Climate Risk Profile
Marsabit County

Highlights

- Pastoral production systems form the main livelihood in Marsabit County, involving about 80 percent of the population. Major sources of income within this livelihood include sales of livestock and livestock products, which account for 85 percent of all county income. Agro-pastoral systems involve about 16 percent of the population and livestock and food crops combined account for 50 percent of all income among agro pastoralists.

- Drought, floods, high temperatures, and erratic rainfall challenge productivity and incomes as well as basic food and nutrition security among the population. Moreover, land tenure system, poor infrastructure, and social factors such as migration in search of pasture and water, pastoral school drop-outs, low literacy and high poverty levels limit the farmers' ability to cope with climate change and variability. Agricultural productivity is further challenged by inaccessibility of inputs due mainly to high input prices, low technological adaptation, and undeveloped markets.

- Strategies adopted by farmers to respond to climate related hazards and risks include water harvesting, value addition, soil and water conservation, diversification and change livestock type and crop varieties to more drought tolerant ones. However, the rate of adoption remains low due to high poverty and illiteracy levels, communal land tenure system, poor infrastructure, insecurity, inadequate skills, high input prices and undeveloped markets.

- Off-farm services that are available and that increase farmers' climate adaptive capacity include agricultural finance, weather advisories and local marketing information and support. Various actors support these services. They include County Government, National Drought Management Authority (NDMA), Meteorological Department, local and International Non-governmental Organizations, Faith-, Community- and Farmer- Based Organizations, and the private sector. However, these actors' capacity to deliver accurate, easy-to-understand, and timely information to farmers is constrained by human, technical, and financial resources.

- Several government, non-government, community-based, and private organizations support climate change adaptation efforts in the county through various channels, such as policy-making and delivery of financial and non-financial incentives and resources to farmers (seeds, fertilizers, pesticides, water tanks). However, although beneficiaries are generally engaged in the planning phases of interventions, they are often absent from subsequent phases including monitoring and evaluation. Coordination of efforts to address vulnerabilities to climate change should be improved.

- Farmers need to be equipped with the tools, knowledge and support services to be able to prepare for and respond to climate related shocks. Appropriate adaptation and mitigation response will be contingent upon farmers' ability to access crucial extension services in a systematic and timely manner.

- Greater investment in processing and value addition infrastructure would be of great benefit across various value chains including livestock, fish, fruits, vegetables and staple crops.

KCSAP
Kenya Climate Smart Agriculture Project
Republic of Kenya
WORLD BANK GROUP

List of acronyms

ACT	Africa Conservation Tillage
AEZ	Agro-ecological Zone
AI	Artificial insemination
ASDSP	Agricultural Sector Development Support Programme
CAADP	Comprehensive African Agricultural Development Programme
CBO	Community-Based Organization
CIDP	County Integrated Development Plan
CIFA	Community Initiative Facilitation and Assistance
DoALF	Department of Agriculture, Livestock and Fisheries
ENNDA	Ewaso Nyiro North Development Authority
EWS	Early Warning System
FAO	Food and Agricultural Organization of the United Nations
FBO	Farmer Based Organization
FH	Food for the Hungry
GHG	Green House Gas
GIZ	German International Cooperation for Development
IBLI	Index Based Livestock Insurance
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
ITK	Indigenous Traditional Knowledge
IUCN	International Union for Conservation of Nature
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research organization
KAPP	Kenya Agricultural Productivity Programme
KES	Kenya Shillings
KFS	Kenya Forest Service
KRCS	Kenya Red Cross Society
KWS	Kenya Wildlife Service
KMD	Kenya Meteorological Department
MLNV	Maize Lethal Necrotic Virus
NAPA	National Adaptation Programs of Action
NC	National Communication
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NCPB	National Cereal and Produce Board
NDMA	National Drought Management Authority
NEMA	National Environmental Management Authority
NGO	Non-Governmental organization
PACIDA	Pastoralist Community Initiative Development and Assistance
SMM	Sauti Moja Marsabit
VCC	Value Chain Commodity
WFP	World Food Programme

