by land size. It borders Meru County to the east, Nyeri County to the southeast, Samburu County to the north, Isiolo County to the northeast, Baringo County to the west and, Nyandarua County and Nakuru County to the southwest. The County's altitude varies between 1,500 m above sea level at Ewaso Nyiro basin in the north to a maximum of 2,611 m above sea level around Marmanet forest (GoK, 2013a). The entire county drainage is dominated by the Ewaso Nyiro North basin. The basin's tributaries have their sources on the slopes of Mt. Kenya and the Aberdares ranges. The tributary rivers include Nanyuki, Ngobit, Burguret, Segeru, Naromoru, Timau, Rongai, Engare, Moyak, Pesi and Ewaso Narok Rivers (GoK, 2013a). The flow of these rivers from the south to north is in sync with the county's topography and thus determines to a large extent the settlement patterns. This is because the rivers are the major source of water for domestic, livestock use and irrigation.

Laikipia County consists mainly of a plateau that is bordered by the Aberdares to the south, Mt. Kenya massifs to the southeast and by the Great Rift Valley to the west (GoK, 2014a). Rainfall in the county is relief or orographic rain due to its altitude and location. The annual rainfall average varies between 400mm and 750mm though higher rainfall averages are experienced in the areas bordering Aberdare Ranges and Mt. Kenya. The plateau receives 500mm of rainfall annually, the drier parts of Mukogodo and Rumuruti receive slightly over 400mm annually, Mukogodo Forest receives an average rainfall of 706mm annually and North Marmanet receives over 900mm of rainfall annually. The short rains occur in October and November while the long rains occur from March to May. The areas around Mt. Kenya and Aberdare Ranges experience some difference in the rainy season as they receive conventional rainfall between June and August. This is as a result of the influence by the trade winds. The annual mean temperature of the county ranges between 16°C and 26°C; the eastern side near Mt. Kenya is cooler due to trade and relief winds whereas the low-lying areas of the north are hotter.

Despite poor weather conditions characterized by frequent dry spells and poor rainfall distribution, agriculture is the mainstay in Laikipia County. Farmers in the county are involved in the cultivation of crops namely maize, beans, wheat, Irish potato, cabbage

and tomato and the rearing of livestock namely cattle, sheep, goats, camels, donkeys, poultry and pigs (GoK, 2014a) both for subsistence and commercial purposes. With only about 20% (198,400 ha) of the land in the county being arable, over 50 % of the other areas are under livestock production. There are few indigenous and gazetted forests covering an area of 580km². There are also few artificial forests namely Ng'arua, Shamaneik Lariak, Marmanet and Rumuruti (GoK, 2014a).

Agriculture is practiced both on a commercial and subsistence basis and contributes to 75% of the household incomes in the County. Furthermore, over 60% of the county's population derives their livelihoods from the sector (GoK, 2014a). According to the Agricultural Sector Development Support Programme (ASDSP), livestock rearing and crop farming employed a total of 141,383 people in 2012 forming 47% of the employed population. Fish farming is also on the rise; through the promotion under Economic Stimulus Programme (ESP), there are about 360,000m² of fish ponds with Tilapia spp., catfish and other fish species. Analysis of food and nutrition security by ASDSP in 2013 indicated that overall 80% of the households did not have enough food to meet their dietary needs. In particular, about 89% of male-, 94% female- and 78% youth-headed households were food and nutrition insecure (GoK, 2013b; 2014a), and this leads to over-dependence on relief food. The quantity and value of agricultural products is about KES 2.55 billion from the major crops (dry maize KES 1,715.3 million, beans KES 380.62 million, tomatoes KES 174.96 million and wheat KES 277.86 million) annually, and KES 705.26 million from major livestock products (beef KES 294 million, mutton KES 270 million, milk KES 83.8 million, poultry meat KES 24 million, eggs KES 14.6 million, honey KES 10.6 million, pork KES 5.4 million and fish KES 2.7 million) annually (ERA, 2015; GoK, 2013b).

People and livelihoods

Laikipia County had a total population of 399,227 persons during the 2009 census (GoK, 2009a). The total population was projected to be at 479,072 in 2015 and to grow to 479,072 by 2017 (KNBS, 2014). By 2012, 321,118 people lived in the rural areas of the county and there was a total of 103,114 households in the county in 2012 (GoK, 2013). Although 2017 projections show that more than 68% of the population in the county still resides in the rural areas, urban population is on the rise as people migrate to town centers in search of off-farm employment. The major urban centers in the county include; Nyahururu, Nanyuki, Kinamba and Rumuruti. These urban centers

collectively held a population of 106,055 in 2012 with projections of 163,175 persons by 2017 (GoK, 2013a). Out of the population in Laikipia County 43% lives in absolute poverty contributing 0.55% to the national poverty rates. Urban poverty stands at 71% while rural poverty is at 39%. This has given rise to informal settlement in the urban centers. Laikipia County (92.5%) lies in the semi-arid/semi-humid to very arid areas (agro-climatic zones IV-VII) while the other part 7.5% lies within the semi-humid to humid areas (agro-climatic zones I-III) (Jaetzold and Schmidt 2010; Wiesmann *et al.*, 2014). Given these characteristics, 27.2% of the population experience food poverty and rely on food aid during food shortages. Lack of food and pasture is a norm especially in the regions that experience extreme weather conditions and this contributes heavily to the high poverty levels in the county. Furthermore, according to the Kenya Demographic and Health Survey (2014), 26.9% of the children in the county are stunted while 4.4% are wasted (KNBS, 2014). The literacy levels in the county are relatively high with those able to read and write representing 86.1% of the population and this is expected to rise with increase in uptake of free primary education. (GoK, 2009a)

Laikipia County lies in the upper Ewaso Nyiro basin and draws most of its water from Mt. Kenya forest and Aberdare ranges. Despite several rivers that flow across the county, only 29.6% of the county residents have access to piped water and 65% to potable water. Access to electricity for lighting across the county is only 17.7 % of the total population while 70.1% use paraffin. The majority of the population 92.5% rely heavily on firewood for cooking and this puts a lot of pressure on the dwindling forest resources. The main agricultural livelihood strategies in the county include the rearing of livestock and the cultivation of crops. Regions with reliable rainfall are under intense cultivation whereas regions with poor rainfall distribution favor animal rearing and pastoral activities. Fish farming is also present in the county.

Fish farming is subsidized under the government's Economic Stimulus Programme (ESP) to stimulate economic growth and to alleviate food insecurity and poverty. In 2013 the surface area of fish ponds in the county was 360,000m² with catfish, common carp and Tilapia the most common species (GoK, 2014a). Employment opportunities in the county are offered by the county government, parastatals, non-governmental organizations, ranches, conservancies, big farms and private entities like hotels among others. A study conducted in Laikipia by Huho *et al.* (2010) established that between 1975 and 2008 drought increased in severity, and more rural livelihoods were

disrupted causing high dependency on relief aid. As a result, farmers ventured into charcoal burning, illegal logging and sand harvesting as alternative livelihood sources exacerbating desertification.

Agricultural activities

Land in Laikipia County has low agricultural potential (GoK, 2014a) and this hinders production. Only 20% of the total land in the county lies in the high and medium potential category where crop cultivation is viable. The total area under crops is about 198,400 ha of which 80% is under food crops. The low potential areas equivalent to 79% of the total land area is unsuitable for crop farming but for livestock rearing and settlement. The percentage of landowners with title deeds is 65.3%. The average farm size for small-scale holders is 2 acres while for large-scale holders is 20 acres. The ranching community holds an average of 10,000 acres. Average land holding in the group ranches per household is 23 acres (GoK, 2014a).

There are six major distinct farming systems in the county which are heavily influenced by climatic conditions and ecological zones. These include; pastoralism, mixed farming, ranching, agro-pastoralism, marginal mixed farming and formal employment/trade/business (GoK, 2014a). Irrigation is widespread along rivers and is mainly practiced by large- and small-scale horticultural farmers. The irrigation system in the county is unsustainable as it is directly from the rivers using water pumps. Very few farmers harvest rainwater for irrigation purposes.

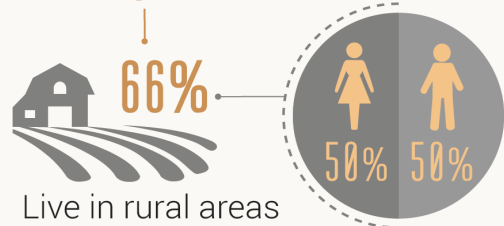
Farmers in Laikipia County use relatively low levels of agricultural inputs, probably due to the high prices, which arise as a result of the poor road infrastructure network and lack of access to inputs in the county. According to a survey by ASDSP, by 2014, only 16.1% of the farmers used basal fertilizer. The majority of farmers used improved seed varieties especially for maize (65%) and tomatoes (80%), however, for beans and Irish potatoes farmers still use local and recycled seeds (95%) and (96%) respectively (GoK, 2014a). Field pesticides are used by 13% of the farmers in the county, storage pesticides by 10%, and herbicides by 7.5% in 2013. Men use fewer inputs compared to women and youth as they are more engaged in pastoral livestock activities and continuous search for water and pastures for livestock.

