

Climate Risk Profile Isiolo County

Highlights

- Agriculture represents the backbone of the County's economy, being an important source of income, savings, and social status for the population. Over 80% of the inhabitants rely on livestock for their livelihoods and less than a third (26%) practice agro-pastoralism. Food poverty rates are alarmingly high (77%), which has led to a high dependency of the population on relief food.
- Over the past three decades, drought hazards and high temperatures have increased significantly in the first season (January-June), while the second season (July-December) has been characterized by lower increase in precipitations and higher mean temperatures. Short- and medium-term climate projections show that the County will remain highly susceptible to more frequent drought periods, increases in mean temperatures, and decrease in intense rain in both seasons.
- In the livestock and crops sub-sector, responses to climate hazards in the County have taken various adaption forms, including pasture establishment and conservation, disease control and surveillance, construction and maintenance of boreholes and watering points for livestock, mass vaccination, destocking, and rearing of drought-tolerant livestock types. Crop farmers combine water and soil conservation practices, conservation agriculture, use of drought-tolerant and early-maturing crop varieties, agro-forestry, and post-harvest management and marketing, among others.
- Despite ongoing on-and off-farm efforts to increase climate resilience, farmers' adaptive capacity remains low and agricultural yields have continued to decrease over the past years. Limited access to water resources, farm inputs, and services, unaffordable productive technologies, and decline in the quality and quantity of natural resources (water, pastures) have led to inconsistent and uneven adoption of sustainable agricultural practices.
- Interventions to incentivize uptake of adaptation practices in agriculture need to target the most vulnerable groups on the first place, as they depend on farming for household income and food security. Now, adoption rates of sustainable practices among the youth and women are among the lowest in the entire County.
- Successful implementation of climate adaptation strategies requires strengthening of the institutional and financial capacity of stakeholders to deliver adequate incentives schemes to farmers. This includes further investments in the provision of timely extension advice, accurate and reliable early warning information, but also broader revisions of the land use policy, to reflect the need of addressing unsustainable cultural practices (e.g. overstocking). However, the capacity of these institutions to effectively deliver the services is constrained by limited funds and human resource capacity.

List of acronyms

ADS	Anglican Development Service
ADESO	African Development Solutions
ASAL	Arid and Semi-Arid Lands
ASDSP	Agricultural Sector Development Support Programme
CNRM	Customary Natural Resource Management Institution
CRS	Catholic Relief Service
DoA	Department of Agriculture
DVS	Department of Veterinary Services
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Programme
KCA	Kenya Camel Association
KCSAP	Kenya Climate-Smart Agriculture Project
KDLDP	Kenya Dryland Development Programme
KFS	Kenya Forestry Service
KLIP	Kenya Livestock Insurance Programme
KLMC	Kenya Livestock Marketing Council
KMD	Kenya Meteorological Department
KRC	Kenya Red Cross
KWS	Kenya Wildlife Service
MoLAI	Ministry of Lands, Agriculture and Irrigation
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoWI	Ministry of Water and Irrigation
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NDMA	National Drought Management Authority
NEMA	National Environmental Management Authority
RUA	Rangeland Users Association
SNV	Netherlands Development Organization
UNDP	United Nations Development Programme
VCC	Value Chain Commodity
VSF	Veterinaires Sans Frontières
WFP	World Food Programme



Agricultural context

Economic relevance of farming

Isiolo County covers an area of approximately 25,700 square kilometers (km²) and is located in the lower eastern region of Kenya. It borders Marsabit County to the north, Samburu and Laikipia Counties to the west, Garissa County to the southeast, Wajir County to the northeast, Tana River and Kitui Counties to the south, and Meru and Tharaka Nithi Counties to the southwest (GoK, 2013) (See Annex 1 for a description of the administrative division of the county).

The county is hot and dry in most months of the year with two rainy seasons. The short rains season occurs in October and November while the long rains season occurs between March and May. The scarce rainfall in the county is an average of 580.2 mm per annum with November and April being the wettest months receiving 149 and 143 mm respectively. The erratic and unreliable rainfall cannot support crop farming which partly explains the high food insecurity and poverty levels in the county (GoK, 2013).

It is one of the counties earmarked for development under the Kenya Vision 2030 programme which aims to transform Kenya into a middle income country by 2030, with plans to develop Isiolo town into a 'resort city' to boost tourism to the area². Almost 80% of the community's income is sourced from on-farm activities (GoK, 2014). More than a half of the households' agricultural income (54%) is related to livestock production. Slightly more than half of the male- and youth-headed households (57% and 56%, respectively) are engaged in agriculture, compared to only 39% of the female headed households (GoK, 2014). The youth provide the largest share of hired labour in livestock production, while adult men are mostly engaged in crop production. Women farmers mainly grow annual food crops such as cowpea, green grams, beans, maize, tomatoes and onions.

In 2012, earnings from major value chain products³ were estimated at about 1.7 billion Kenya shillings (KES). In 2013, the crop production area was estimated at 1,497 hectares (ha) and is expected to increase to 3,000 ha, once the Rapsu and Makadaka irrigation schemes are completed by end of 2017 (GoK, 2013). In 2014, the

total estimated household income was KES 206,056, with an annual per capita income of KES 34,343. In the same year, average annual per capita gross wealth was KES 76,579 (obtained from crop sources), while the daily per capita income was estimated at KES 94. Youth and male-headed households tend to earn more income compared to female-headed households (KES 111, 95 and 47 respectively) (GoK, 2014).

People and livelihoods

The latest population census conducted in 2009 estimated a total number of 143,294 people living in Isiolo County, as well as an average population growth rate of 1.47% by 2018⁴. The population consists largely of Cushite communities i.e. the Oromo, Boran, and Sakuye; the Turkana; the Samburu; the Meru; the Somali and other populations migrating from other parts of the country. Most of the communities (approximately 59%) reside in the rural areas. The urban population is expected to increase in number once the Lamu Port South Sudan Ethiopia Transport (LAPSSET) Corridor⁵ is finalized.

The main livelihood activities in the County are livestock keeping (mainly through nomadic pastoralism), subsistence crop farming, and - to some extent - mining (particularly sand harvesting), Trading in urban and peri-urban centres, and Charcoal burning in Wambara, Burat and Kinna wards. Mainly pastoralists (especially by the Boran and Sakuye, Turkana, Samburu, and Somali populations) for milk, meat, eggs, hides, and skins keep goats, camels, cattle, and poultry. Milk is produced by local cross-breeds and exotic cattle, local goats, exotic/dairy goats and camels. Agro-pastoral populations mainly practice crop farming (maize, bean, tomato, green gram, cowpea, onion, and kale) across the County, where rainfall can support crop growth and under irrigation along various rivers (GoK, 2013).

Production of crops is more common among female-headed households (20% of all female-headed households), compared to youth-headed households (18%) and male-headed ones (6%). All gender are involved in commercial crop production (marketing)⁶. The youth also tend to be more engaged in improved pasture/forage production (13% of all youth), compared to men (2%) (GoK, 2014). Female-headed households are the groups most affected by food shortages and

2 <http://www.vision2030.go.ke/>

3 Including camel milk, goat meat, poultry, and green gram.

4 The growth is mainly attributed to a decline in mortality rates and the development of Isiolo town into resort city.

5 The corridor is expected to link Kenya, Ethiopia, Uganda, and South Sudan, and involves the construction of railways, highways, international airports, resort cities, crude oil pipeline, and oil refineries, among others.

6 More exactly, around 18 % of men farmers and 16% of youth farmers in the County.

malnutrition, due to low access to productive inputs and land, lack of adequate access to clean drinking water, and increased workload, which affects maternal and child health. The prevalence of child wasting is estimated at 3%, while child stunting rates reach 19% (GoK, 2013).

The County is characterized by a very high poverty rate (72.6%)⁷ and over-reliance on relief food (GoK, 2014). Unemployment, low literacy levels⁸, and exposure of the population to climate hazards explain high poverty incidence. Food insecurity in the County is largely driven by low agricultural productivity, prolonged drought and high temperatures, low and erratic rainfall, periodic outbreaks of livestock pests and diseases, poverty, and conflicts. The County's main source of energy is wood fuel, with over 85% of the households relying on firewood/charcoal as their main source of energy (GoK, 2013).

Of the 31,326 households in Isiolo County, only eight percent (approximately 2,500) have access to grid electricity. For lighting purposes, approximately 42% of households use petroleum products, nine percent use wood fuel and 14% use solar (KNBS, 2009; GoK, 2013). As the County receives more than nine hours of sunshine per day, it has a huge potential for harvesting and utilization of solar energy. Potable and piped water is accessible to only 35% and six percent of the residents, respectively. The distance to the closest water source is, on average, five km⁹. Most communities depend on water pans and boreholes for domestic and livestock water supply since most rivers are dry. Each year, households in water-stressed areas in Oldonyiro, Merti, Sericho, Cherab and Garbatulla rely on as little as eight litres of water per person per day. Water availability and access is expected to aggravate in future, as many of the water resources are increasingly drying up due to high evaporation rates (NDMA, 2017).

Agricultural activities

Isiolo County is generally an arid and semi-arid area with low-lying plains on most parts of the region. 80% of the land is non-arable (22,000 km²) and is used for grazing while agro-pastoralism is practiced in a few areas. Isiolo is classified as 100% arid and semi-arid, covering three agro-ecological zones (AEZs): semi-arid (5 percent of the total land in the County), arid (30%), and very arid (65%) (Herlocker et al. 1993; Sombroek

et al. 1982; GoK, 2013). Some of the characteristics of these AEZs are discussed below.

- **The semi-arid zone** (Zone V) covers part of Wabera Ward, Bulla Pesa Ward, and some parts of Burat Ward in Isiolo North Constituency, and southern parts of Kinna Ward in Isiolo South Constituency. This zone receives between 400 and 650 mm of rainfall annually¹⁰ and the vegetation mostly consists of thorny bush with short grass. The main crops grown in this zone are Maize, beans, cowpeas, green grams, onions, tomatoes, mango and pawpaw.
- **The arid zone** (Zone VI) covers Oldonyiro, Ngare Mara, some parts of Burat Wards in Isiolo North Constituency, the entire Garbatulla Ward, and northern parts of Kinna Ward in Isiolo South Constituency. Rainfall ranges between 300 and 350 mm annually and supports grassland and few shrubs. Crops grown in this zone are mainly maize, beans, cowpeas and green grams.
- **The severe arid zone** (Zone VII) covers Chari, Cherab, parts of Oldonyiro Ward in Isiolo North Constituency, and Sericho Ward in Isiolo South Constituency. The area is barren, very hot, and dry most of the year, with annual rainfall averaging 150-250 mm. Such harsh climatic conditions do not favour crop growth in this zone.