Foreword

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

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

This document presents the Climate Risk Profile for Marsabit County, where a sequence of extreme weather events have affected and continue to affect the agriculture sector and livelihoods of the people at large. Drought frequencies have increased to every 1-3 years, during which pastoralists can lose up to 50 percent of their herds[1]. For instance, in March 2017, pastoralists in the county lost over 60 percent of their livestock due to prolonged drought[2], while in January the same year, more than 150,000 people faced starvation as a result of prolonged drought[3]. Floods on the other hand have also ravaged the county. For instance, in 2017, nearly 5,000 goats and sheep were swept away in Karare, Huri hills, Elgade, Olturot, Toricha, Bori and Sololo[4]. These, together with the poor performance of the crop sub-sector, worsen the food situation in the county; more than 20 percent of children below 5 years are undernourished. The food crisis attracted, among other actors, humanitarian organizations such as the Red Cross, who intervened through a cash transfer to more than 1,500 affected families. The Kenya and Danish Red Cross also implemented a livestock insurance plan, which involved buying livestock before the body condition deteriorated[5]. While responding to these disasters is important, the need for plans to sustainably cushion pastoralists and farmers in Marsabit County cannot be over-emphasized.

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

1 Source: GoK (2013c).
2 http://marsabitdaily.co.ke/2017/01/13/marsabit-governor-ukur-yattani-announces-raft-of-measures-to-deal-with-ravaging-drought/
3 http://www.the-star.co.ke/news/2017/02/07/marsabit-to-rely-on-red-cross-as-drought-ravages-the-county_c1501121
4 http://www.nation.co.ke/counties/marsabit/Pastoralists-counting-loses-after-heavy-rains/3444778-3911914-xt30hk/index.html
5 http://www.nation.co.ke/counties/marsabit/Marsabit-drought-kill-livestock/3444778-3796668-j43o4jz/index.html

Agricultural context

Economic relevance of farming

Marsabit County occupies the extreme part of northern Kenya, bordering Ethiopia to the North, Lake Turkana to the West, Samburu County to the South and Wajir and Isiolo Counties to the East. It is located between Longitudes 37° 57' and 39° 21' East and Latitudes 02o 45' and 04° 27' North.

The county covers 70,961.2km^2, which is largely an extensive plain lying between 300 and 900m above sea level, sloping gently towards the south-east. The plain is bordered to the west and north by hills and mountain ranges and is broken by volcanic cones and calderas. The most notable topographical features of the county are: Ol Donyo Ranges (2066m above sea level) in the south-west, Mt. Marsabit (1865m above sea level) in the central part of the county, Hurri Hills (1685m above sea level) in the north-eastern part of the county, Mt. Kulal (2235m above sea level) in the north-west and the mountains around Sololo-Moyale escarpment (up to 1400m above sea level) in the north-east.

The Chalbi Desert forms a large depression of approximately 948 km^2. The depression is also the largest drainage system that receives run-off from the surrounding lava and basement surfaces of Mt. Marsabit, Hurri Hills, Mt. Kulal and the Ethiopian plateau. There are no permanent rivers in the county; only seasonal rivers namely Milgis and Merille to the extreme south; they flow eastward and drain into the Sori Adio Swamp. Other drainage systems include the Dida Galgallu plains, which receive run-off from the eastern slopes of Hurri Hills, and Lake Turkana, into which seasonal rivers from Kulal and Nyiru Mountains drain. Soils are shallow and poor since volcanic rocks form the most dominant geological formation.

Marsabit County is mostly arid, with the exception of high potential areas around Mt. Marsabit such as Kulal, Hurri Hills, and the Moyale-Sololo Escarpment. About 75 percent of the total land area consists of low potential range land that lies below 700m above sea level. The areas at the foot of the mountains comprise Moyale-Sololo Escarpment, the slopes of the Hurri Hills, the lower slopes of Mt. Marsabit, and the middle slope of Mt. Kulal, and the plains of Dida Galgallu, Bure Dera, Kaisut, and Milgis. These areas receive moderate annual rainfall of about 700mm. The highland areas in the county include Mt. Marsabit, Mt. Kulal and Ol Donyo Mara Range which have moderate rainfall and productive agricultural soils. Livestock and crop production are the major economic activities with maize, sorghum, millet, beans, fruits and vegetables being the main crops.

The county experiences extreme temperatures ranging from a minimum of 10.1°C to a maximum of 30.2°C, with an annual average of 20.1°C. Annual rainfall ranges between 200 and 1,000mm. Its duration, amounts and reliability increase with increase in altitude. North Horr, which is 550m above sea level, has a mean annual rainfall of 150mm; Mt. Marsabit and Mt. Kulal receive 800mm while Moyale receives 700mm of mean annual rainfall.