Livelihoods and agriculture in Laikipia

Demographics

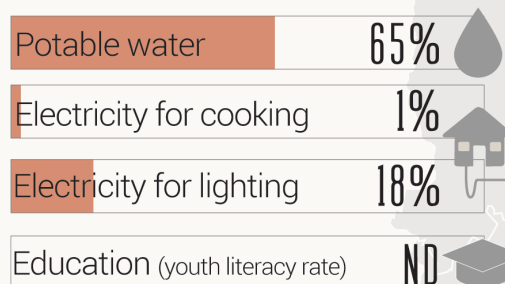
ND Of Kenya's population

399,227 inhabitants



Access to basic needs

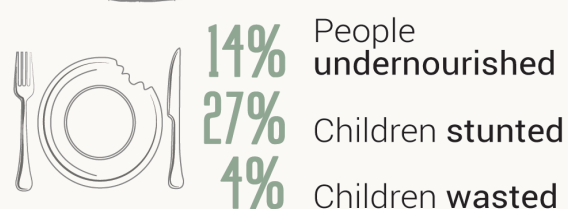
43% of the population lives in absolute poverty



Food security

27% of the population suffers from food poverty

ND of household income spent on food



ND: No data

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

Farming

County's farming area

1,984km² 21%

47% of the population employed in agriculture production

ND of farmers have title deeds ND are women

Farming activities

Food crops



Cash crops



Livestock



15%

2%

Of county's agricultural land

13 Group ranches

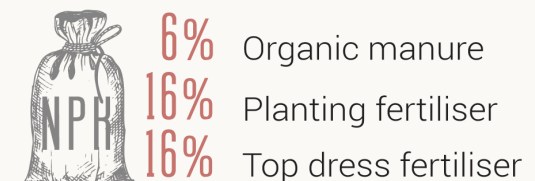
30 Company ranches

Farming inputs

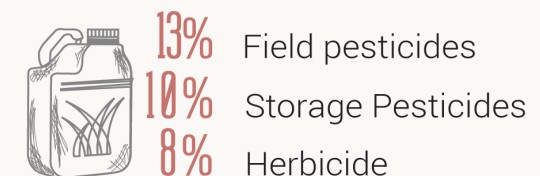
Water uses



Fertilizer types (% of households)



Pesticide types (% of households)



A broad diversity of agricultural commodities is 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 programmes; economic value (KES/bag or KES/livestock or KES/unit livestock product)⁵; resilience to current weather variability and future climate change⁶; and number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor). The selected VCC were maize, cattle (milk), sheep and local chicken.

Maize is a major crop in Laikipia County and a major contributor to livelihoods with 61-80% of the population being involved in the value chain. It is mainly grown during the long season both as a cash crop and a subsistence crop by small-scale farmers on 0.5 acre farms and large-scale farmers (up to 20 acres). By 2012, the area under maize in the county was 36,163 ha where 1,331,689 90kg bags of maize were harvested (GoK, 2015). In large-scale farms maize is grown under monocrop systems while in the small-scale farms, it is grown under mixed cropping systems. The large scale-commercial monocrop systems are found in parts of Ol-Moran, Githiga, Mochongoi, Rumuruti, Marmanet and Igwamiti wards. The medium-scale commercial monocrop systems are found in parts of Ol-moran, Sosian, Rumuruti, Mochongoi, Marmanet, and Igwamiti, Leshau/Pondo, Salama and Gathanji wards. Small-scale intercropping systems are found in Ol-Moran, Sosian, Rumuruti, Mochongoi, marmanet, and Igwamiti, Leshau/Pondo, Kidita, Gatimu, Gathanji, Tigithi, and Ngobit wards.

headed or youth-headed households (GoK, 2014a) probably due to their higher financial capacity in acquisition of inputs. Although men are the major decision makers in the value chain, women and youth are engaged differently across the value chain stages. For example women dominate the production stage while the youth are heavily involved in transporting, loading/unloading and also marketing.

Input suppliers vary in terms of scale, for example seeds and fertilizer are supplied by big companies such as Syngenta, National Cereals and Produce Board (NCPB) and Kenya Seed and also locally by agro vets and agro dealers. Spraying is done through knapsack on small-scale farms but done by tractors on large-scale farms. Maize farmers face several challenges especially in the acquisition of inputs, for example due to high demand for the drought tolerant 5 series maize seeds, dealers now produce locally manufactured seeds that are of poor quality and usually result in low yield. These low quality seeds are also prone to pest and diseases and are of a lower weight. Although there are still individual farmers who sell their produce to brokers, a good number of farmers in the county belong to agricultural cooperatives. These cooperatives offer them better marketing opportunities and increase their bargaining power to negotiate better prices.

Dairy farming is a major value chain in Laikipia County and involves 41-60% of the population. Dairy cattle are mainly kept for commercial milk production under small-scale mixed farming systems. Zero grazing systems are found in Nyahururu, Marmanet, Kinamba and Nanyuki areas, free range systems are found in Ol-Moran, Sosian, Segera, Dol dol, Lolagai and Umande areas while mixed farming systems are found in Sipili, Kinamba, Marmanet, Rumuruti, Jikaze, Ngobit, Naromoru, Matanya, Nanyuki and Umande areas. Input suppliers of feeds, vaccines and supplements range between medium- to large-scale suppliers. A major large-scale supplier of dairy cow supplements is Unga Limited. In most farming households in the county, men are the main owners and decision makers of the dairy cattle value chain. Nevertheless, women engage in almost all the on-farm activities such as feeding and milking. The youth are also very involved in the value chain. For example, the Ng'arua dairy cooling plant has engaged youth to collect milk

7 Categorization of "poor" people was based on workshop participant perceptions and not on any standard index normally used to measure poverty. 7 Categorisation of "poor" people was based on workshop participant perceptions and not on any standard index normally used to measure poverty.

all over Ng'arua and take it to the cooling plant. This has not only created employment for the youth, it has improved their standards of living, reduced crime rate and dealt with the issue of middlemen who exploit farmers.

The major challenge facing the dairy value chain is reduced pasture and water shortage especially during the dry spells for instance the one experienced recently. Milk production under adequate pasture and supplement can increase to 35-40 liters per cow per day but the prevailing drought has reduced the production to about 8 liters per cow per day. Farmers who preserve hay for their dairy cattle are better adapted as compared to those farmers who do not since they are forced to purchase imported hay from the neighboring Nakuru County which can be quite costly. Milk is usually collected and marketed through cooperatives and this has given farmers a collective bargain and fair pricing. Currently there are over 46 dairy cooperatives with 34 registered under Laikipia Dairy Development Network. Dairy farmers are continuously being advised and supported to form groups and join cooperatives so that they can collectively access markets and bargain for better prices. The New Kenya Cooperative Creameries (KCC), Brookside and Moran companies are also major players in the dairy value chain in Laikipia County.

Sheep

Between 61-80% of the county's population is involved in the sheep value chain. In Laikipia North constituency almost all households keep sheep as a major livelihood. In Laikipia East and West constituencies, sheep is kept as a supporting value chain to crop production. Actors across the value chain differ in scale, for example supply of breeding stock is offered at large scale by Olpajeta and Lengetia farms. There are small-scale farmers who also supply breeding stock. Unga Farm Care, small agro vets and the government are also involved in the supply of supplements used to fatten sheep. By 2013, there were a total of 396,098 sheep in Laikipia County (GoK, 2015). A herd with over 200 heads of sheep is considered large-scale, between 50 to 200 heads medium-scale and less than 50 heads small-scale.

In Mochongoi, Githiga, Marmanet, Rumuruti, Ol-Moran, Suguta/Marmar, Lodokejek, Sosian, Mugogodo West, Oldo-Nyiro, Umande, Mugogodo East, Burat, Kisima, and Timau, parts of Salama and Segere wards, sheep is under large-scale pastoralism. Free range large-scale systems are found in Central, Ngobit, Mugunda, Naromoru, Tigithi, Thingithu, and parts of Salama and Segere wards. In Igwamiti, Leshau/Pondo, Kiriiti,

Gatimu and Gathanji wards, sheep are kept under enclosed mixed small-scale systems.

Sheep are kept for commercial purposes on a large-scale by the Maasai pastoralists in the northern parts of the county. In the other regions, sheep are kept under medium-scale pastoralism and in small-scale mixed farming systems in the high potential areas. Transportation, auction, abattoir and butcheries are usually small-to medium-scale. Sheep are usually sold locally or through auctions, however there is no major body or collective marketing to govern pricing.

Chicken (local)

Local chicken production is an important value chain in Laikipia County. Between 81-100% of the population is actively involved in the value chain. It is practiced by most households within the county as a major source of food and income. In Githiga, Mochongio, Rumuruti, Marmanet, Igwamiti, Leshau/Pondo, Kiriita, Gatimu, Gathanji, Central, Ngobit, Mugunda, Mwiwogo/Endarasha, Tigiti, Gakawa, Timau, Kisima and parts of Segere and Salama wards, local chickens are kept under free-range small-scale systems. In Nanyuki and parts of Ngobit, Nyahururu and Igwamiti, some semi-intensive medium-scale local chicken farmers are present.