Given the aridity of the County, 80% of the land is non-arable and used for grazing¹¹. The erratic and unreliable rainfall cannot support crop farming, which partly explains the high food insecurity and poverty levels among the population in the County. Approximately 12% of arable land¹² was dedicated to subsistence crops and 15% to commercial crop production in 2013 (GoK, 2013). Agro-pastoralism is practiced in a few areas, including Isiolo Central, Merti, Garbatulla, Kinna, and Sericho (GoK, 2013).

Much of the land (80%) is communally owned and is under the trusteeship of the county government. Government land constitutes 10 % of total land and includes land for schools, administration, army barracks, and health facilities. The remaining 10% of the land is under private ownership and was alienated for private investment in housing, industrial and commercial purposes (GoK, 2013). On average, landholding per household amounts to 0.4 ha (1.1

⁷ The national poverty rate is estimated at 46%.

⁸ Only 60% of the population can read and write. School enrolment is at 60%; the rate is higher among men, compared to women (52% and 33%, respectively) (GoK, 2013).

⁹ A water source refers to surface water (e.g. rivers) and underground sources (e.g. boreholes, shallow wells, and earth pans).

¹⁰ This relatively high amount of precipitation is due to influence of Mount Kenya and Nyambene Hills in the neighbouring Meru County.

¹¹ Most of the County's area is devoted to communal grazing (GoK, 2014).

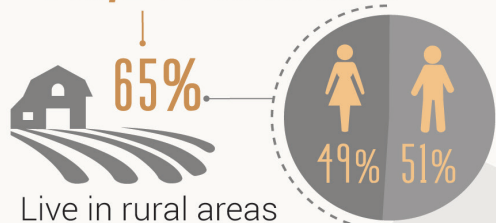
¹² Arable land in Isiolo County was estimated at 3,700 ha in 2013.

Livelihoods and agriculture in Isiolo

Demographics

0.37% Of Kenya's population

143,294 inhabitants



Access to basic needs

71% of the population lives in **absolute poverty**

Potable water 35%

Electricity for cooking 29%

Electricity for lighting 0%

Education (youth literacy rate) 28%

Food security

77% of the population suffers from **food poverty**

ND of household income spent on food

ND People undernourished
19% Children stunted
3% Children wasted

ND: No data

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

Farming

County's farming area

3,700ha

14%

8% of the population employed in agriculture production

0% of farmers have title deeds ND are women

Farming activities

Food crops



Cash crops



Livestock



40%

ND

Of county's agricultural land

1 Group ranches

1 Company ranches

Farming inputs

Water uses



ND



ND



ND

Fertilizer types (% of households)



4% Organic manure

4% Planting fertiliser

1% Top dress fertiliser

Pesticide types (% of households)



6% Field pesticides

3% Storage Pesticides

3% Herbicide

acres), out of which 65% is homestead. At least seven percent of the households have title deeds, while 82% hold the land without any formal document¹³ (i.e. title deed); almost two percent of the farmers lease the land. There are few cases of landlessness, mainly among poor, immigrant communities in urban centres.

Most irrigation schemes are found along the main rivers, namely Ewaso Ngiro, Isiolo, and Bisanadi, where smallholder mixed farming is practised. Roughly seven percent of the farmers' practise irrigation farming (GoK, 2014). Rain fed crop production is common in Bulla Pesa, Wabera, and Kinna wards where the black cotton soil can retain moisture long enough to allow for crops to mature. At least 40% of the grain farmers use both local and improved seeds¹⁴. The amounts of inputs such as seeds, planting materials, fertilizers, organic manure, herbicides and pesticides used were very low in the various annual and perennial crops like beans (common), cowpeas, grain maize, onions (bulb), sorghum, Sukuma Wiki/kale, tomatoes and watermelon.

There is no reported use of yield enhancing inputs in perennial crops in Isiolo County. While planting materials and irrigation water have adoption rates higher than 10%, management practices such as the use of fertilizer, herbicides, are limited among farmers. For livestock production, input use is also low, with the exception of de-wormers (40% of the farmers), acaricides (40%), and other veterinary drugs (37%) (GoK, 2014). Low agricultural inputs use in the County is explained by high prices, unavailability on the market, long distances to input market, and lack of timely access to inputs (GoK, 2014).

Agricultural value chain commodities

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), resilience to current weather variability and future climate change¹⁵, and the number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor¹⁶). The VCCs selected are: Camel milk, Goat meat, Poultry and Green grams¹⁷. The VCCs were selected mainly for their economic importance, and notable resilience to climate variability and change.

Camel (milk)

Camels (*Camelus dromedarius*) are multipurpose animals increasingly kept for milk and meat. As highlighted in the ASDSP, camel milk is one of the most strategic value chains in Isiolo (GoK, 2014), being a major source of food security and income for the County's population and holding a significant cultural value (Mwaura et al, 2015). The product contributes up to 50% of the total household nutrient intake and 30% of the annual caloric intake. There are approximately 39,084 camel heads¹⁸ in the greater Isiolo area, yielding roughly 22,500 litres of milk per day; out of these, only about 4,500 litres of raw milk are supplied to the main East Leigh market in Nairobi accounting for 70% of marketed camel milk (Mwaura et al. 2015). The rest is sold on the local market in Isiolo town¹⁹ or aimed for household consumption.

The value chain characterization in Isiolo County shows that up-to 20% of the population is engaged in the camel milk value chain. In the provision of seeds and other inputs stage, the types of actors in the value chain are the service providers at medium scale, and suppliers at small scale. The importance of all gender groups in the value chain is generally the same.

¹³ Approximately 84% of the male-headed households, 77% of the female-headed households, and 81% of the youth-headed households do not have title deeds for their lands.

¹⁴ Cowpeas, onions and tomatoes are almost exclusively grown from improved seeds.

¹⁵ 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.

¹⁶ Categorization of "poor" people was based on perceptions of workshop participants and not on standard poverty-measuring indices.

¹⁷ Rice was identified also as an important cereal after maize, and with a lot of potential in terms of nutrition and returns to farmers.

¹⁸ Farmers in the County use Somali, Rendille/Gabbra, and Pakistani breeds, which yield approximately 5, 3, and 10 litres (l) of milk per day, respectively. The live weight of these breeds can reach 450-700 kg in the case of Somali breeds, 300-450 kg for Rendille/Gabbra, and 400- 600 kg for Pakistani camel breeds.

¹⁹ Isiolo town represents the main bulking, cooling, and trading centre for camel milk.

The types of actors in the value chain at the on farm production stage are the service providers at small scale, and farmers at large scale. The importance of women in the value chain is low.

Harvesting, storage and processing stage, the types of actors in the value chain are the service providers at medium scale, and processors at large scale. The importance of women in the value chain is very low.

At the product marketing stage, the types of actors in the value chain are the service providers at small scale, and wholesalers/retailers at medium scale. The importance of women in the value chain is low.

Production occurs in four main clusters, based on milk yields: The Mlango-Ngarentare-Burat cluster in Central Isiolo, the Kulamawe cluster in Kinna, and two minor clusters in Modogashe-Eldera in Sericho and Boji-Galfarsa-Malkadaka in Garbatulla. Only two of these clusters, the Central Division and Kulamawe are significantly developed and operating at meaningful levels of commercialization. The two clusters mainly contribute the bulk of camel milk traded in Isiolo town having a total camel population of 6,000 largely Somali breeds, in Kulamawe and 9,000 in Isiolo Central respectively. Of the total volume of camel milk that enters Isiolo Town from Isiolo Central and Kulamawe production clusters, camel milk traders and businesses within Isiolo Town handle an average of 3,422 liters daily in the dry season and 4,532 liters in the wet (Mwaura et al., 2015).

The Isiolo camel milk value chain is associated with a number of risk factors. Among the risk factors include poor personnel hygiene, inadequate cleaning and sanitation of milk handling containers, lack of potable water for cleaning of milking containers, poor camel health management, unfavorable high ambient temperatures, longer time taken for milk to be cooled at cooling facilities. Strategies to improve pastoralists' income and livelihoods from camel milk should therefore focus on innovative ways of reducing camel milk contamination, spoilage and post-harvest losses along the camel milk value chain. This can be achieved through well-tailored hygiene and food safety education aimed at improving pastoralists' knowledge on food hygiene and sanitation and hence improved quality and safety of marketed milk (Odongo et al., 2016).

In an effort to address these challenges, marketing groups, in collaboration with Kenya Camel Association (KCA), Kenya Livestock Marketing Council (KLMC), Netherlands Development Organization (SNV), KALRO and Veterinaires Sans Frontieres Suisse (VSF-Suisse), train milk producers and traders on hygienic camel milk handling practices, and promote the use of aluminium cans (instead of plastic containers²⁰), and value addition through yoghurt and cheese.

Green gram

Green gram is a short duration crop, mostly used in intercropping systems. The crop plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. In Isiolo County, the crop is produced exclusively by smallholders for household consumption, and, to some extent, for markets. Production occurs mostly in the semi-arid areas of the County²¹, but also under irrigation schemes along the main rivers or under rain fed systems.

Long rain season planting starts in March and ends in May with harvesting taking place in July-August and the short rain season is from October to December with harvesting taking place in January and February. There are two main varieties are the local Green gram variety which is small and ripens unevenly while the improved variety K26 has bigger seeds and tends to ripen uniformly.

In 2014, the area under green grams was approximately 60 ha, with a production of 359 (90 kg) bags in total (GoK, 2015).

The value chain characterization in the County shows that, between 41- 60% of the population is engaged in the green gram value chain. In the provision of seeds and other inputs stage, the types of actors in the value chain are the service providers at large scale, and suppliers at small scale.