Agriculture is the main economic activity in Marsabit County. It involves crop production, livestock keeping, bee keeping, fishing and agroforestry. Agricultural production in the county is predominantly livestock based. Approximately 81, 16, and 3 percent of the population is engaged in pastoralism, agro-pastoralism, and other livelihoods respectively[6]. Crop production is limited to a few areas given the low and erratic rainfall in most parts of the county.

The livestock types reared in the county include cattle, goats, sheep, camels, donkeys, and poultry. Bee keeping is also practiced, and fishing is mainly done in Lake Turkana. The crops grown are maize, green grams, wheat, teff, beans, millet, vegetables (kales) and fruits (mangoes, oranges and avocadoes). Fruit trees are considered as part of agroforestry, a practice limited to areas around Mt. Marsabit and Sessi.

According to Economic Review for Agriculture (2015), the livestock population in 2014 comprised 424,603 cattle, 1,143,480 goats, 960,004 sheep, 203,320 camels, 63,861 donkeys, 50,690chickens, and 2,691 bee hives. The main livestock products include milk, beef, mutton, and camel meat. Together with the products, the livestock resources were valued at over KES 9 billion in 2014 (GOK, 2014). Fish production (fish caught) average 630 metric tons annually[7]. Only about 5,060 ha were under crop production in 2014. The value of the crops was therefore relatively low (KES 27 million) compared to that of livestock (GOK, 2014).

Over 60 percent of household income in the county is derived from on-farm sources (GoK, 2014). However, income sources are not diversified within the sector since over 50 percent of the households depend on a

6 Source: http://reliefweb.int/sites/reliefweb.int/files/resources/Marsabit percent20County percent20LRA percent202016 percent20Report.pdf

7 Most of this fish is mostly sun-dried causing a major loss in market value of the fish.

single income source. More specifically, male-headed households depend on a single source of income compared to female- and youth-headed households (37, 8, and 7 percent respectively). More male headed households depend on income from crop production compared to female- and youth-headed households (50, 12, and 1percent respectively). However, more youth-headed households depend on livestock activities compared to female- and male-headed households (98, 88, and 27 percent respectively) (GoK, 2014). The differences in the proportions of male-, female- and youth-headed households depend on different agricultural activities. This is attributed partly to the patriarchal social institutions common in pastoralist communities where women have limited control over land. At the same time, most of the land is still communal, hence women and youth can access it for livestock production.

The contribution of the agriculture sector to employment is very high; approximately 70 percent of the labor force is employed in agriculture in the rural areas (GOK, 2013). Most labor is provided by the family. The youth provide the largest share of family labor in crop production while adult females provide the least. In livestock production, the youth provide the largest share while the adult males provide the least. Hired labor for crop and livestock production is mostly provided by youth- followed by male- and female-headed households (GOK, 2014).

Apart from production, farm level value addition to agricultural products is very basic. In crop production, dehulling is the common practice in cereals while in livestock production, preserving meat into *Nyirinyiri*[8] is the most common practice. Milk value addition involves fermenting, boiling, and traditional ghee making.

People and livelihoods

In 2017, the population[9] of Marsabit County was estimated at 372,931 persons (GOK, 2013a). This comprised 193,544 males and 179,387 females. Majority of the population (78 percent) lived in rural areas (GoK, 2013a). The county has two towns - Moyale and Marsabit, and three urban centers- Sololo, Loiyangalani, and Laisamis. The majority of the urban population live in Moyale (57 percent) and Marsabit (23 percent).

Absolute poverty in the county stands at 80 percent. Ninety-two and 39 percent of the poor resided in the rural and urban areas respectively (GoK, 2013a). The food security situation in the county is dismal. Eighty-three percent of the county population experience food poverty[10] (GoK, 2013a). Food poverty is caused mainly by over-reliance on rain fed agriculture. Rainfall in the county is erratic. The labor force constitutes almost half of the population. The high unemployment rate (65percent) mostly affects the youth. The literacy level is only 24percent with those who can read and write accounting for only 27and 22percent of the population respectively. Apart from low literacy levels, the county suffers frequent and prolonged droughts, poor infrastructure, insecurity, environmental degradation, and underdeveloped markets. These factors contribute to the high poverty levels especially in rural areas. The health/nutrition indicators show that up to 30 and 26 percent of the children under five were malnourished and stunted respectively while Global Acute Malnutrition was 16.3 percent (GOK, 2013).