By 2013, there were 332,360 local chickens in Laikipia County. Local chicken farming is majorly a women and youth affair. Women and youth are involved across all stages of production from the cleaning of the chicken houses, feeding, egg selection and grading, sale of eggs and processing of chicken meat. Men are also involved financially in the acquisition of vaccines. Local chicken are usually kept for household consumption of meat and eggs, however, eggs are also sold during peak laying season. Local chicken are usually kept on small-scale free-range systems, with only few large-scale farmers near major urban centers. Local chicken are well adapted to warm weather but high temperatures and drought periods have affected the value chain negatively. Chick survival is low due to extreme heat; egg laying is also affected as there is less food during periods of drought.

Emerging parasites, diseases and unfavorable weather has led poultry farmers to rethink about the free ranging of chicken. Parasites linked to climate change have been noted around the eyes of the local chicken. During extreme wet conditions, local chicken especially the chicks have been found dead in the morning. Newcastle disease and Pneumonia where the coughing symptom and trembling common during cold weather reduces the chicken population

drastically. The sale and marketing of local chicken is still on a local scale and this brings issues of pricing and quality of produce. The marketing of local chicken is done at household level and the beneficiaries are usually the brokers who purchase the birds at very low prices to resell in urban centers.

Agricultural sector challenges

Laikipia County is prone to climate variability with dry spells recurring every 4 to 5 years (GoK, 2013b). Ol-Moran, Mukogodo, Sosian and Lamuria divisions are the hardest hit by drought leading to food starvation that forces people to rely on relief and other food donations from neighboring counties and countries. Livestock lack pasture and water, they become weak and emaciated or worse still die.

Overdependence on rain fed agriculture leads to crop failure as water harvesting and storage is very low in the county.

Regions near Mt. Kenya and the Aberdare ranges are the only areas that receive adequate rainfall. This means that the other areas experience water shortages and this puts pressure on the diminishing water resources. Water Resource Management Authority (WARMA) advocates for sustainable and rational water use from rivers. For instance water must first be used for domestic purposes, livestock uses and finally for irrigation purposes. Unfortunately upstream farmers irrigate their crops directly from the rivers causing tension between them and downstream dwellers. Human-wildlife conflict especially in unprotected areas has resulted in crop damage, livestock losses, human injuries and sometimes even death.

Flash floods and heavy winds cause erosion of fertile soils, destruction of farm structures and temporary displacement of people which affects agricultural productivity. Deforestation for construction and charcoal burning purposes, encroachment of water catchment areas and ignorance further aggravates the negative impacts on agricultural activities. Poor land use systems characterized by poor legislation and policing has led to uneconomical land holdings. This has resulted in overstocking and overgrazing and consequently degradation of land and emergence of less palatable grasses replacing pasture. For example the appropriate land carrying capacity is 4 acres for a livestock unit (GoK, 2013b) and the stocking rates in Laikipia are way higher than this (up to between

5 to 10 livestock units per 4 acres). Pastoralists who migrate from other counties also put pressure on the limited water and pasture resources.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

Laikipia has a cool climate having mean annual temperatures largely below 21°C in most parts of the county, with the western and southern parts of the county having cooler temperatures which only rise moderately in the eastern corner to between 22°C and 24°C (GoK, 2013b). Annual average rainfall over most of the county ranges between 400mm to 750mm (GoK, 2013b). There are areas with rainfall averages below or above these figures. Rainfall totals greater than 1000mm per year are recorded in some south-western areas bordering the Aberdare Ranges and the slopes of Mt. Kenya. The drier northern pockets around Mukogodo and Rumuruti receive the least rainfall of between 250 and 500mm annually. Heat stress and drought are major agricultural risks for the county which often result in pasture deterioration, drying of water sources, livestock emaciation, natural resources based conflict among pastoralists, crop losses and human-wildlife conflict over water. Flash floods also occur in the county often with impact on infrastructure, and crop and livestock production.

Analysis of historical temperature trends in the county over 25 years (1981 to 2005), indicate a moderate increase in both first and second season mean temperatures by 0.2°C⁸. On the other hand, rainfall trends over a 35 year period (1981-2015) showed that first season rainfall average has not changed significantly although the second season average rainfall has increased by over 50mm. Although average first season rainfall has not increased significantly, the slightly increasing temperatures have resulted in an increase in heat stress days. In the second season on the other hand, the increase in precipitation has resulted in an increased risk of high intensity rainfall, hence an associated increase in the risk of flash floods.

Looking ahead to the future, climate projections based on two representative concentration pathways (RCPs⁹)

8 For this study, the first season (season 1) refers to the 100-day wettest period during the months of January to June, while the Second Season (Season 2) is the 100-day wettest period during the months of July-December

9 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m², respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible depending on how much greenhouse gases are emitted in the years to come. RCP 2.6 assumes that global annual GHG emissions (measured in CO₂-equivalents) peak between 2010 and 2020, with emissions declining substantially thereafter. In RCP 8.5, emissions continue to rise throughout the 21st century.

Agricultural value chain commodities in Lakipia



Provision of
seeds and other
inputs



On-farm
production

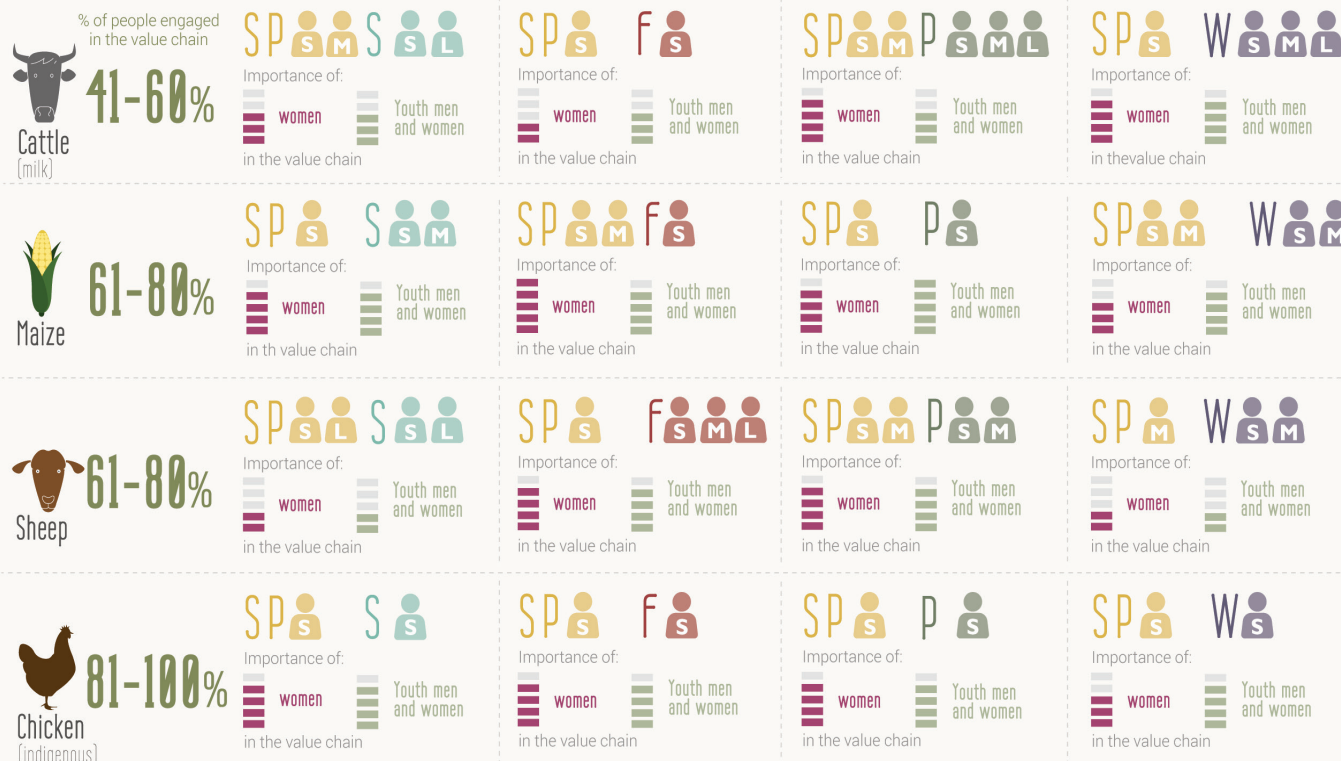


Harvesting
storage and
processing



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

s small-scale M medium-scale L large-scale

ND: No data

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

indicate that under both scenarios there is expected to be a continued increase in mean temperatures. Under both scenarios moisture stress¹⁰ is expected to increase however, the increase is more pronounced for the first season which is projected to experience and increase of over 60% in moisture stress days. In terms of precipitation, mean first season rainfall is expected to remain fairly constant in the first season regardless of the emissions scenario, however second season is expected to rise by up to 20% under the high emission scenario. Flood risk¹¹ is projected to increase under both scenarios and for both seasons with

the maximum 5-day running precipitation average expected to increase by at least 25% regardless of the emissions pathway taken. In terms of season onset and duration, under the low emissions scenario both seasons are expected to start earlier, however under the high emission scenarios the season onset is expected to recede. Season length under both scenarios and for both growing periods is expected to decrease moderately. The projections under the two GHG emissions scenarios show some differences, however both indicate the likelihood of increasingly variable rainfall, shifts in season onset and duration,

¹⁰ Number of days with ratio of actual to potential evapotranspiration ratio below 0.5

¹¹ Maximum 5-day running average precipitation.

and continued rises in temperatures and these result in an increased risk of both heat stress and flood risk.