On farm production stage, the types of actors in the value chain are the service providers' at large scale, and farmers' at medium scale. The importance of women in the value chain is low while all genders importance is low.

Harvesting, storage and processing stage, the types of actors in the value chain are the service providers' at large scale, and processors' at small scale. The

20 Plastic containers are more difficult to clean and therefore cause milk spoilage.

21 In these areas, green gram yields are not significantly affected by periodic droughts, as the crop is drought-tolerant and suitable for dryland farming.

importance of women in the value chain is very low while all genders importance is medium scale. At the product marketing stage, the types of actors in the value chain are the service providers at small scale, and wholesalers/retailers at medium scale. The importance of women in the value chain is high while all genders importance is medium scale.

The crop's sweet, sticky secretion attracts a host of insects; therefore, pest control is very important for high grain quality. Various diseases whose incidence is influenced by management practices such as late planting, use of infected seeds and other cultural practices including intercropping with cereals and other various crops also affect green grams. Clear sanitation and proper plant protection measures must be followed in order to avoid the infestation of pest and diseases. Some of the notable key pests are Thrips, Aphids, and Pod borers, White flies, Caterpillars, Foliage beetle and Weevils. The diseases are Powdery mildew, Yellow mosaic virus, and Rust. The conventional control measures are application of pesticides like Thiodan, Karate, Duduthrin, Thiodan, Bestox, Actellic super and Sherpa plus. Local farmers have also over the years developed traditional strategies and generated knowledge to manage pests and diseases. This involves use of wood ash, animal dung, different herbs (botanicals), dust, sand, smoke, sun drying and oil treatment, among others.

The National and County government (the Ministry of Agriculture, Livestock and Fisheries) in collaboration with other partners offer seeds, technical advice to the farmers on input utilization, good agronomic and storage practices through various capacity building platforms The key market channels for the crop are brokers and institutions.

Chicken (local)

Poultry rearing in Isiolo County is rapidly being embraced as a cost effective alternative for white meat in the growing emerging centers and towns in the county. There is a consumer preference for indigenous chicken especially among the health conscious emerging middle-income earners. Indigenous (local) breeds represent 80% of the chicken population in Isiolo County. The chicken production systems in Isiolo include extensive or free range systems, semi-intensive systems and intensive systems. Constraints to production include diseases, predators and poor nutrition. Indigenous chicken can be profitable if managed well. Control of common diseases in the free-range system could improve survival rate of chicks by at least 30% while improved feeding, housing and

disease control could increase survival rate to 80%. On average, each household holds at least 100 birds. In 2015, slightly over 30,000 poultry were registered and annual poultry meat production was estimated at 21,307 kg, which were valued at approximately KES 85,227 billion (GoK, 2014).

The value chain characterization in the County shows that, between 61- 80% of the population is engaged in the local chicken value chain. In the provision of seeds and other inputs stage, the types of actors in the value chain are the service providers at medium scale, and the suppliers. The importance of women in the value chain is at medium scale while all genders (Youth, Men and Women) importance is low.

On farm production stage, the types of actors in the value chain are the service providers at small scale and the farmers at small scale. The importance of women in the value chain is high while all genders importance is medium scale.

Harvesting, storage and processing stage, the types of actors in the value chain are the service providers' and the processors'. The importance of women in the value chain is low while all genders importance is also medium.

At the product marketing stage, the types of actors in the value chain are the service providers, and wholesalers/retailers. The importance of women in the value chain is very high while all genders importance is medium scale.

The majority of chicken keepers are women, as men tend to be more engaged with cattle, camels, sheep and goats rearing. In the local poultry value chain, the farmers mainly engage in feeding, cleaning, vaccination, slaughtering, processing, collection, transportation and wholesaling. The role of women in poultry management is significant through provision of basic care. Income from the sale of chicken and eggs is also used to purchase food that the households do not produce on their farms, supporting food security and meeting other household needs. Households sell the chicken to traders (who bulk them and transport to Isiolo town) or consume them in the household, given the important protein content found in eggs and meat. Given limited knowledge, equipment and financial resources, value addition activities are limited to de-feathering, and boiling. The County and national government provide extension services related to disease control and vaccination and ensure quality of the chicken-related products on the market.

Pests and disease management is important in local chicken farming. Important diseases include: New Castle Disease, pullorum disease, coccidiosis and fowl typhoid. Pests and diseases can be controlled through vaccination e.g. the Thermostable New Castle Disease vaccine – Avivax I and strategic worm control. Pests and diseases can also be managed through improved sanitation, eggs and nest fumigation using formaldehyde pellets in the nest.

The National and county government through the (MoALF), NGOs and other development partners plays an important role in the value chain, providing extension services and technical support. This includes improved feeding, housing, disease control, and marketing. NGOs such as REGAL-IR, a USAID-funded project promoting resilience and economic growth in the arid lands to support farmers with capacity building on poultry keeping and business management. REGAL-IR is supported 2000 poultry projects in Isiolo County, helping communities build resilience through enhanced livelihood diversification²².

Goat (meat)

The pastoral meat sector, especially goat, makes a significant contribution to the economy of Isiolo. Goats have short-generation intervals and high adaptive capacity to harsh conditions. They play a seminal role in the food security and income of pastoral households. About 75% of the County's households keep goats. In 2014, the goat population was estimated at approximately 262,205 heads²³. Annual chevon production is estimated at 212,733 kg, worth KES 85.093 billion (GoK 2014).

About 61- 80% of the population is engaged in the goat meat value chain. In the provision of seeds and other inputs stage, the types of actors in the value chain are the service providers and suppliers both operating at small scale. The importance of women in the value chain is at very high scale while all genders (Youth, Men and Women) importance is medium.

On farm production stage, the types of actors in the value chain are mainly the farmers at large scale. The importance of women in the value chain high.

Harvesting, storage and processing stage, the types of actors in the value chain are the service providers at small scale. The importance of women in the value chain is generally low.

At the product marketing stage, the types of actors in the value chain are the service providers at medium scale, and wholesalers/retailers at small scale. The importance of women in the value chain is very high.

The main goat breeds in the County include the Galla and the Small East African goat, which reach a live weight of approximately 50 kg. Goats are sold both to local butcheries and to markets outside the County (e.g. Meru, Laikipia and Nairobi). Value addition activities undertaken by farmers include meat smoking and drying ('nyiri nyiri'). The later involves frying of the meat in ghee and spices (cardamom and garlic), enabling storage for several months without refrigeration. Though *nyiri nyiri* is offered at mainly in traditional ceremonies, the local and international demand for it has increased significantly. However, strict regulations regarding the sourcing of meat from disease-free areas prevent many households and traders from selling the product in regulated, formal markets.

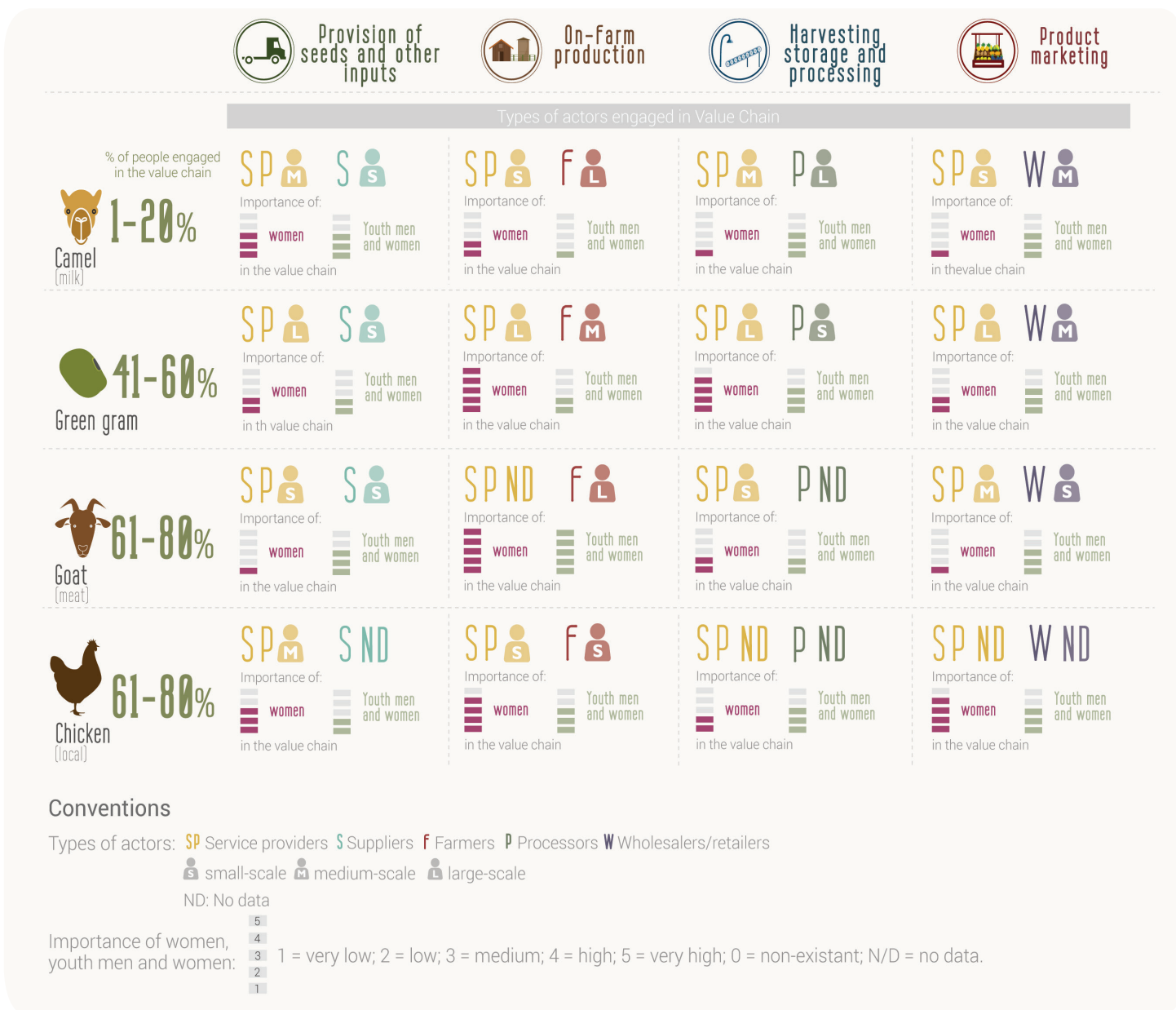
The Department of Livestock Development, NGOs and development partners plays an important role in the value chain, providing vaccinations for disease control²⁴. Development partners and NGOs such as the Action Aid, ADS, Caritas, CRS, International Livestock Research Institute (ILRI), Kenya Red Cross (KRC), the United States Agency for International Development (USAID), the World Food Programme (WFP) and, VSF-Suisse contribute to funding of programmes and projects in the county, injecting new resources in form of credit, grants and material support. They also contribute to strengthening delivery of livestock health services, livestock disease control, livestock products value addition, improvement/construction of abattoirs, and livestock disease surveillance. In addition, they do capacity building of extension staff and households on disaster prevention awareness and early warning system through various platforms.