Access to various utilities is concentrated in urban areas. In 2012, out of the 56,941 households in the county, 1,273 had electricity connection, 3,050 had access to piped water, and 8,250 had access to potable water representing 14% of the households (GoK, 2013a). The population using firewood for cooking and lighting was 92and 48 percent respectively (Ibid).

Land tenure is largely communal, with less than 2 percent of the land in the county is registered. Among the registered sections are those in the mountains including Marsabit Township and Dakabaricha in Saku Constituency. Landlessness is not common even though frequent conflicts lead to displacement of communities. Displaced people normally return to their land after the situation calms.

Livelihood activities in the county include livestock keeping, crop farming, fishing, forestry, and trade with minimal mining and tourism. The population is 81 percent pastoralist[11] and 16 percent agro-pastoralist[12]. Fishermen constitute 2percent of the population and are mostly concentrated in the surroundings of Lake

8 Nyirinyiri is meat fried and stored in oil. Common practice in ASAL areas.

9 Population projections based on 2009 National Population and Housing Census. In 2009, population stood at 316,206 persons comprising of 164,105 male and 152,101 female. This gives annual population growth rate of 2.75 per cent.

10 Food poverty in this case means the population of people who do not have enough food to meet their daily requirements.

11 Nomadic and sedentary pastoralists keep livestock. Nomadic pastoralists still practice the movement from place to place depending on pasture and water availability, sedentary pastoralists have settled in specific areas and rarely move.

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Turkana especially Loiyangalani where fishing is the sole livelihood. The main fish species caught include Tilapia, Labeo, and Nile perch.

The main livestock types are cattle, goats, sheep, camels, donkeys, poultry, and bee keeping. The main livestock products are milk, beef, mutton, and camel meat. Crop farming is practiced around Mt. Marsabit and Moyale. The main cash crops grown include vegetables and fruits whereas the main food crops include maize, teff, beans, and millet.

Forestry activities are common in the three forests in the county - Mt. Marsabit, Mt. Kulal and Hurri, covering a combined area of 750 km^2. The main forest products are charcoal, grass, plants for herbal medicine, stones, wood fuel, timber, poles and water. Blue quamline and mica are mined in South Horr, Laisamis Constituency. Other mining activities include sand harvesting (though in small quantities) at Segel, Kargi, and Bubisa; open cast quarrying at Gof Choba, Manyatta Dabba and adjacent areas in Saku Constituency; and mining of chromite in Moyale Constituency. Exploration of petroleum is also on-going at Maikona, Laisamis, and Kargi. The county also has a number of tourist attraction sites, which include: Marsabit National Park and Reserve, Sibiloi National Park, Lake Paradise, Mt. Marsabit, Tropical Rain Forest, and diverse cultures from different communities.

Agricultural activities

Marsabit County has a total of 1,582,750 ha of arable land. This represents 22 percent of the total land area in the county and about 27 percent of the national arable land. The total acreage under food crops is 5,060 ha, representing 0.3 percent of the arable land (GoK, 2013a). Much of the area is underutilized due to unfavorable climatic conditions for rain fed agriculture.

In terms of precipitation, the county is classified into arid, semi-arid, and semi-humid. Pastoralists are mostly in the arid zones while agro pastoralists are in the semi- arid zones.

Land in the county is largely communal except in parts of Saku Constituency around Marsabit, where less than 2 percent of the farms are registered. Although only a small portion of male-headed households (2.6 percent) have land with title deeds, the youth-headed households lead in ownership of communal rights to use land compared to female- and male-headed households (100, 86, and 76 percent respectively) (GoK, 2014). The youth access more of the communal land as they have limited access to the land with title deeds; more resources are required to acquire such land. The communal land tenure system hinders long-term investments on land and conservation. It also results in inter-communal conflicts over resources, especially during dry spells as different communities claim rights to the resource.