Climate Perceptions by the farmers

Farmers' perspective on climate change is that it's partly a natural occurrence that has been aggravated by human activities. As a result, it has brought about drought, moisture stress and uncertainty of onset of season especially of the March to June season. These hazards coupled with conflicting water uses have resulted in encroachment into wetlands, tension between upstream and downstream users, massive livestock losses and migration of pastoralists to Mt. Kenya slopes in search of pastures. Farmers in the county have been experiencing climate variability which is affecting their agricultural activities. Initially, farmers used to plant at specific dates but with the changing weather, there is no certainty on when to plant. Farmers attributed these changes to be a result of natural changes in weather patterns, deforestation and environmental pollution.

The major rivers and streams that were initially permanent and used to flow from the Aberdare ranges and Mt. Kenya throughout the year are now becoming seasonal. A substantial increase in horticultural farming activities upstream have led to increased water abstraction along the major water catchment areas by both large- and small-scale farmers. As a result the volume of water in these rivers have reduced and others dried up leaving pastoralists with very little or no water downstream particularly during dry periods. The weak enforcement of environmental friendly policies and poverty has greatly contributed to environmental degradation. Furthermore, water shortage periods have resulted in mixed roles within the households, for example men also go to look for water especially for livestock or remain behind to give children food.

The rains that come late are usually torrential and pour over a short time span. This causes massive soil erosion and destruction of crops. In extreme cases there have been instances of mudslides and landslides that have destroyed property and displaced farming communities. Farmers also attested that there has been an increase in temperature in the county and this affects perishable horticultural crops like vegetables and fruits. In extreme cases, there have been instances of heat stress on livestock which reduces production and sometimes leads to livestock death.

Climate vulnerabilities across agriculture value chain commodities

Expected future climate change and variation pose serious threats to the value chain commodities prioritized for analysis in Laikipia County. Hazards include: moisture stress, uncertainty in the onset of the growing season, drought and intense rainfall.

Maize

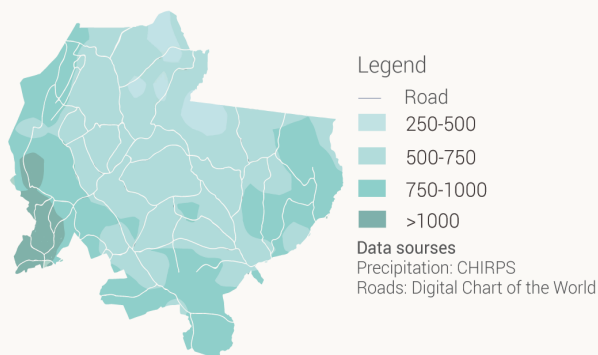
The two hazards identified to be the most problematic in the maize value chain are uncertainty in the onset and duration of the growing seasons and moisture stress. Areas most prone to uncertainty in the onset and duration of rains include Sosian, Ol-Moran, Githiga, and Mochongoi, Marmanet, Rumuruti, Igwamiti, Kiriita, Gatimu and Gathanji. Salama ward, Leshau/Pondo ward and parts of Sosian ward. Uncertainty in the rain season imposes a number of challenges on the value chain. Farmers are not sure exactly when to prepare land and when to plant. Post-harvest losses through aflatoxins, moulds and rots may occur if the rains come during harvest time. Marketing is also affected since farmers may be forced to sell immediately after harvesting at low prices.

Moisture stress affects all activities along the value chain. Farmers use less fertilizer when there is less moisture hence low yields and incomes. The post-harvest stage is likely to be affected negatively as there will be low volumes to be bulked and transported. Shelling and storage costs are likely to go up for farmers with reduced yields. As a result, there will be reduced linkage to buyers, and price will also go up as demand will be high with low supply.

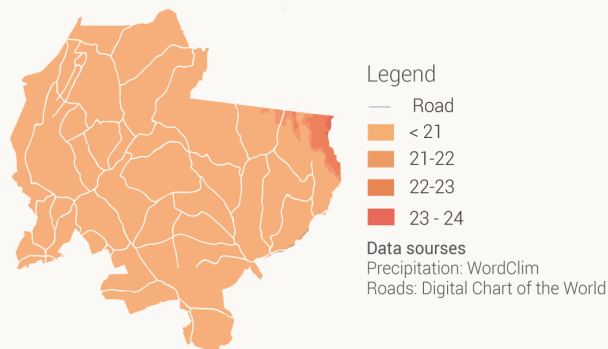
Farmers are now embracing drought tolerant maize varieties to reduce the consequences of moisture stress. Farmers can also adapt to these hazards through accessing timely information and extension services. Water harvesting through roof top gutters, water pans and dams will go a long way in irrigation especially during moisture stress periods. Small-scale farmers who are resource poor are the most vulnerable as they are not able to diversify or purchase the high cost inputs when these hazards strike. Farmers located far from extension workers are also more vulnerable as they are not able to receive updated information in time. Illiterate farmers who cannot decipher and understand information are also more vulnerable.

Past and future impacts of climate hazards in Laikipia

Historical annual mean precipitation (mm/year)

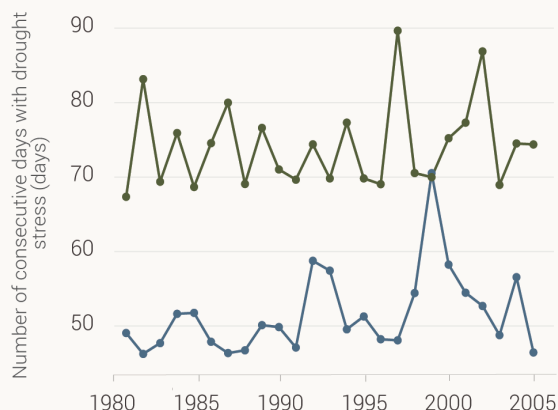


Historical annual mean temperature (°C)

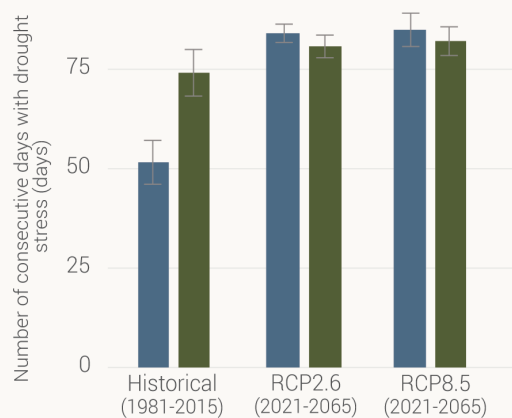


Moisture stress hazards

Historical extreme moisture stress events



Historical and expected extreme moisture stress events

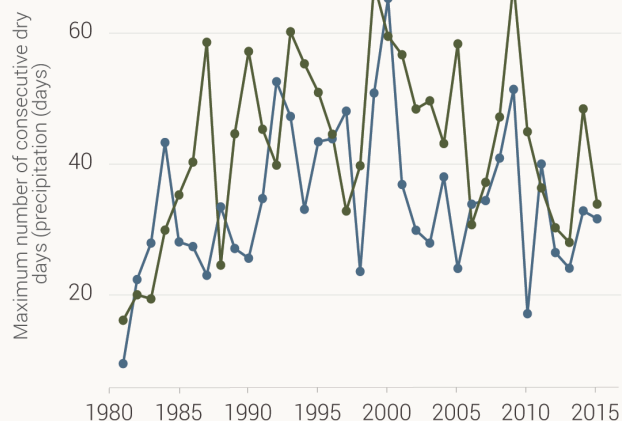


■ January - June ■ July - December

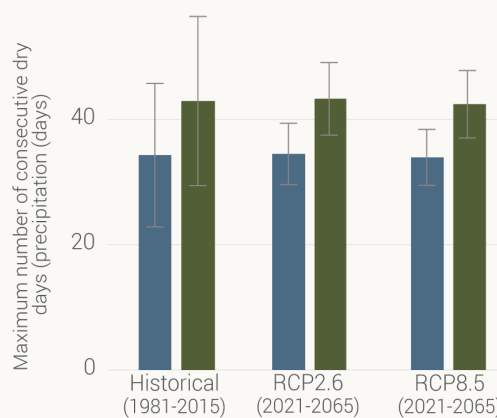


Drought hazards

Historical drought stress events



Historical and expected drought stress events



Cattle (milk)

To ensure maximum quantity and quality in milk production, quality fodder, supplements and adequate water are needed. The hazards identified most catastrophic to the value chain were uncertainty in the onset and duration of the growing season and moisture stress. Areas identified to be more prone to uncertainty in the onset of the rainy season include Ol-Moran, Githiga, Mochongoi, Marmanet, Rumuruti and Tigithi wards. Parts of Salama, Ngobit, Mwiyo/Endarasha, Thingithu and Umande were identified to be more prone to moisture stress. The dairy value chain is dependent on inputs such as hay and fodder that solely rely on rain fed agriculture. Uncertainty in the onset of the growing season will affect the input supply stage negatively as supplementary feeding will be on high demand as fodder production will be low. Extension services will also be on high demand thus expensive. At the on-farm stage, there will be high costs in the maintenance of dairy cattle as production of feeds will be reduced. In the post-harvest stage, there will be increase in the cost of transport with reduced volumes, storage and bulking costs will also rise with reduced volumes of milk. At the output market stage, promotion would be hindered, pricing will also be affected with uncertainty in the onset of the growing season.