²² <http://adesoafrika.org/regal-ir/updates/updates/chicken-are-new-employers-in-isiolo-town/>

²³ Goat production is most common among women and youth.

²⁴ Integrated disease-control packages formulated and promoted by the government include the East Coast Fever (ECF) vaccine and the thermo-stable Peste des Petits Ruminants (PPR) vaccine.

Agricultural value chain commodities in Isiolo



Agricultural sector challenges

Agricultural production has declined over the years due to the erratic and unreliable rainfall, increasing temperatures, poor soil fertility, poor production practices, low investments in efficient technologies, dependency on (relief food supply) among other factors. Drought has been a major contributor to crop and livestock losses, natural resource depletion and degradation, income losses for households, famine and malnutrition. The projected demographic rise in Isiolo's human population to 191,627 by 2017

is expected to trigger increased demand for food products, both from livestock and crops. High demand in turn exerts pressure on the factors of production, such as natural resources, which may result in their degradation. Changes in land use, such as the establishment of conservancies, the mushrooming of new settlements and trading centers, and the spread of farming along the Ewaso Nyiro river basin, are already driving the fragmentation of rangeland in certain areas. As a result, the movement of livestock is being restricted, leading to localised degradation of rangeland resources (GoK, 2016).

Agricultural production in the County is also challenged by competing demands for and conflict over natural resources use. Cases of livestock invading croplands, especially during dry spells, are very common. In particular, the migration of camels is always associated with conflict because they are often left to roam and therefore graze on any available vegetation, foraging on food crops, reserve pastures, and live fences (fences made of thorny plants). As a result, crops are destroyed and human lives and livestock are sometimes lost.

Crops have become more vulnerable to pest attacks and diseases such as aphids, thrips, *Tuta absoluta*, weevils, powdery mildew, yellow mosaic virus and rust associated with higher temperatures and low rainfall, causing losses in crop yield and harvest quality and sometimes leading to total crop failure. Farm produce is lost or spoiled mainly due to harvesting too early or late, exposure to rain, drought and extreme temperatures, pest and disease damage, and physical damage from inappropriate handling. The rate of deterioration is highly influenced by factors and practices that increase product exposure along the value chain to extreme weather, pests, and physical damage. Consequently, food prices continually increase thereby eroding household's purchasing power.

The long distances between grazing areas and water sources²⁵ and endemic livestock diseases have continued to reduce livestock productivity. There were several incidences of infection and death of goats from sheep and goat pox in Isiolo North sub-county. Other diseases reported during the period under review were Contagious Caprine Pleuropneumonia (CCPP), Trypanosomosis, and Heart Water diseases, which are endemic across all livelihood zones. Water shortages were severe in Sericho, Merti and Garbatulla, Shallow wells that were in use dried up in Bassa, Dakiye and Malkagalla and people and livestock are facing severe water shortages (NDMA, 2017).

Poor infrastructure like poor roads network limits the ability of extension workers to reach households in a consistent and timely manner, and makes access to markets more difficult. This leads to higher transportation costs, which, in turn, drives up prices of food and other basic commodities. Lack of adequate storage or value addition facilities (e.g. abattoirs) has forced farmers to sell raw products (milk, meat) to middlemen at very low prices and, in many cases, has led to post-harvest losses due to perishability of such products.

In addition, the current land tenure regime, based on principles of non-excludability²⁶ and free riding²⁷, does not stimulate long-term investments and conservation measures, such as agroforestry. The social norms and beliefs, exacerbated by low literacy levels, also hinder agricultural development. Livestock has a strong cultural value, being considered a wealth indicator. Keeping large herds is also a means for gaining social status, not just income, yet in times of dry spells, this can come in the detriment of those pastoralists who refuse to sell part of their livestock, increasing their vulnerability.

Credit and insurance access is also very low, not only due to the few financial institutions that offer such services, but also to the low cultural acceptance of such services (especially livestock insurance) and other new technologies and innovations. Over-reliance on livestock production has hindered optimal land utilization as lots of land is preserved for pasture despite the low milk production from livestock. Livestock production has also led to anxiety between agro-pastoralists and pastoralists due to competition for pasture, land and water resources.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

Isiolo's CIDP, (2013-2017) recognizes that the county is one of the most vulnerable counties to climate change in Kenya. Some of the key vulnerabilities emanating from climate change include drought and unpredictable rainfall, floods, spread of water- and vector-borne diseases, intra and extra conflict among the agro-pastoralist and the pastoralist, wildlife-farmers conflict, loss of forests and wetland ecosystems, land degradation, desertification and scarcity of portable water. These effects impact negatively on the economy of the county leading to reduced crop yield, low livestock productivity, high livestock mortality, loss of income for farmers, famine and malnutrition.

The county has a generally hot and dry climate throughout the year. Most of the county has mean annual temperatures greater than 25°C however mean annual temperatures in the western extremities do fall to as low as 21°C with variations in some places due

²⁵ The average water distance in pastoral livelihood zones was 10km while the distance was 7.2km in the Agro-pastoral livelihood zone by June, 2017.

²⁶ Refers to the impossibility to restrict utilization of a resource to some individuals or groups only.

²⁷ Occurs when some individuals refuse to participate in conservation but still benefit from the efforts of other people.

to altitude. There is a north-eastern to south-western gradient of increasing precipitation with the south-eastern parts of the county receiving mean annual rainfall predominantly below 250mm per year, the central areas receiving between 250mm and 500mm per year and the south-eastern parts receiving between 500mm and 750mm per year. As such, dry spells, heat stress, and drought are hazards that strongly contribute to agricultural risk in the county, especially in the northern and eastern parts.

In February 2017, the National Drought Management Authority (NDMA) indicated that up to 80,000 residents of the county were in need of food aid as a result of drought²⁸, and cases of conflict over water and pasture were reported during the period as a result of scarcity of the two resources²⁹. Although drought and heat stress remain the main hazards for the county, the occurrence of intense precipitation does sometime result in flash floods, especially in the low lying plains of the county.

Analysis of temperature trends in the county over 25 years (1980 to 2005), showed an increase of about 0.5°C in the mean temperatures of both seasons. On the other hand, analysis of rainfall, measured over a 35-year period (1980-2015), showed little change in rainfall amount with average first season rainfall remaining fairly constant and average second season rainfall increasing only moderately (≤ 25 mm). The combination of the moderate increase in temperatures and the relatively unchanged precipitation have resulted in an increase in the number of heat stress days in both seasons, as well as an increase in drought risk for the first season.

Looking ahead to the period 2021-2065, climate projections based on two representative concentration pathways (RCPs³⁰) indicate that temperatures in both seasons are expected to continue to increase with the rise being greater under the high emissions scenario. While heat and drought stress have been indicated as the main hazards for Isiolo, under both scenarios the number of heat stress days³¹, compared to the historical average, are expected to reduce, while the maximum number of consecutive dry days are expected to remain reasonably constant for both seasons. Under the high emissions scenario, rainfall is expected to reduce and

moisture stress³² expected to increase particularly in the second season. Under the conservative emissions scenario, a decrease in rainfall intensity for both seasons is expected, although both moisture stress and dry spell duration are also expected to reduce in the first and second season respectively. An increase in season length is also expected for both seasons under the conservative GHG emissions scenario although a reduction in length expected under the high emissions scenario.

Climate Perceptions by the farmers

Farmers' perceptions on climate may be influenced by notable more recent climate trends such as the prolonged droughts, unpredictable rains and rising temperatures. From the farmers' perspective there has been a remarkable variation in the climatic conditions in Isiolo County over the years. The most common changes cited include warmer temperatures, erratic rainfall, water scarcity and prolonged drought periods that occur after every two years. In terms of perceptions of long-term change in climate, an overwhelming majority of farmers perceived an increase in average temperatures and a decrease in average precipitation.

Farmers indicated that the weather has become more unpredictable than in the past, mostly as a consequence of human activities and land degradation. Major climate change and variability hazards noted by farmers include prolonged drought periods where the water sources (e.g. shallow wells, boreholes, water pans and rivers) become totally depleted and high temperatures generate heat stress that destroys crops and pastures. As a result of the continuous drying up of water sources, women have to travel longer distances to fetch water, compared to previous years³³. The heat stress suffered by animals also reduces the rate of animal feed intake and results in poor growth performance and low production of milk and meat. Changes and variations in climate have posed important economic and social consequences. Farmers report that the rains have not only decreased but have also changed patterns. Dry spells have taken over the 'long rains' season, normally expected from March to May and October to November, turning livestock migration to neighboring counties into a necessary survival strategy.

28 <http://reliefweb.int/report/kenya/drought-leaves-over-80000-isiolo-need-relief-food>

29 <http://www.ndma.go.ke/resource-center/send/15-isiolo/4404-isiolo-may-2017>

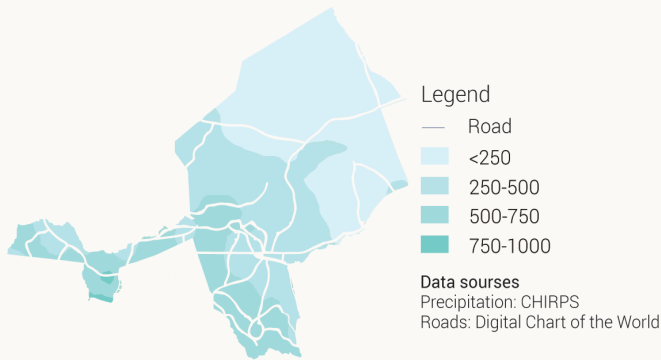
30 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m², respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible 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.