Lower levels of inputs are used in crop farming than in livestock farming. Male-headed households use more inputs than female- and youth-headed households. The difference in the level of input use for crops and livestock is largely due to the fact that livestock is the major livelihood activity in the county. The two major inputs used in crop production are seed and herbicides (7 and 4 percent of households respectively). Only 2, 1 and 4 percent of the households use organic manure, storage pesticides and herbicides respectively. Males make most of the decisions on food crops, except wheat, where females dominate. The contribution of youth in decision-making is mostly limited to maize and beans. For livestock production, the two mostly used inputs are acaricides and dewormers (87 and 86 percent of households respectively). Adult males make most of the production decisions on all the livestock types except chicken, where adult females dominate. The youth are less involved in production decisions on most livestock (GoK, 2014). Predominance of the males in decision making in most of the production activities explains why male-headed households use more agricultural inputs than female- and youth-headed households.

Fifty percent of female-headed households have access to agricultural technologies compared to 43 percent of male- and 42 percent of youth-headed households. Livestock technologies are the most accessed- by at least 36 percent of the households. However, almost half of the households access any agricultural technology (GoK, 2014). The major constraints to use of inputs include high prices, insufficient income, long distances to the input markets, lack of access to inputs at the right time and lack of technical skills on the use of inputs.

Livelihoods and agriculture in Marsabit

Demographics

1% Of Kenya´s population

316,206 inhabitants

78% Live in rural areas

48% 52%

Access to basic needs

80% of the population lives in **absolute poverty**

Potable water	14%
Electricity for cooking	0.2%
Electricity for lighting	8%
Education (youth literacy rate)	28%

Food security

83% of the population suffers from **food poverty**

ND of household **income spent on food**

ND People **undernourished**

27% Children **stunted**

16% 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 1,582,750ha 22%

2% of the population employed in agriculture production

1% of farmers have title deeds ND are women

Farming activities

Food crops 32%

Cash crops ND

Of county´s agricultural land

Livestock

Goat (heads)	1,186,452
Sheep (heads)	2,029,490
Cattle (heads)	218,755

Farming inputs

Water uses

ND ND ND

Fertilizer types (% of households)

NPK

2% Organic manure

0% Planting fertiliser

0% Top dress fertiliser

Pesticide types (% of households)

0% Field pesticides

1% Storage Pesticides

4% Herbicide

Agricultural value chain commodities

There are a diversity of agricultural commodities grown in the county. Of these, 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 (VCCs) 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)[13]; resilience to current weather variability and future climate change[14]; and the number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor[15]). This activity was conducted in a stakeholder's workshop. The VCCs selected are: Goat (meat), teff, kales, fish.

Goat (meat)

Goats are reared across the county since they can survive harsh climatic conditions compared to other livestock types. About 60-80 percent of the population is involved in goat production, which is largely under the extensive pastoralist system. Except in Marsabit Central Ward where small-scale production (1-50 goats per household) is practiced, large-scale production is practiced in the rest of the county (over 50 goats per household). The stock of goat[16] raised for meat in 2014 stood at 1,185, 964, valued at about KES 6 billion (GoK, 2015). Male-headed households are most likely to own goats and are the ones who make most of the decisions relating to goats, such as slaughtering or selling.

Pastoralists are the major actors in the goat (meat) value chain; they operate on a relatively small scale (50-150 goats). Other actors include input suppliers, processors, service providers, and wholesalers as well as retailers who operate on a small scale. The County Government is involved in marketing through investments in marketing structures in collaboration with donor partners. The partners are also involved in disease surveillance and control, provision of extension services, and capacity building. Goat are sold at the primary markets such as Olturut, Korr, Ilaut, Godoma, Misa, Dabel, Odda, Forolle, Dukana, North Horr, and Turbi. The main buyers at these markets are other producers who use them as replacement breeding stock. Local butchers slaughterthem at local butcheries and traders buythem for resale to secondary or terminal markets. Secondary markets are Merille, Jirime, and Moyale. Terminal markets are Nairobi and peri-urban markets. Some local traders export them to Ethiopia. About a third of the households involved in goat production have established contractual agreements for sale of live animals, meat, and skins. However, over 90 percent of these agreements are informal.