The effects of moisture stress include: reduced fodder supply thus increased demand and higher costs of supplementary feeds, higher cost in maintenance of dairy animals, reduced quality and quantity of milk, higher cost of bulking, storage and processing related to low volumes and reduced quality milk.

Although these hazards affect all farmers in the county, the most vulnerable will be the less educated, the resource poor farmers, women and youth. This is because they have little access to the resources and information required to cope with climatic hazards. Farmers practice fodder conservation in form of silage, hay and Boma Rhodes to ensure that their animals have food during such calamities. The volumes are however still low and must be increased. To further cope with the hazards, farmers should harvest rainwater and make use of irrigation systems to cope with periods of drought.

Sheep

The hazards identified to be most problematic in the sheep value chain were drought and moisture stress. All areas in the northern parts of Laikipia

were identified to be prone to drought while Ngobit, Central, Tigithi, Naromoru and Mwiyo/Endarasha wards were identified to be more prone to moisture stress. Moisture stress causes both water and pasture scarcity. As a result, livestock are poorly fed and become sick and emaciated. This leads to low livestock productivity, which also affects availability of breeding stock. Livestock keepers also need to spend more money on disease control and surveillance. Reduced quality and quantity of stock will also affect the post-harvest stages, such as selection and grading as well as transportation.

Farmers with low financial capacity and low literacy levels are more likely to suffer from the consequences of these hazards. Youth and women are the most affected because they lack the knowledge and finance to adapt to these extreme events. Farmers/pastoralists who are always on the move to look for water and pasture are more likely to be affected as extension workers cannot keep track and monitor their stock. Timely surveillance and disease control is also on the rise. Disease resistant varieties are also being introduced e.g. Dorper Ram. Farmers can conserve pasture as an adaptive measure. Water harvesting to ensure the stock has water during drought and moisture stress periods is also an important adaptation strategy in the county.

Chicken (local)

The most problematic climatic hazards identified for the local chicken value chain were intense rainfall and moisture stress. Areas more prone to intense rainfall included Githiga, Igwamiti, Gatimu, Ngobit, Thingithu, parts of Marmanet, Umande and Tigithi wards. Parts of Rumuruti, Salama, Central, Ngobit, Tigithi, Naromoru, Thingithu and Mugogodo East are some of the wards identified to be more prone to moisture stress. Intense rainfall has a major impact on all stages of the local chicken value chain. Intense rain has been associated with scarcity in chicken feed, reduced production of feeds, outbreaks of respiratory diseases, parasites and reduced quality and weight of chicken meat. It will also affect grading due to low quality and with low volumes; transport costs are likely to go higher, destruction of chicken house structures, sudden deaths and reduced breeding stock. Impassable roads hamper transportation and lead to high transport costs. Intense rainfall also negatively affects marketing chicken products since prices increase because of low production/high demand.

Moisture stress has been associated with scarcity of chicken feed, reduced production of feeds, outbreaks of respiratory diseases, parasites and reduced quality and weight of chicken meat. It will also affect grading due to low quality and with low volumes; transport costs are likely to go higher. In addition, it will affect marketing and advertising of chicken products at the output market stage negatively as these services would not be required during low production. Chicken product prices would also increase as demand rises with low production. Furthermore, low quality birds and products would fetch very low prices in the market. To cope with these climatic hazard, farmers are building stronger housing structures for their birds, vaccinating them against emerging diseases, and preserving feed for their birds.

The most vulnerable people are the farmers with low financial capacity and low literacy level, as well as women and the youth because they lack the knowhow and finance to adapt to these climate risks.

Adaptation to climate change and variability

On-farm adaptation practices

Overdependence on rain fed agriculture makes farmers in Laikipia County vulnerable to climate change and variability. According to Water Resource Management Authority (WARMA), in the recent years, water supply fell by more than half and this is worse in the current dry spell. Farmers are now being encouraged to practice rain water harvesting through roof top gutters, water pans and dams to mitigate against moisture stress and to be able to sustain their crops and livestock production. This is because major rivers are drying up, for example Nanyuki, Timau, Tehesoni, Naromoru and Ewaso Nyiro. Drilling of boreholes and water vendors have increased to satisfy the water shortages as rainwater is no longer adequate. Women nowadays spend less time on farm as they have to search for water. In extreme situations, gender roles have been reversed with men taking up few household chores like feeding the children when the women are looking for water.

Diversification is also encouraged where farmers are encouraged to grow early maturing, drought tolerant and pest and disease resistant varieties of maize. Maize varieties series like 520, 517 and 516 are examples of short-term varieties that are being promoted by the

Ministry of Agriculture (MoA) to ensure that farmers have a crop even during shorter planting seasons. The county has begun acquisition of drought resistant livestock breeds such as the Galla Buck breed for goats and Dorper Ram for sheep. These breeds also have a fast growth rate and are resilient to climate variability. Drought resistant crops are also encouraged as an adaptation measure, for example hay is continuously being grown and promoted in different parts of the county.

Livestock in Laikipia County is facing challenges as a result of climate change and vulnerability. This is further aggravated by the fact that land parcels are now smaller and not enough to include fodder. In the highlands, priority is given to cash crops while in the lowlands there are no major cultivation activities and pasture is left to emerge during the rainy periods. Nevertheless, fodder conservation is now being promoted across the whole county in the form of hay and silage. The county government distributed hay seeds to farmers and they were able to feed their livestock and even export to other counties like Garissa and Mandera. This shows the potential that fodder has in the county, not only as a feed to the livestock but as a cash crop.

Although not very widespread, conservation agriculture is on the rise where there is minimal tillage to conserve moisture and nutrients within the soil. A good example of the potential benefits of conservation agriculture is the Lengetia farm within the county. In an ASAL area, the farm is able to produce up to 4.5 t/ha of wheat each year under minimum tillage and rain fed agriculture. Conservation agriculture is still challenged by the fact that there is no training at grass-root level and that older farming generation which forms the majority of the landowners in the county is still held up in their familiar farming methods and thus do not adopt the new interventions.

Flooding also occurs in Laikipia County especially in areas along major rivers and lowland areas due to increased precipitation that now occurs within short durations of time. Farmers are warned especially by WARMA through flood monitoring and advised to move from low areas. No agricultural or settlement activity is allowed near rivers that are prone to flooding. The government through the county is developing retention dams to store water as a long term adaptation measure. Dams control flooding but also double up as sources of water for irrigation, livestock and household consumption.

Off-farm adaptation practices

Extension services and capacity building activities on how to improve and manage livestock and crops are present in the county and are offered by the Ministry of Agriculture Livestock and Fisheries (MoALF). Water Resources Management Authority (WARMA) works closely with the WRUAS to ensure catchment conservation, they also capacity build in practices such as water harvesting. East Africa Grain Council (EAGC) works in postharvest management through capacity building especially in the maize value chain by providing shelling, sieving equipment and moisture meters. Food and Agriculture Organization (FAO) of the United Nations promotes climate smart agriculture through capacity building. CARITAS is an FBO that is engaged in tree planting by providing seedlings, breeding stocks for sheep and goats, as well as capacity building communities. Kenya Meteorological department (KMD) provide climate and weather predictions and advisories in collaboration with extension workers. Although devolution of agricultural to the county governments has affected the smooth running of extension services, the impact of the services cannot be overlooked. This has also led to a new program Laikipia Agricultural Sector Extension Programme (LASEP) that is aimed at reviving extension services. With improved extension services, the programme is expected to improve crop and animal production through timely and result-oriented interventions like improved seed varieties, use of fertilizer, improved livestock breeds and pasture conservation.

There is also provision of agricultural climate information through early warning systems. For example, the meteorological department sends out sub-county specific climate based advisories to farmers in the form of quarterly bulletins and this helps farmers in preparations of farm activities. They also include information on onset of rains or changes expected during cropping seasons. Farmers are advised to move from areas prone to flooding especially river banks and low land areas to reduce calamities. Several other services are also offered to farmers by various organizations within Laikipia County in the effort to mitigate and/or adapt to climate change and variability. For example, conservation agriculture is promoted by ASDSP, FAO, county government and Lengetia farm among others through Farmer Field Schools, trainings and demonstrations. Research and development is rampant in various organization to come up with various options to withstand harsh conditions and CETRAD is one of the major players in this. Breeding

activities are offered by ranchers, Lengetia farm, CARITAS among other smaller private entities.