31 Indicated by the number of days with T_{max} greater than 35°C

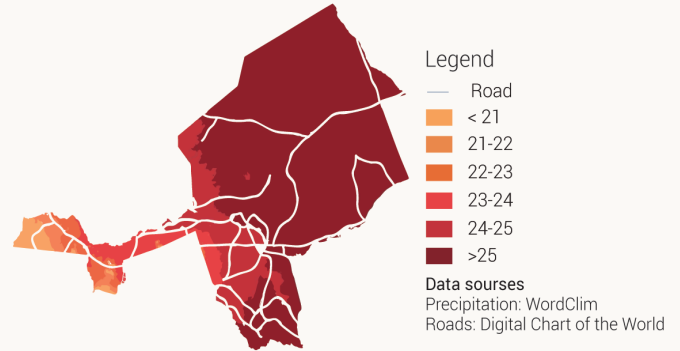
32 Indicated by the number of days with ratio of actual to potential evapotranspiration ratio below 0.5

Past and future impacts of climate hazards in Isiolo

Historical annual mean precipitation
(mm/year)

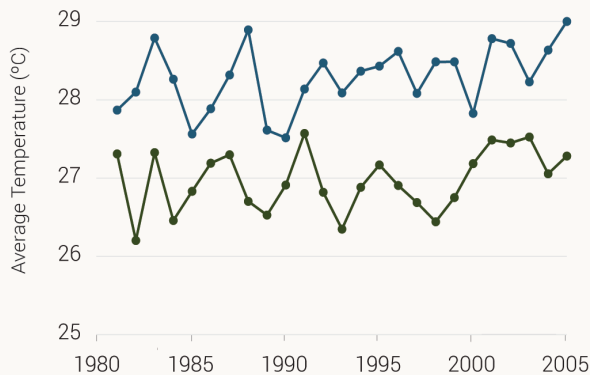


Historical annual mean temperature
(°C)



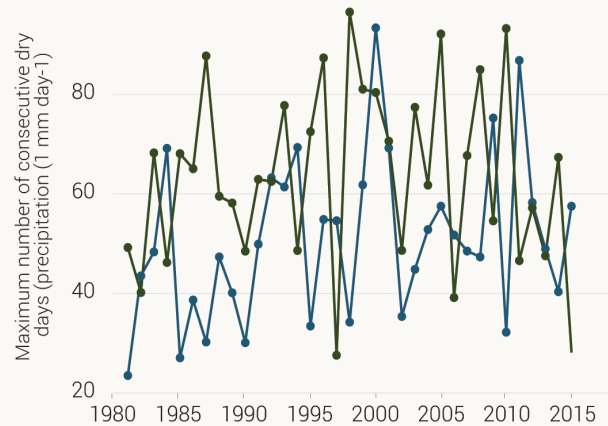
Heat stress hazards

Historical extreme heat stress events

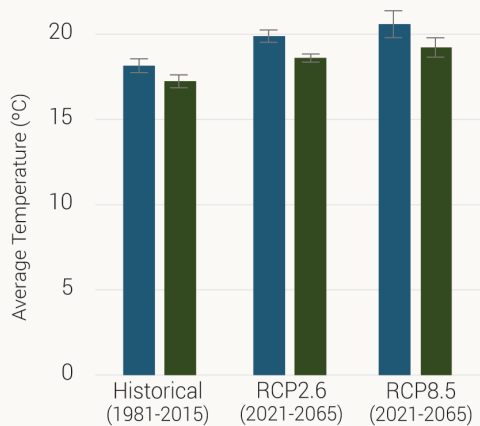


Drought hazards

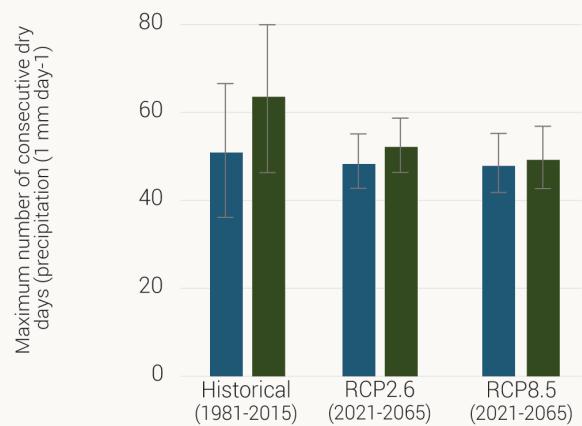
Historical drought stress events



Historical and expected extreme heat stress events



Historical and expected drought stress events



Frequent crop failures as a result of droughts or high temperatures increase household's susceptibility to food insecurity and poverty. Due to high evaporation rates as a result of high temperatures, there is need for supplemental irrigation for food crop production.

Due to low, unsustainable incomes from agriculture, women engage in other income-generating activities such as charcoal burning, whereas men and youth migrate to urban centers in search of employment. These changes have resulted in family disintegration and higher school dropout rates among the youth and children. Increased and uncontrolled charcoal burning has led to deforestation, environmental degradation, worsening the impacts of climate variability. The effect of climate change has seen an increasing number of families lose their entire herds to droughts, forcing them to settle for relief food. These are expected to impact negatively on the economy of the county, leading to reduced livestock and crop productivity, high livestock mortality, loss of income for community members, famine and malnutrition.

Climate vulnerabilities across agriculture value chain commodities

Climate change is bringing both opportunities and threats to the county. The main opportunity is a possible increase in the resources that support crops/livestock value chain, such as water and forage, which also allows some cultivation during the rainy seasons, resulting in increased production and productivity. The main threats include the outbreak of pests and diseases, an increased risk of flooding resulting in damage to infrastructure and property, and prolonged drought with its impacts on crop failure and livestock mortality, degradation of rangeland resources, and morbidity. Expected future climate change and variation pose serious threats to the value chain commodities prioritized for analysis in this study. Drought and high temperatures were identified as key hazards, both currently and in the future. These hazards affect the prioritized value chain commodities differently as detailed in the following discussion.

Camel (milk)

Camels are a key pastoral asset, given their ability to adapt to and survive harsh climatic conditions. Notwithstanding, it has been noted that low and poorly distributed rainfall and higher temperatures have affected milk yields significantly, as a result of lower quality fodder crops and reduced quantity of water for livestock, especially during dry spells. Pastoralists

are increasingly producing milk for the subsistence as well as for market contributing to the growth of a production subsector with notable resilience to climate variability and change. The major climate hazards affecting camel milk include drought and high temperatures. The vulnerable areas to drought and high temperatures are Isiolo central and the northern part of the county where camel milk value chain is a key economic activity. Prolonged drought and high temperatures lead to reduced pasture for the animals hence milk production is reduced as the body condition of the animals deteriorates.

Milk is more sensitive to high temperatures both at production and value addition (transportation) stages. As a result, milk output is affected, and most milk is often spoilt before reaching the market as refrigeration facilities are not available to households and value addition are limited. Consumers also receive less milk when production decreases as a result of prolonged drought spells. Low milk production affects the food security of households, and especially pastoralists. Transporters are also affected by the decreased demand for transportation.

Drought and high temperature also result in increase in livestock diseases such as Rift Valley Fever, and pests, including ticks leading to animal deaths.

Green grams

Drought and high temperature affect every ward in Isiolo County where green grams are grown. Despite being a heat-resilient crop, suitable for dryland farming, green gram can be adversely affected by drought and high temperatures. Green gram grown during the dry spell is normally of poor grades due to poor germination, flower abortion and withering. The associated consequences include low production that is associated with food insecurity at household level, and poor quality of the product, a factor that impairs marketability. Other challenges associated with drought and high increase in temperatures include: unavailability of, and increased expenditure on production inputs (seeds, fertilizers, water for irrigation); crop failure; increased crop infestation from the incidence of pests; Moreover, high temperatures affect land preparation activities. This is through reduction in land acreage and also the need for more labor since the soil becomes hardened. All genders are affected by these consequences since they all are engaged in the value chain. The underlying factors are that most of the households lack purchasing power due to low income. Women are also more vulnerable since they are involved in most household chore activities.

33 More exactly, the average distance to the closest water point use to be five km in 2013. In 2017, this increased to eight-ten km.

Chicken (local)

In as much as local chicken value chain is rapidly being embraced as a cost effective alternative livelihood and perceived to be resilient to climate hazards, drought and high temperatures affect the local chicken negatively throughout the county. The notable consequences of the drought and high temperatures range from an increase in poultry feed prices and drugs as a result of feed scarcity and households cannot afford to buy them; reduced extension service (households migrate to different places in search of pasture and water hence extension officers cannot locate them), reduced egg production due to high temperature; reduced egg shelf life due to reduced quality of eggs; low volumes in the market- (low turnout of buyers and traders); high prices (law of supply and demand); lack of water for cleaning, and increased incidences of pests and disease causing organisms.

Service providers are also impacted because of infrastructure challenges rendering some areas inaccessible. At on farm production, the key activities/consequences include chicks having heat stress that leads to mortality. This is because the material used to construct the chicken coop is iron sheets, and as a result of heat stress more diseases occur and spread faster. The underlying factors include ignorance, limited extension services and infrastructural issues. Women and youth, remain highly vulnerable to climate impacts on poultry production, given their scarce resources to buy the feeds and limited access to input supplies.

Goat (meat)

The demand for goat meat is predicted to rise dramatically in Isiolo, expanding the existing small ruminant value chain. However, in the goat meat value chain, drought and high temperatures have been identified as the most problematic hazards. The affected areas by these hazards include Isiolo town, Garbatullah, Sericho, Oldonyiro and Merti. These hazards cause water and pasture scarcity, which affects availability of feeds and ultimately leads to lower productivity and animal susceptibility to diseases. Increased temperatures and more frequent and prolonged droughts hinder pasture and herd recovery from previous climate hazards, encouraging herd migration to new, favorable territories.