Institutions that intervene in the value chain include the Kenya Agricultural and Livestock Research Organization (KALRO), SIDAI, and the County Government. KALRO is involved in research and dissemination of technical knowledge to farmers. SIDAI Africa is the largest input supplier in Marsabit County, providing animal health inputs (drugs and animal feeds) and technical advice, and training farmers on husbandry. The County Government, through the Department of Livestock, provides disease control services such as vaccination, disease surveillance and control, and creation of awareness to communities during disease outbreaks. The department also provides extension services, capacity building, and promotion of other agriculture-related enterprises.

Major value addition activities undertaken by the households include *Nyirinyiri*[17], (7 percent of the households) drying (14 percent), differentiation of parts (11 percent), and smoking (3 percent). Production decisions are made mainly by adult males (63 percent) followed by adult females (19 percent) and youths (17 percent).

Kales

Kale is one of the major vegetables grown in Marsabit County. It is a very versatile and nutritious green leafy vegetable. The crop prefers rich organic soil and a cool climate with light frosting, hence it is grown mostly in the mountainous areas. It is an annual crop grown in Moyale, Saku, and Laisamis. In Kurungu and Madoadi, kales are produced under irrigation at large scale while

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

14 Resilience is as defined in IPCC (2012); where we consider the general risks posed by climate change in the county. Value chains which are perceived to survive the local conditions under the current production systems holding other things constant (including variations in technology adoption rates among farmers/pastoralists) are considered more resilient.

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

16 Apart from goat raised for meat, there is goat for milk and hair (488 and 2,029,490 respectively) (GoK, 2015)

17 Nyirinyiri refers to preserving meat by frying and keeping in fat.

in Hurri Hills, production is rain fedand at medium scale. In Walda, Kinisa, and Kalacha, production is under irrigation at small scale, while Songa, both irrigation and rainfall are used. Farm sizes on average span from 0.1 to 0.4 ha. Kales significantly contribute to household food security and income.

Some of the kales are used within the household and the rest are sold. The farmers who are mostly women use family labor in production. High production during rainy seasons creates temporary surpluses. The farmers avoid over supplies by diversifying to other crops such as tomatoes, coriander, and onions. Women and youth normally harvest and carry out related activities that include sorting, grading, and packaging. After bulking, the farmers transport the produce to a collection centre for onward transport to the main markets in Marsabit and Moyale. They also sell the kales to restaurants and individuals.

Various organizations support kale production in the county. Except for the county government, which provides extension services, all the actors along the value chain are small scale. The Department of Agriculture, Livestock and Fisheries (DoALF) is a key actor. DoALF coordinates development partners such as Concern World Wide, Community Initiative Facilitation and Assistance (CIFA), German International Cooperation for Development (GIZ), Kenya Red Cross Society (KRCS), Pastoralist Community initiative and Development Assistance (PACIDA), Food for the Hungry –Kenya (FH-K), National Drought Management Authority (NDMA), Agricultural Sector Development Support Programme (ASDSP), KALRO, and local FM radio stations. Other organizations include farmer-based organizations such as Saqaqe and Badasa self-help groups. Community organizations such as Sauti Moja Marsabit (SMM) also exist. They support extension, water harvesting, irrigation infrastructure, capacity building, provision of farm tools, execution of research, and dissemination of information. However, access to inputs such as fertilizers, herbicides, pesticides, and seeds is a challenge due to high costs attributed to the small number of suppliers and poor road infrastructure. The farmers operate with no formal arrangements such as cooperatives, but informal systems allow some members to travel to the market and sell produce on behalf of the others. Poor organization coupled with lack of quality standardization result in lower income for the farmers due to low bargaining power. A cooperative structure can help in developing marketing hence improving income for the farmers in addition to assisting access to credit for members.