Information that encompass weather advisories and forecasts, improved seeds varieties and crop specific fertilizers is passed to farmers through the media (television and radio) in the local language that farmers can easily integrate and understand. A major player in this is radio Sawanga that has specific programs to advice farmers on appropriate farming technologies (improved seed and livestock breeds, fertilizer, crops and livestock management among others). Guests from MoALF, KMD and farmer groups are usually invited to speak and share information on how to improve agriculture and realize maximum production. Farmers also receive advisories in form of short messages through their phones (SMS) so that they are more prepared for different situations. The government through KFS promotes activities like afforestation and re-afforestation that mitigate climate change through sensitization and provision of seedlings.

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

Chicken (local)

Provision of seeds
and other inputs



On-Farm
production



Harvesting
storage and
processing



Product
marketing



Intense rainfall

Loss/reduction of chicks; reduced production levels due to cold from the rains; scarcity of chicken feeds hence high costs of those available; destruction of structures thus loss of stock due to predation, cold and disease

Interruption of labour availability/labor costs will increase; increases disease outbreaks hence reduction of flock; there is interruption of breeding activities hence minimal reproduction

Loss of chickens due to disease or structures being destroyed; low quality of stock; interruption of the grading process; loss of income; loss of protein; impassable roads hence minimal transportation

Reduced marketing; network connectivity is also affected; increased market prices due to low supply

Magnitude of impact

Major

Major

Major

Major

Farmers' current strategies to cope with the risks

Import of chicks and provision of heat during cold; importation of chicken feed from other counties; sourcing feed directly from mills; construction of better housing structures using locally available materials for instance grass, polythene; using waste food as feed

Rescheduling of farm activities; use of indigenous medicinal knowledge for instance Aloe vera and pepper; use of incubators to hatch chicks; shifting from free range system to semi intensive to minimize loss

Use of alternative means of transport e.g. carriers and cattle carts, donkey carts; Destocking at the onset of rains before it becomes intense

Diversifying into other products or other sources of chicken; selling chicken parts in small affordable quantities to try and meet the demand

Other potential options to increase farmers' adaptive capacity

Devolution of KALRO services to the counties; diversification to other poultry types e.g. goose, turkey; capacity building to the youth to start CBOs that specialize in chicken feeds; subsidize and zero rating of raw materials; houses to be built raised above the ground to avoid water flooding/wetness; subsidize building materials

Use of systems that are less labour intensive; county government sponsored breeding programs; subsidize breeding stock; intense capacity building to create awareness on disease control; subsidized/zero rating drugs

Establishment of chicken slaughter slabs; capacity building in the grass roots; diversification into other types of poultry; upgrading and proper maintenance of roads

Value addition e.g. chicken balls, fillets. contract farming; adapt e-advertisement which is more efficient and effective at present and in future; farmers to be in groups to enable them to control the pricing of chicken



Moisture stress

Less feed availability hence low quality and volume of chickens; feeds becomes expensive; invasion by parasites causing diseases thus reduction in quality and volume of the chicken

Diversion of labour to other activities; reduced production of feed, therefore the number and quality of the breeding stock reduces; increased parasites and diseases

Limited options in grading due to low quality in chicken; reduced meat quality and quantity; transport cost and means will not be affected but the volume of chicken transported will be low

Less chicken marketed; less advertisement since there will be more competition of resources; reduction in prices due to poor quality of chickens

Magnitude of impact

Major

Moderate

Moderate

Moderate

Farmers' current strategies to cope with the risks

Use of incubators; selection of more hardy breeds e.g. the bare neck; importation of feeds from other counties; use of local formulation; fumigation of the chicken houses; re-use of kitchen waste to be used as feed

Rescheduling of farm activities; designation of chicken rearing activities to family members; use of indigenous medical knowledge e.g. use of Aloe vera, pepper; ensuring hygiene in the chicken house; allow feeding on worms from mulch and kitchen gardens

Destocking before the dry spells begin; importation of chicken feeds; re-use of waste food as chicken feed; transporting in groups to minimize transport cost

People opt for alternative/affordable sources of proteins e.g. beans

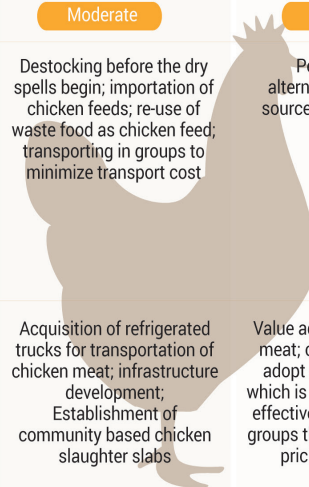
Other potential options to increase farmers' adaptive capacity

KALRO services to be devolved to the counties; diversification to other poultry breeds i.e. turkey, goose, guinea fowl; subsidization of raw materials; youth empowerment to start CBOs specialising in quality animal feed production

Adopt less labour intensive systems; promote water harvesting; poultry meat diversification e.g. ostrich, turkey and geese; government to initiate indigenous chicken breeding programs; government disease control programmes; chicken drugs subsidies

Acquisition of refrigerated trucks for transportation of chicken meat; infrastructure development; Establishment of community based chicken slaughter slabs

Value addition of chicken meat; contract farming; adopt e-advertisement which is more efficient and effective; farmers to form groups that will control the pricing of chicken



Cattle (milk)



Uncertainty of seasons

Increased demand for tick drugs; cost/ demand for extension services will be high; high demand for supplementary feeds hence high prices

Reduced feed production; high cost of maintaining the animal; milk hygiene will be affected if less cleaning is done

High cost of bulking since production is low; storage volumes reduce; increased cost of transport due to reduction of milk volume

High production costs; high milk prices; limited marketing and market access; reduced promotion

Magnitude of impact

Moderate

Minor

Moderate

Major

Farmers' current strategies to cope with the risks

Seek information from government extension officers/experienced agro vets; agro vets sources and stocks hay and other supplementary feeds

Use of drought tolerant crops; fodder conservation (silage and hay). formulating own feeds; reducing labour

Reducing collection points; buying more milk from non-cooperative members; registering more cooperative members; reduce the number of transport vehicles; adopting aluminum cans to enhance cleaning when carrying or transporting fresh milk

Looking for better buyers with good and higher prices; promote through small scale trading; value addition

Other potential options to increase farmers' adaptive capacity

Vaccination against East Cost Fever (ECF); strategic feed reserves developed and operationalised; bulk sourcing of feed raw materials

Homemade balanced rations trainings; increased fodder production; fodder conservation; training on clean milk production; use of aluminum cans; training on clean milk production; improved cattle housing to enhance hygiene

Small capacity coolers strategically positioned near farmers across the production areas; solar powered coolers; reduction of price of power; recruit and organise farmers into cooperatives and marketing organisations; providing cooling plants to collect from small coolers; enhance production of milk; small coolers near production areas; increase production and sustain it through fodder production and conservation technologies

Organize and support cooperatives in the county to develop processing plant; research to be conducted on cost reduction strategies along the milk value chain especially at supplementary feed level; promote milk consumption; promote value addition. increase long life milk and milk powder capacity



Moisture stress

High cost of supplementary feeds due to increased demand

Production of feeds will be reduced and cost of maintaining the animal will be high; it will affect the quality and quantity of milk; cleaning is easier during moisture stress

Bulking is expensive due to low production of milk; storage volume in cooling plant will reduce; cost per unit will increase

Higher production cost than income earned by the farmer due to expensive feeds; low linkages due to low milk production; no promotion because volume is low to certain the market

Magnitude of impact

Minor

Minor

Major

Major

Farmers' current strategies to cope with the risks

Agro vets will get online extension; varieties of feeds. Seek financial support from banks for inputs

Adopt drought tolerant crops; conservation fodder (silage); supplementary feeding

Reducing the labour to reduce the cost; get few collection points to reduce the cost of transport; buy more milk from non-members to compensate the volume; reduce the operation cost

Exploring better paying markets; sales to middlemen; Seek financial support from banks to buy more milk

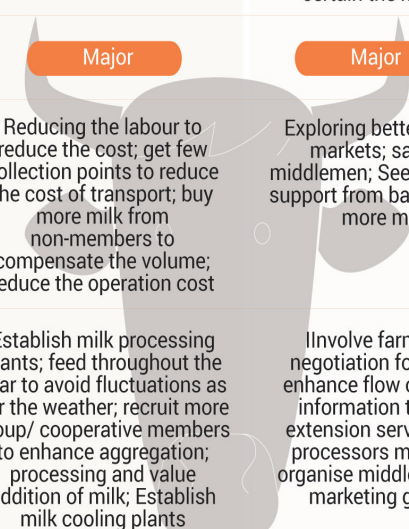
Other potential options to increase farmers' adaptive capacity

Improve access to finance for livestock inputs; establish revolving funds; group trainings for agro vets; e-extension enhanced; strategic feed reserve development; develop livestock support fund to help in purchase of feed and raw materials; Drought tolerant fodder varieties; enhance production using dry feeds