Moreover, production costs go high, given the high demand for inputs such as feeds, vaccines and veterinary services. The risk of losing livestock significantly increases especially during feeding and transportation due to dehydration. As a result,

households sell their stock at very low prices partly due to weight loss and market over-supply in seasons of feed scarcity. Both hazards trigger higher need for selling goats and increased animal slaughtering to avoid losses as well as increased need for shelter to prevent heat stress. Poorer households especially those with smaller livestock holdings and less-developed social support networks are generally more affected by drought and high temperatures. Women and youth are most hit by these consequences, since they are more involved in goat production.

Adaptation to climate change and variability

The main adaptation strategies Isiolo households are using to cope or mitigate against risks associated with agricultural production and food security are specific to certain value chains whereas others cut across value chains. Following the adverse impacts of the climatic hazards identified along the different value chains, adoption of measures enhancing resilience of the value chains is important. For crop farmers these include improved drought resilient crop varieties; fast growing and early maturing variety of crops; rain water harvesting and conservation; conservation agriculture; crop rotation and intercropping; afforestation and irrigation.

For livestock keepers these include fodder production and conservation; rearing improved breeds; breeding management; and livestock health management. To manage and lessen the effects of climate change, the county must step up efforts towards adoption of renewable and alternative sources of energy. Capacity building on improved crop varieties and livestock breed suitability can be emphasized to enhance technology adoption in the county.

On-farm adaptation practices

Roughly half of the households (about 48%) in Isiolo County have adopted at least one measure aimed at boosting on-farm crop production and improve pastures under adverse climate conditions, according to the ASDSP survey conducted in 2013. The most widely adopted practices for soil and water conservation are irrigation (common among 14% of the households); water harvesting (12%); and value addition (10%). In livestock production, changing livestock type, feed conservation, and water harvesting are most common.

In times of drought and high temperatures, crop farmers also opt for changing the crop type and

varieties they cultivate, including early-maturing and drought-tolerant green gram and cowpea. Soil and water conservation is an important adaptation strategy in the county. This involves preserving soil conditions, maintaining water content through mulching, tree planting and agro forestry, and using manure. High adoption of soil and water conservation measures among the female headed households may be attributed to the fact that women are the ones who are responsible for water harvesting, and more involved in crop farming compared to men who are more likely to move to other areas with livestock in search of water. Given their increased interest in new technologies, youth-headed households are more likely to adopt such measures compared to male- and female-headed households. Nevertheless, unavailability of improved seeds and high prices are key barriers to uptake.

Livestock keepers establish water pans, drill boreholes or keep more resilient livestock, such as camels, local chicken and goats. In other cases, they move their livestock towards riverine areas or other counties so that they have better access to water and pastures. To address the problem of feed shortages occurring during the dry season, some households undertake grasslands rehabilitation through reseedling, establishment of irrigated pastures, and fodder harvesting and conservation.

Mass vaccination of livestock is another important adaptation strategy for the livestock sector. It is common in the entire county in view of the many livestock disease outbreaks particularly during the dry season. The situation is worsened by in-migration of livestock from neighboring counties. This measure helps reduce the likelihood of livestock contracting diseases as they migrate. In spite of the adaptive measures, there is need to strengthen disease surveillance and establish disease-free zones. This needs to be accompanied with regulation of livestock movement from the neighboring counties.

Value addition is also a common adaptation strategy carried out by crop farmers and pastoralists in the County. It helps increase the shelf life of agricultural products while enabling an increase in farmers' bargaining power especially through activities such as bulking. Value addition also makes households get better prices compared to selling raw products. This includes smoking, drying and frying of goat meat (referred to as "nyirinyiri"), boiling and fermentation of milk, and de-feathering of chicken. Value addition for crop products refers to sorting, grading, transporting, bulking and processing. These are mostly farmer group initiatives. The biggest challenge to value addition

in the livestock and crop sector is lack of capacity in terms of knowhow, equipment, and resources.

The challenge of poor access to markets and low quality marketable products has not been addressed satisfactorily by the on-going adaptation strategies. Households still opt to sell their products individually hence losing on market bargain; there is minimal value addition; and most crop is harvested prematurely. These strategies can be complemented with options such as collective marketing, capacity building households and providing the required resources for value addition, and engaging households in contract farming. Encouraging farmers to organize themselves into groups can also help in reducing the cost incurred in transportation.

On-farm interventions in Isiolo County are mostly geared towards harvesting or conserving water to boost crop production and improve pastures. As water scarcity is a recurrent challenge for crop and livestock households in Isiolo County, water harvesting techniques and irrigation have become widely popular. These include construction of water pans, irrigation canals, shallow wells, water tanks, and de-silting of existing dams to cope with drought and high temperature. Such techniques can be very costly to low-income households, hence financial and technical support is important. This can be achieved by increasing alignment of public and private funds aimed for agricultural development to the sector's needs. This would enable a better functioning of the institutions which currently lack resources to effectively deliver services such as (climate information, extension, veterinary support and subsidies). There is also need for improved weather forecasting. Diversification of food production is also necessary.

Off-farm adaptation practices

In Isiolo County, government institutions and development partners facilitate off-farm services such as early warning systems (EWS), storage facilities, market information, and extension. Early warning systems, for example, enable farmers to know when to plant and when to migrate with livestock, based on information on occurrence of drought, rainfall onset and cessation or floods. Access to such information is facilitated by the National Drought Management Authority (NDMA), Kenya Meteorological Department (KMD), and the Kenya Red Cross (KRC) and dissemination occurs through various channels, including radios, workshops, and trainings.

Department of Veterinary Services (DVS) does mass vaccination of livestock, as livestock disease outbreaks are very common across the County, particularly during the dry season and due to migration of livestock from neighbouring counties. In line with these measures, disease surveillance in the County need to be strengthened and the establishment of disease-free zones encouraged. The DVS also offers artificial insemination services to the livestock keepers. Despite existence of financial institutions such as banks and micro-finances in the county, access to financial credit (loans and insurance) is very low according to the ASDSP survey of 2014. A very small percentage of households accessed credit and savings services. None of the households reported accessing agricultural insurance services. The situation also persists since most of the financial institutions shy away from the ASALs given the high production risks. Limited awareness about credit services (from the side of the farmers and pastoralists alike) is also a contributing

factor. As an alternative option, household members have been seeking off-farm employment opportunities such as sand harvesting business or move to urban centers in search of jobs to mitigate the climate variability risks (GoK, 2014). Forest products like gums and resins also contribute to the household economy.

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

Camel (milk)



Droughts

Reduced vet services due to logistics problem; reduced extension services; increased labor due to pasture and water search

Few animals lactating; less milking; less feeding due to less pasture; less spraying due to less ticks

Reduced milk processing due to reduced milk production; increased transportation cost

Less selling and promotion due to less milk; high demand hence high price

Magnitude of impact

Major

Major

Moderate

Major

Farmers' current strategies to cope with the risks

Mobile vet services; pastoralist buying own drugs; increase in number of herders; advice from more experienced herders; take extension service to pastoralists whenever they are by government and NGOs

Increase food rations for herders by livestock owners; migration to find water and pasture; fodder production; purchase and provision of commercial feed; tick control; avoiding pest infested areas

Sour milk; transport on motor bikes, donkeys, bicycle and human; boiling of milk; use of milk preservation containers

Alternative income generating activities by women; increase milk prices; using designated milk marketing centers; advertising with posters/bill boards; reduced milk consumption

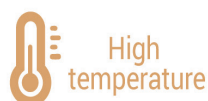
Other potential options to increase farmers' adaptive capacity

Government to deploy skilled personnel; decentralize vet services; proper early warning system by government and provision of commercial feeds in time by the government; government to deploy more extension officers

Proper grazing management; Provision of animal feeds supplement in time; creation of feed storage facilities; development of pasture bulking plots; decentralization of livestock facilities; use long lasting acaricides

Establish processing plants near production areas; source milk from other places; use of pasture production systems; use of latest milk preservation containers; use of proper milk processing methods, yoghurt production; convert into powder milk

Use of mass media; bill boards; product labelling; quality land management; pasture management; selling milk other places



High temperature

Reduced vet services mobility; reduced extension services; increased labor due to pasture and water search

Reduced milk production due to heat stress; animals resting under shed hence reduced feeding; less spraying due to less ticks

Limited processing due to low milk production, spoilage and high bacterial growth; increased costs on refrigerated vehicles

Increased storage cost; more milk spoilage due to heat; less promotion due to less milk production; increased prices

Magnitude of impact

Minor

Minor

Minor

Moderate

Farmers' current strategies to cope with the risks

Refrigerated storage of vet drugs; contact vet and extension services in the mornings and evenings; listen to radio for extension advice; move resting shed for animals

Reduce milking frequency; milk when temperatures are low; graze morning, evening and at night; spray morning, evening and under shade

Collect milk in morning or evening and reduce number of trips; use of modern milk preservation containers; keep milk in the shade

Use of powdered milk; use of other livestock milk; alternative businesses; advertise to contacts and using billboards; reduce volumes used

Other potential options to increase farmers' adaptive capacity







Decentralize and increase number of vet / extension staff; promote private vet services; create extension tent; improve roads; use maintained reliable transport

Create resting sheds; pasture production; capacity building on grazing management; timely provision of animal feed; establishment of cattle dips; buying of spraying pumps

Decentralization of processing plants; provision of storage/preservative chemicals; improve access to refrigerated vehicles; establish more milk cooling centers

Improve local markets and marketing methods; source milk from other areas; proper livestock treatment and feeding; improve road infrastructure