Enhancing production and conservation of feed and fodder; feed inspection by feed inspectors to avoid poor quality feeds; improve timeliness of weather information; use aluminium/ food grade plastic containers

Establish milk processing plants; feed throughout the year to avoid fluctuations as per the weather; recruit more group/ cooperative members to enhance aggregation; processing and value addition of milk; Establish milk cooling plants

Involve farmers in negotiation for prices; enhance flow of market information through extension services and processors meetings; organise middlemen into marketing groups



Maize

Provision of seeds and other inputs



On-Farm production



Harvesting storage and processing



Product marketing



Uncertainty in start and duration of growing season

Uncertain extension services; uncertainty in variety selection Low supply of seed; uncertainty of timely supply of the right fertilizers; low supply of fertilizers; late purchase of herbicides

Uncertainty in planting time, high input costs; incur extra costs on machinery, equipment and labour

Great losses in post harvesting through aflatoxins, molds and rots; uncertainty in store preparation leading to post harvest losses; poor quality maize; low prices

Fluctuation of prices which affects buyers and sellers; uncertainty in supply and volumes leading to low prices; poor quality produce on the market

Magnitude of impact

Major

Major

Major

Major

Farmers' current strategies to cope with the risks

Use of Indigenous Technical Knowledge (ITK); use of internet; use of trails and guesswork; use of previous records; trails and guess work, use of farm yard and composted manure; use of previous years records; use of local varieties

Use of traditional methods; trials and guess work; Conservation Agriculture (cover crops, slashing, herbicides and rotation); use of good agricultural practices; soil sampling and testing; crop insurance

Use of motor shellers; sorting and grading; use of moisture meters; use of hermetic bags and metallic silos; use of aflatoxin detectors; construction of warehouses/aggregation centers; certification of warehouses/aggregation centers by EAGC;

G-soko/e-soko/internet; millers; sourcing market information through local radio stations/internets/local dailies; formation of marketing groups through EAGC and FAO, ASDSP; banks for warehouse receipt system financing

Other potential options to increase farmers' adaptive capacity

Conduct trainer of trainers (TOT) and capacity building on timing of planting; frequent weather advisories; private extension services; research on improved seed varieties; provision of subsidized seed by government; credit facilities for traders; support farmer groups access seed; increased soil sampling; support organized farmer groups access fertilizers

Early planting; increased ca equipment and machines to farmers; timely weather advisories; access to ca equipment and machineries; upscale ca capacity building/adoption to farmers; upscale ca weeding equipment and training to farmer; crop cover; mulching

Upscale shelling equipment; increased moisture meters to organized farmer groups' use of hermetic bags; access to drying machines and equipment; warehousing; aggregation centers; farmers access to aflatoxin kits and moisture meters; construction of warehouses; improve on infrastructure (roads)

Create more market linkages; improve access to market information to farmers; support farmer groups; warehouse receipt system; G-soko/e-soko; government to support farmers on linkages; upscale local radio station programs; increased support to agro processing industries; training farmers on farm agro processing



Moisture stress

Reduced extension services; giving alternative choice of enterprise; low supply of seeds and change in varieties of seeds; low supply of fertilizers

Uncertainty in planting time leading to loss of inputs and reduced yield; Less costs and low yields

Greater cost for shelling and storage as compared to yields; low volumes of bulking leading to reduced income

Low quality, volume and less income; Poor linkage and low income; Poor quality, less volumes, less income, high costs in the market

Magnitude of impact

Severe

Moderate

Major

Severe

Farmers' current strategies to cope with the risks

Supply short rain seeds e.g. 5 series; early maturing varieties; use of manure; subsistence fertilisers; soil sampling and testing

Early planting; Conservation Agriculture; water harvesting; conservation agriculture; early land preparation; shallow weeding; herbicides; cover crops; mulching

No significant impact

Source of manure. Mulching; On farm feed conservation

Other potential options to increase farmers' adaptive capacity

Training of TOTs; more research on adaptable moisture stress seed varieties; access to affordable credit facilities; upscale use of compost and farm yard manure; upscale soil sampling and testing; access to affordable subsidized fertilizers

Early harvesting; water harvesting technologies e.g. ponds, dams; upscale use of conservation agriculture; early land preparation; access to ca land preparation equipment; increase shallow weeding equipment; crop cover/mulching; subsidized herbicides to farmers

Increase shelling equipment, sorting and grading equipment; build more warehouses; increase access to hermetic bags; capacity build farmers on postharvest handling; support more aggregation centres; support capacity building for farmers on agro processing; introduce cottage industries

Create more market linkages/networks; use of internet, marketing i.e. G-soko, radio stations and mobile networks; create more linkages to millers/processors through county government and organizations; promote agro-processing on farm by products; capacity building on farmers

Sheep

Provision of seeds and other inputs

On-farm production

Harvesting storage and processing

Product marketing



Moisture stress

Reduced ability to breed quality stock; slight increase in the cost of surveillance and disease control; afford only the small equipment

Reduced pasture available to flock; slight effect on time for routine management of farm; slight increase in cost of health management of the flock

Reduced ability to fatten flock due to lower pasture availability; slight difficulties in culling and selection of flock; slight reduction in flock quantities being transported

Slight reduction of sales due to reduction in quality and quantity of flock; slight reduction in ability to promote flock due to reduced quality; slight reduction in linkages to farmers

Magnitude of impact

Moderate

Minor

Minor

Moderate

Farmers' current strategies to cope with the risks

Adaptable breeds e.g. Dorper; herbal medication; traditional equipment

Feed conservation; traditional routine management; herbal preparation

Feed conservation; farmers and traders; trekking to auction sites

Selling at reduced price

Other potential options to increase farmers' adaptive capacity

Adaptable breeds e.g. Dorper available in groups; regular surveillance and vaccination of flock; form societies to buy inputs

Feed conservation like silage; capacity building for the same; capacity building on routine management; capacity building on health management

Supplementary feeding; programmed culling/selection; commission societies to develop common transport systems

Commission societies to create bargaining power; commission societies to promote flock as a brand; commission societies to link farmers to buyers



Drought

Unavailability of breeding stock. because drought affects animals by dying; poor response and high cost of surveillance and disease control; ability to afford equipment, because of lack of market due to poor quality of animals

Unavailability of pastures; reduced time for farm management due to increase in time to manage drought situation; high cost of health maintenance of flock/compromised health

Inability to fatten flock due to lack of pasture; difficult to select; minimal need for transport

Reduced quality and oversupply of poor quality flock leading to low prices; difficult to promote poor quality flock; no linking farmers to buyers

Magnitude of impact

Severe

Severe

Major

Severe

Farmers' current strategies to cope with the risks

Feed adaptable breeds e.g. Dorpers; herbal preparations; traditional equipment e.g. castration using clubs, open castration

Feed conservation; traditional routine management system e.g. use of ash as a pesticide; herbal preparations

Feed conservation; increase culling; trekking to auctions

Selling at reduced prices

Other potential options to increase farmers' adaptive capacity

Acquiring adaptable rams in groups; regular surveillance and vaccination; form societies to buy inputs e.g. equipment

Storage of feeds i.e. feed conservation, capacity building; capacity building on routine management; capacity building on health management

Supplementary feeding; programmed culling/selection; commission societies to develop common transport system

Commission societies to create bargaining power; societies to promote flock as a brand; societies to link farmers to buyers

Policies and Programmes

The Climate Change and Natural resources management sub-sector is guided by a number of policies and legislations¹² whose overall objective is to enhance the contribution of the natural resources in the provision of economic, social and environmental goods and services. Such policies guide and ensure that there is awareness creation, communication and reporting to public through participatory approaches for better conflict resolution and optimal use of resources by women, youth and vulnerable persons in line with the social inclusion, policies and regulations. The Forest Act, 2005 established the Kenya Forestry Service which is a state corporation mandated to develop, manage and conserve the forest resources within Kenya and assist county governments in achieving this. It also advocates that harvesting of trees must be done in a sustainable manner maintaining the 10% forest cover. Large-scale harvesting must be accompanied by a harvesting plan as dictated in the Act. The main gaps in implementation of these natural resources management policies and legislations are the lack of an environment policy and the spatial land use plan in the country, lack of harmonization in enforcement of the natural resource management policies with the sector policies and challenges in resolution of community land disputes. There is also a weak framework for conflict resolution in the quest for emerging interest in environmental resources.

The crops sub-sector is guided by several national policies and legislation whose overall objective is to promote food security and incomes and enhance sustainable use of land resources. These policies include the National Food and Nutrition Security Policy, National Agriculture Service Extension Policy, National Agri-Business Strategy, National Horticulture Policy, National Root and Tuber Crops Policy, The Kenya Sugar Industry Strategic Plan 2010-2014, Kenya Seed Policy. Most policies within the sub-sector have embraced issues addressing interests of men, youth, women and persons with disabilities among other vulnerable groups. To further this social inclusion, the Agri-business Strategy has identified and provided support to Small and Medium Enterprises run by women, youth and persons with disabilities.