Green grams

	 Provision of inputs	 On-Farm production	 Harvesting, storage and processing	 Product marketing
 Droughts	Farmers migrate to different places in search of pasture; reduced field demonstrations due to crop failure; no water for demonstration plots; reduced procurement for seeds and planting materials due to low purchasing power	Reduced land preparation; reduced acreage for planting; low production; reduced weeding due to crop failure and low production	Food insecure at household level, high commodities price; in-flow from other counties; high transportation cost; reduced collection due to crop failure	High commodity prices due to law of supply and demand; low market linkage; poor grades due to low quality of grains
Magnitude of impact	Severe	Severe	Severe - Major	Moderate
Farmers' current strategies to cope with the risks	Time of operation adjusted; accessing of relief seed; provision of farm inputs by NGOs and government	Conservation agriculture; use of drought resilient varieties; Diversification of crops and livelihoods	Training on appropriate technology; outsource of better and affordable price	Group marketing; bulking, training in marketing, use of ICT (text, WhatsApp, e-agriculture platform)
Other potential options to increase farmers' adaptive capacity	Use of ICT e.g. mass media, mobile phones; continuous use of appropriate technologies; exchange tours; continue encourage saving culture; formation of groups; revised policy focused on ASAL areas	Scaling up of conservation agriculture; use of drought resilient varieties; use of certified seeds; use IPM; use early maturing crops	Introduction of treated sacks instead of direct application of storage chemical; skills development through training; farmers forming groups to cut down transportation cost, government provide transport subsidy	Policy formulation to control essential commodity price; enhance networking and linkages through training; encourage use of machines during
 High temperature	Reduce number of training; drying of seedlings due to high temperature or withering	Low production hence low income; reduced number of land operations; poor germination; withering of crops; Low labour productivity	Difficulty in storage; pest infestation during storage; low transport volumes; mechanical breakdown of equipment due to high temperatures; reduced produce to be collected	High prices for the commodity due to low production; reduced market linkages; reduced grading due to low productivity
Magnitude of impact	Major	Severe	Moderate	Moderate
Farmers' current strategies to cope with the risks	Group procurement of inputs - Farmers group leaders/representatives given enough time to mobilize; provision of seeds by agriculture department/organisations	Communal land preparation; selection of varieties that survive at low moisture content; shorten irrigation intensity; increase frequency of irrigation and use of waste water; decrease land under crop	Spraying with pesticides and use of improved seeds; adjust time of operation (late evening and early in the morning); adjust time of operation (late evening and early in the morning)	Group marketing; Change sales times to coincide with better prices and market demand
Other potential options to increase farmers' adaptive capacity	Conduct trainings in the morning and evening; use of ICT for sharing extension and weather information (mobile phones, ICT platforms); agricultural input subsidies	Promotion of conservation agriculture; capacity building on Integrated Pest and Disease Management (IPDM); Promotion of efficient irrigation	Use of modern harvesting and processing equipment; opening of cottage processing industries in rural areas; plan collection timing with farmers	Formation of ICT platforms for market information; establishment of decentralized market centres

Chicken (local)

Provision of seeds
and other inputs



On-farm
production



Harvesting,
storage and
processing



Product
marketing



Reduced extension services (farmers migrate to different places hence extension officers cannot locate them); reduced vet services; heat stress; low production

Reduced cleaning due to lack of water; reduced feeds availability; commercial feeds become expensive; reduced vaccination due to limited funds

Minimal transportation due to increased conflict among communities (transporting of eggs and chicken is hindered)

Difficulty in linking farmers to buyers; high prices due to the law of supply and demand; low selling volumes due to low purchasing power as a result of lack of funds

Magnitude of
impact

Severe - Major

Minor - Major

Minor

Major-Severe

Farmers' current
strategies to cope
with the risks

Mobile pastoralist training unit (MPTU); community vet health workers, private vets (sidai); use of local materials like sticks and thorns

Water harvesting and storage; water trucking; free range system; use of indigenous herbs e.g. *Alloe vera*, pepper

Sell off the birds; diversify products for storage; peace meeting to alleviate conflicts

Diversify the livelihood e.g. keeping alternative stock; price standardization; import eggs from other counties

Other potential
options to
increase farmers'
adaptive capacity

Adapt demand driven extension; e-extension (mobile); embrace electronic media; mobile vets e.g. sidai; establish a county revolving poultry value chain fund

Water harvesting; conserve catchment areas; feed supplements; free range system; feed formulation; seek/link farmers to financial services providers

Adapt battery cage system; introduction of drought resistant breeds (improved breeds, dual purpose, and rainbow roster); introduce other bird species; strengthen peace committees; preach co-existence; online marketing and selling

Strengthen the market linkages via group formation and trainings; enhance production of eggs through quality feeding and rearing of high breed that are tolerant to drought; bulk selling (sell in group)



Reduced extension services, farmers migrate to different places hence extension officers cannot locate them; reduced vet services; poor housing

Reduced cleaning; multiplication of pathogens, disease causing microorganism thrive well and multiply due to high temperature; low feed intake; low feed intake due to high temperature; vaccines loose viability

Reduced egg collection; reduced shelf life due to reduced quality of eggs; the frequency of transportation is reduced

Reduced linkage of farmers to buyers; low pricing due to high perishability to eggs spoilage; low selling volumes in the market

Magnitude of
impact

Severe - Major

Minor - Severe

Moderate - Minor

Moderate

Farmers' current
strategies to cope
with the risks

Bulk selling (sell in group); use of cool boxes to store vaccines; build well ventilated structures

Culling and spraying; supplementary feeding with multivitamins; use of cool boxes; group vaccination

Eggs collection in the morning and evening; regular disposal; storage in pots; transport very early in the morning to avoid the scorching sun

Sharing information; regular disposal; outsource from other counties

Other potential
options to
increase farmers'
adaptive capacity

E-extension; mobile vet services; training of more community disease monitors; enhance disease surveillance; capacity building on anti-heat agents

Culling; improve enclosure designs (heat resistant); introduce multivitamins and other supplements to increase feed intake; supplement feeding to improve survival

Adapt egg collection patterns; design battery cage technology; research and development on egg storage; adapt egg transportation patterns

Enhance product linkages; enhance market research; bulk selling; import eggs from other counties

Goat (meat)



Provision of seeds
and other inputs



On-Farm
production



Harvesting
storage and
processing



Product
marketing



Intense rains

Reduced financial capital; the banker cannot lend funds due to risk involved; reduced extension services; reduced veterinary services

Reduced feeding due to low pasture production; limited deworming; limited vaccination

Reduced grading; selection for sale and grading is compromised; increased produce losses along the value chain due to dehydration; increased need for storage

Difficulty in linking farmers to buyers; reduced prices; increased slaughtering to avoid deaths

Magnitude of
impact

Moderate - Severe

Moderate - Severe

Minor - Severe

Minor - Severe

Farmers' current
strategies to cope
with the risks

Selling of livestock through off-take; increased use of extension services; community disease surveillance and strategic vaccination

Feed purchasing and migration to highlands; strategic deworming for goat; strategic vaccination

Strategic destocking; transported by trucks/lorries; construction of bomas

Informal sharing of information between buyers and sellers

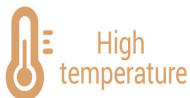
Other potential
options to
increase farmers'
adaptive capacity

Putting in place digital backing in all feeder markets; formation of cooperative societies; promotion of e-extension services; establish cold rooms and laboratory equipment at all market centers

Improved rangeland management; improved water harvesting and management systems; proper timing of deworming before drought; proper timing of vaccination before drought; proper disease control; establishment of group feedlots

Capacity building on value addition e.g. goat meat drying and sales, goat skins processing and sales; improve feeder roads network to the market; establishment of group feed lot systems

Putting in place holding grounds for livestock improvement for buyers to come; putting in place and develop market centers at feeder points for buyers to buy; off-take of livestock for slaughtering



High
temperature

Banks cannot lend due to the risk involved (reduced financial capital); reduced extension services; lack of motivation or incentives; reduced veterinary services

Reduced feeding due to reduced pasture and water; increased deworming; increased vaccination

Low quality goats; difficulty in transportation due to heat; need for shelter to prevent heat stress

Reduced linkage between farmers and buyers; increased animal slaughtering to avoid losses in case of death

Magnitude of
impact

Major

Major

Moderate

Major

Farmers' current
strategies to cope
with the risks

Financial capital through selling of goats; extension services and early warnings through media, meetings; -disease surveillance

Farmers organized Dedha system on pasture grazing time and management; continuous deworming; vaccination to prevent disease outbreak

Infrastructure development of feed lot, grass farm at LMD; movement regulation; disease surveillance; construction of bomas

Broker provision of market information; provision of livestock selling markets; construction of slaughter houses. -meat inspection services

Other potential
options to
increase farmers'
adaptive capacity

Link farmers to financial institutions; electronic extension services; provision of efficient transport and operationalise laboratory services for vet services

Hay banking; promotion of livestock insurance; regular deworming; regular vaccination; Alternative livelihood e.g. beekeeping; introduce eco-tourism

Improve road networks to the market; use good condition double-decker trucks; develop good shelter infrastructure at market centers and provide water

Put in place digital system marketing system at all market centers; formation of livestock cooperatives for bargaining power; rehabilitate the existing abattoir

Policies and Programmes

Isiolo country lacks a holistic climate change policy and strategy to manage climatic hazards. The existing efforts to manage the impacts of natural disasters including recurrent droughts and floods, high temperatures, and negative impacts such as degradation of soil fertility are very short-term and concentrate on ad hoc crisis response through relief supplies e.g. relief food to those already affected. However, there has been an effort to develop local policies, and programmes to address climatic vulnerabilities of the population in Isiolo County. Nevertheless, policy gaps still exist since the County agriculture policy is not yet developed for example.

Isiolo County Livestock Policy (draft) is anchored in The Constitution of Kenya 2010. The overall objective of this policy is to strengthen the capacity of the pastoral households and other stakeholders, to formulate and implement livestock sector and related policies that enhance the contribution of the livestock sector to sustainable food security and poverty reduction in the county (GoK, 2016).

In light of the National Policy for the Sustainable Development of Northern Kenya and other Arid Lands³⁴ (revised in 2015) and the Land policy of 2009³⁵, the County has some Bills that are on the draft stage that include Agriculture and Climate Fund Bill. The Isiolo County Agricultural Development Fund Bill of 2014 outlines the entry points for agriculture sector investments. The principal object of this Bill is to provide for the growth and development of the agricultural sector, enhance production, and improve quality, value addition, and marketing and to establish the County Agricultural Development Fund to finance the agricultural sector. This will enhance agricultural productivity in the county and improve the economic status of farmers in the community. The Isiolo County Climate Change Fund Bill of 2016 lays a framework for funding and coordinating climate change interventions at lower levels of decision-making. Mandates for operationalising these policies mainly rest with NDMA and ASDSP.