The goal of the National Livestock Policy is to enhance food security, create employment, improve livelihoods and contribute to GDP through the livestock sub-sector. This is achieved through effective private, public and community partnerships. Through the Policy several institutions such as Kenya Animal Genetics Resource Centre, Kenya Leather Development Council, Kenya Tsetse and Trypanosomiasis Eradication Council have been established. There has

been formation of farmer dairy groups to promote milk production, value addition and marketing of long life milk. There has also been establishment of medium- and long-term strategic plans for emergencies. The policy implementation is however challenged by inconsistencies with the Constitution of Kenya, delays in the finalization of developed standards for some key products e.g. honey and camel milk, and lack of a strategy for policies implementation.

The Fisheries Act CAP 378 (2012), National Oceans and Fisheries Policy (2008), and the Aquaculture Policy (2012) exist to guide the upcoming fisheries value chain. The overall objective of these policies and legislations is to enhance the fisheries sub-sectors by contribution to wealth creation, increased employment for youth and women, food security, and revenue generation through effective public and community partnerships. Some successes include improved infrastructure development in fish producing areas e.g. fish cold chain facilities, mini processing plants and national fish quality control laboratories. There are also regular fish inspection and quality assurance programmes such as Fish Farming Enterprise Productivity Programme (Economic Stimulus Programme 2009-2012) for youth. The fisheries sub-sector provide for inclusion of women, youth and vulnerable persons in the resource access and management in line with the social inclusion, policies and regulations.

Agricultural Sector Development Strategy (ASDSP) was initially initiated in collaboration between the Kenyan and Swedish governments to formulate specific policies, work plans, projects and programmes to deal with food security and nutrition issues. ASDSP enhances farm productivity while conserving the natural resource base within the county. The overall goal of ASDSP in the county is to revolutionize agriculture not to be geared towards subsistence only but to an economic and commercial enterprise that can provide employment to the youth and improve livelihoods within the county. Through the years collaboration with other development partners has also made the mandate of ASDSP more viable at the county level. ASDSP efforts have widely been felt throughout the county where value chains like dairy, maize, sheep and goat have been promoted and supported. ASDSP contributes to and develop agriculture and livestock, alleviate poverty by promoting pluralistic, efficient, effective and demand-driven extension services among crop farmers and agro-pastoralists.

Laikipia County Government has come up with different programmes to mitigate and deal with climate change and variability issues within the county for example the Laikipia Agricultural Sector Extension Programme (LASEP) that is

¹² These policies and legislations include the Forest policy (2007), Mineral Development Policy, Land policy (2009), Environmental Management and Coordination Act (1999), the National Land Commission Act (2012), Water Act (2002), Forest Act (2005) and National Climate Change Response Strategy (2010).

aimed to revive extension work and help farmers especially in the marginalized areas of the county. This will ensure that farmers have on-farm support when they need it. Unwritten laws and cultural beliefs also go a long way in the protection of the environment. It is under the support from such laws that Community Based Organizations (CBOs), Faith Based Organizations (FBOs) e.g. CARITAS and Water Resource Users Associations (WRUAS) and group ranches are able to have a smooth running and count milestones in the protection and equitable use of resources. This also allows banks and cooperative societies to support farmers through loans, insurance and inputs. A major challenge is that financial resources to run county programs are usually limited and this hinders policy implementation.

The Agricultural (Farm Forestry) Act of 2009 advises farmers to maintain at least a 10% forest cover on every agricultural landholding and to preserve and sustain the environment in efforts to combat climate change and variability. These rules purpose to promote and maintain forest and conserve soil. In accordance with the act, Laikipia County is at 22% forest cover which is safely above the national targets but still under threat for timber and fuelwood, especially because a majority of the population within the county still use forest products (firewood and charcoal) for cooking (GoK, 2009b; 2013b). The drastic reduction of forest cover coupled with the fact that most of Laikipia County is classified as semi-arid land further contributes to global warming. Trees act as carbon sink and forests are able to sequester huge amounts of carbon (IV) from the atmosphere (IPCC, 2014). The Act also discourages the maintenance of any Eucalyptus spp. in wetlands and riparian areas.

The Conservation agriculture for Food security and profitability (CA4FS) program supported by African Conservation Tillage (ACT) is also a major vulnerability and climate change player in the county. The program's goal is to improve income and food security and build resilience of smallholder farmers in Laikipia County by enhancing the adoption of conservation agriculture practices. Some of their main activities involve backstopping of farmer demonstration plots to see their performance, community meetings to showcase CA equipment and connecting farmers to markets. A major impediment for the program in accessing markets is poor infrastructure and barriers caused by limited resource base, lack of information and inadequate institutional support and poor policing.

Governance, institutional resources, and capacity

There are various governmental institutions, non-governmental (NGOs), community-based, and private organizations that deal with climate change and vulnerability issues. At the county level, such

departments and agencies include: Water Department that construct water pans and drill bore holes, Agriculture Department that provide crop extension services, Livestock Department that provide livestock extension services, Fisheries Department that promote and support fish activities. The Department of Environment protects the environment through proper policing, Energy Department provides options in renewable energy use, Department of Lands governs land use and gives title deeds, Kenya Meteorological department (KMD) provides climate and weather data and advisories, Kenya Forestry Service (KFS) that protects forests and provide tree seedlings and National Environmental Management Authority (NEMA) regulates and coordinates environmental projects, Water Resource Management Authority (WARMA) manages water resources, National Drought Management Authority (NDMA) reduces the effects of droughts through different interventions.

The majority of these governmental entities provide agricultural extension, inputs, programs and policy support to farmers and resource users within the county. For example, the extension staff from the Agricultural Department support farmers through field visits and supply of inputs. They also decipher climate information from KMD and integrate it with agricultural information for use by farmers. Research institutions within the county are also doing a lot on climate change and variability. For example CETRAD is doing research on water resources. They are also involved in capacity building activities. The Resilience Project is involved in disease control and surveillance, the project also supports pastoral livelihoods through interventions. Faith Based Organizations (FBOs) like CARITAS are involved in tree planting, provision of goat and sheep breeding stock and capacity building on environmental conservation. Community Based Organizations (CBOs) are also continuously doing a lot in environmental resource conservation. For example the WRUAS (Water Resource Users Associations) promote equitable water use and advocate for peaceful conflict resolution. Private institutions e.g. Lengetia farm is a key promoter of conservation agriculture and often train farmers during FFS (Farmer Field Schools) in conjunction with the Ministry of Agriculture. The farm also provides improved breeds of sheep and goats.

The devolvement of agriculture has affected county extension services as there are no clear budgets by the county to support such activities. The officers are also few in numbers and are not able to cover the vast Sub-Counties further hindering their efficiency. The funding and staffing hindrances are across the various county government departments and this

Staff within different agencies and county departments confirmed that they have not been trained on climate change and vulnerability issues as it is still a new phenomenon within the county and has not been fully integrated in developmental activities. There is thus need to capacitate staff members through training. More funds should also be allocated to deal with climate change issues. Currently, such issues are dealt with on a crisis basis and this is not effective. Most of the programmes and departments also identified staffing as a challenging issue and a hindrance during dissemination of interventions. Coordination of all the players in the mitigation of climate change and vulnerability is necessary to achieve tangible milestones. In Laikipia County, through partnerships like Mt. Kenya Ewaso partnership and forums like Laikipia Wildlife Forum, resources are now being properly managed.

Agriculture is the mainstay of Laikipia County which enables and sustains over 75% of rural livelihoods. The sector faces several challenges; low land productivity, livestock diseases, poor management of pastures, inbreeding, high cost of veterinary drugs and insecurity, wildlife/livestock/human conflict, persistent and prolonged droughts, incidences of cattle rustling, poor land use, land degradation, inappropriate land tenure system, poor extension services, inadequate and poor quality water supply. As drought, moisture stress and uncertainty in the onset and duration of growing seasons are foreseen to occur with greater frequency in the county, enhance capacity of farmers to cope with these new conditions is needed.

and nutrition support to the severely malnourished through relief food. Further, fodder conservation through community groups and at individual levels has been encouraged amidst the introduction of hybrid livestock breeds like the dairy goats, rabbits, poultry and bees. The reengineering of the community action groups (CBOs like WRUAS) and enhanced capacity on environmental protection and sustainable use of natural resources with support from relevant institutions such as NEMA, NDMA, WRMA, ENNDA, AWF, CETRAD, KFS, and other stakeholders involved in environmental issues is also a priority in the county.

There are various challenges that affect adaptation to climate change, for example policies are usually contradicting within different county departments causing challenges during domestication. This calls for harmonization of policies and programs. There is also no clear department mandates and this usually results in overlap of duties. Another major challenge is that pastoralists who form a big population of marginalized in Laikipia move from time to time in search of water and pasture for their livestock leaving behind women and children. This situation makes it challenging for development agencies and the government and to provide basic services to these communities. The situation is worsened by high levels of poverty, drought, poor management of the group ranches, diseases, inadequate pastures, high illiteracy levels and inability to exploit the available resources in sustainable ways. These challenges must always be put into consideration during the formulation of interventions to ensure that they are practical and can be incorporated in the livelihoods of the people in Laikipia County.

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