The ASDSP is a sector-wide programme initiated in 2012 and implemented by the government across Kenya, with the view to transform the agriculture sector through commercialization. For the major value chain commodities, the programme supports farmer groups to enhance improved agricultural production, value addition, and access to markets, through capacity building programmes³⁶ (GoK, 2014).

Despite the above draft policies and programmes, several policy gaps continue to undermine the full potential of the interventions to build the sector's resilience to climate change. Because of the ongoing devolution of services and restructuring of institutions, there is need for periodical but constant review of existing legislations and formulation of new laws. Weaknesses in legal and institutional framework have been demonstrated in the livestock policy document as one of the main contributors to the limitations affecting the performance of enterprises in the livestock sub-sector. The key weaknesses observed include regulation and facilitation of services such as animal breeding services, feed production, privatization of veterinary services, regulation of veterinary drugs, resolution of livestock/wildlife conflicts, quality assurance of livestock inputs and products, coordination of research and extension, information as well as monitoring and evaluation of projects and programmes.

Weak land tenure is one of the key underlying issues that have held back sustainable livelihoods and development in the area. As a result, laws and policies that promote the individualization of land tenure are undermining the common property regime, which has traditionally allowed pastoralists to sustainably manage vast areas of land. As such, dry-season grazing reserves have been lost, livestock movements have been restricted, and land degradation has increased, consequently undermining the sustainability of the pastoral livelihood system.

Appropriate policies will lead to more sustainable and equitable management of natural resources. Stronger mechanisms for enforcement of locally appropriate by-laws leads to efficient resource utilization and sound management of natural resources such as land, forest and water resources. A review of existing legislation is essential for the creation of an enabling environment for climate resilience, which reflects current challenges and opportunities identified at local level. Dissemination of policy issues to the community gives members an opportunity to understand what is required of them, hence support to implementing institutions. Due to cultural values, people have a strong attachment on livestock thereby influencing them to practice pastoralism. Creating a policy, regulatory and institutional framework that will improve technical and technological interventions in the pastoral meat trade subsector and market and road infrastructure is essential.

34 The policy aims to promote sustainable land utilization, end drought-related emergencies, and provide an enabling environment for sustainable agriculture.

35 The Land Policy recognizes communal management of land resources. A number of customary natural resource management institution, such as the Merti Rangeland Users Association, promote sustainable communal management of water resources, an indication of the relevance of unwritten rules are in resource management in the County.

36 Through ASDSP, farmers are also able to access trainings on crop selection, the use of improved seeds and early-maturing varieties, among others.

Governance, institutional resources, and capacity

Good governance is prerequisite for sustainable development and when insufficiently addressed, development interventions are slow and at times impractical. Governance process is vital in fostering transparency and demanding people’s rights.

There are various governmental actors, NGOs, community-based organisation (CBOs), faith-based and private organizations in the County engaged directly or indirectly in building resilience to climate risks (See Annex 3 for a detailed list). County-level government institutions include local offices of the Ministry of Agriculture, Livestock and Fisheries (MoALF), Ministry of Lands, the Ministry of Water and Irrigation (MoWI), Kenya Meteorological Department (KMD), Kenya Forestry Service (KFS), the National Environmental Management Authority (NEMA), Kenya Wildlife Service (KWS), and NDMA. In general, these departments and agencies provide agricultural extension, inputs, and policy support (mainly through ASDSP), such as: construction of water facilities (e.g. boreholes and water pans) by (MoWI), provision of vaccinations and treatments (Department of Veterinary Services (DoVS), procurement of livestock feeds and destocking by (the MoALF), among others. NEMA coordinates most environmental initiatives in the County, while KWS is responsible for regulation of livestock movement. KFS promotes tree planting and controlled bush clearing .NDMA is the only organization that directly deals with climate change risks, providing early warning information to farmers, in collaboration with KMD.

Key development partners working on resilience in the County include ADESO, Action Aid, Care Kenya, the Food Agricultural Organization of the United Nations (FAO), KRC, and WFP, among others. These organizations provide technical advisory for the implementation of good agricultural practices, establishment of water tanks, deliver agricultural inputs like fertilizers and pesticides, support the establishment of greenhouses, and deliver trainings to farmers. Faith-based organizations such as the Anglican development service (ADS), Catholic Relief Service (CRS), and CARITAS focus mainly on emergency response, engaging in activities such as conflict resolution, rescue services, administration of food aid, and climate disaster management. The organizations also have a development component, providing extension, inputs such as fertilizers, high-yielding seeds, and irrigation equipment to farmers. They also link farmers to markets by encouraging them to organize themselves into groups so as to strengthen their bargaining power.

Lack of timely and sufficient funding to cover operation costs, staff salaries, and equipment constitutes a major hindrance for successful implementation, coordination, and monitoring of interventions. To address this, a devolved county-level climate finance mechanism, the Isiolo County Adaptation Fund (ICAF), was established in 2010, with primary support from DFID and an additional grant from the Catholic Organisation for Relief and Development Aid. Following the initial success in Isiolo, DFID invested an additional £6.5 million accountable grant (2013-2016) for the creation of an Adaptation Consortium (ADA)³⁷ under the leadership of NDMA and with support from Christian Aid, CARE Kenya, the Met Office (UK), KMS, and the International Institute for Environment and Development.

Early warning and emergency preparedness is necessary for diminishing the impacts of droughts, floods, diseases, and other climate hazards affecting crop and livestock systems. In the absence of an integrated data bank on crops, livestock and livestock products, feed and water availability, efforts of the government and other service providers to identify and support vulnerable groups are limited, leading to an inability to design appropriate intervention programmes and mobilize adequate resources.

Employing modern technology in crop and livestock production will ensure food security. Improved value chain system will ensure value addition to agricultural products thereby improving income generation to the local community. The county government through the veterinary department under the Ministry of Agriculture, Livestock and Fisheries at subsidized rates offers vaccination services. However, pastoralists move with their livestock, sometimes at night, making vaccination and regulation of livestock migrations difficult. Inadequacy of finances to enable the veterinary department to purchase the vaccines also reduces accessibility of the veterinary services. In addition, frequent monitoring and evaluation of the programmes/ interventions become a challenge given the vastness of the region, a factor that is likely to reduce success rates of interventions.

Effective preparedness and management of climate change impacts will largely depend on the establishment of an all-inclusive coordination mechanism bringing together various key actors. Strong research and extension institutions are key in enhancing competitiveness in the agricultural industry and increasing agriculture/livestock productivity. The main constraints in research and extension service delivery within the agriculture/livestock sub-sector include low investment in agricultural research by public and private sectors; inadequate attention to

37 ADA is aimed at ensuring that drylands become an integral part of climate change adaptation policy and relief and at attracting national and international climate finance for locally defined climate-resilient growth.

post-production research, particularly value-addition and marketing; and inadequate investments in dissemination of the research findings.

Several interventions geared towards improving agricultural productivity, such as construction of water pans, dams, proper land use management, economic land use systems such as irrigated farming, have been held back due to insufficient funding and low budgetary allocation to the sector (currently at 9 percent of the total County's budget)³⁸. Shortage of funds has also diminished the capacity to buy and maintain equipment, vehicles, machinery, and pay for staff salaries, preventing the completion of the proposed Isiolo County flagship projects such as the construction of the Isiolo abattoir, livestock feedlots, livestock sale yards, and the development of disease-free zones (GoK, 2016).

Synthesis and Outlook

More frequent and prolonged droughts and unreliable rainfall have had major consequences for the environment and livelihoods of the population in Isiolo County over the past years. Given that crop systems in the area are largely dependent on rainfall, the effects of such extreme events have set footprint on food security and nutrition, increasing dependency on food aid and overall poverty. The increasing temperatures and low rainfall coupled with poor soil fertility impact negatively on productivity of the various crops. The crops become more vulnerable to pest attacks and disease causing microorganisms that lead to reduced crop yield, poor quality produce and sometimes contribute to total crop failure. Weather changes also contribute significantly to post-harvest losses and food safety during storage. The changes in rainfall patterns, in addition to shifts in thermal regimes, influence local seasonal and annual water balances. These in turn affect the distribution of periods during which temperature and moisture conditions permit crop production.

The resulting losses in livestock production include higher mortality rates, low or zero calving rates, reduced production of milk and weight loss. The heat stress suffered by animals also reduces the rate of animal feed intake and results in poor growth performance. The frequent shortages of feed during the dry seasons imposes severe nutritional stresses to the animals resulting in low productivity (i.e. meat, milk, eggs) and even pre-disposes the animals to a number of diseases that frequently lead to high rates of mortality. Increased climate variability has also led to conflicts over the limited pasture and water in the region.

To cope with such challenges, with the help of extension agents and development organizations, farmers have adopted a set of water and soil conservation and management practices and tools, including water pans, shallow wells, de-silting of existing dams and water tanks, mulching, crop rotation, agroforestry systems, and drought-resilient crop varieties and livestock breeds. While upscaling of such initiatives is crucial for achieving food security goals, integrated agricultural development requires adaptation measures that target the entire value chain activities, including post-harvest handling and marketing opportunities for farmers. It also calls for a clearer institutional and governance structure, where policies and strategies faithfully reflect local needs and opportunities. Additionally, where public and private actors have sufficient resources and capacity to realize commitments and deliver results. Moreover, resilience-building interventions need to go beyond conventional emergency response strategies, seeking to build a long-term vision for addressing the underlying vulnerabilities of the people. Investments in basic public services such as promoting and facilitating access to potable water, electricity, and education could help in reducing inequalities in terms of access to resources across different groups in society, increase literacy levels, enhance diversification into other income generation activities, and eventually ensure food security, and break the vicious poverty cycle.

A broader governance mechanism, as well as an enabling institutional and policy environment is critical for addressing climate vulnerabilities. The formulation and implementation of county-level climate change action plans grounded on assessment of local needs and resources could represent an important step towards the operationalisation of the country's climate strategy. Identification of an appropriate institution to implement the National Climate Change Programme, which should cascade down to the vulnerable smallholder farmers.

38 This percentage was equivalent to KES 278 million in 2015-2016; received KES 209 million.

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