Fish

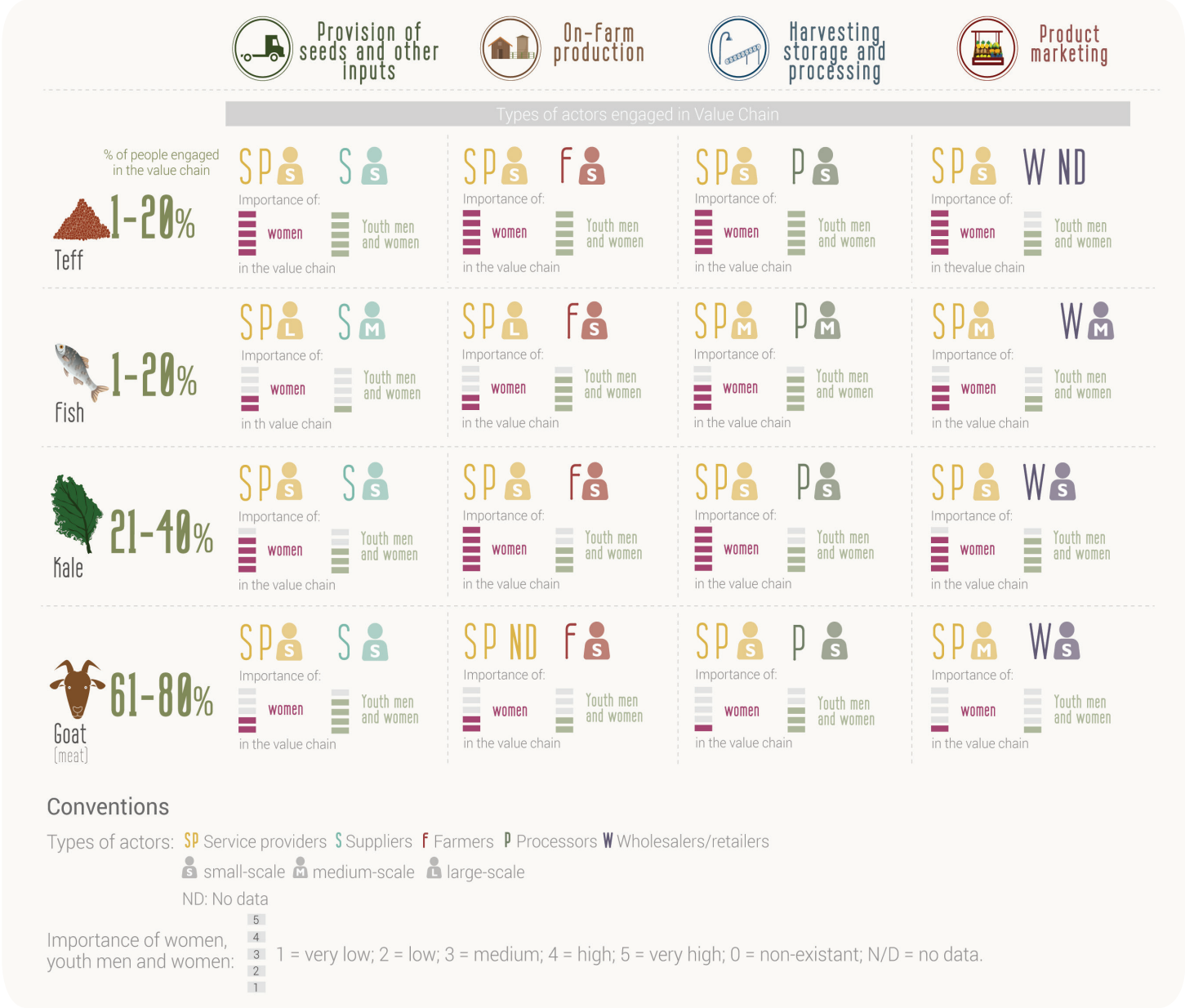
Fishing is a very important livelihood activity; it is undertaken mainly along Lake Turkana. The value chain involves about 1 - 20 percent of the households[18]. Those involved in fishing reside near the lake in Laisamis and North Horr sub-Counties. They are small-scale fishermen who use rafts and small boats. The main fishing and landing areas are in Loiyangalani, El Molo Bay, Moite, Ileret, and Telesgaye. The types of fish commercially harvested are tilapia, labeo, and Nile perch. Fishing provides direct employment to the fishermen, traders, transporters, and boat builders. Fishing from the lake involves mainly men while women are involved in processing (gutting) and preservation activities such as drying and salting. Few youth are involved in fishing since it is considered a last-resort value chain, mainly for survival and not commercial purposes. Application of appropriate technologies in fish harvesting and preservation is still very low, due to lack of skills and finances. Non-motorized boats, rafts, and dug-out canoes are the main vessels used in Lake Turkana. However, efforts by County Government and other partners such as GIZ are under way to commercialize fishing.

Annual fish production is estimated at 630 metric tons (MT), valued at KES 159 million (GoK, 2013c). About 80 percent of the fish is transported and sold to destinations outside the county such as Kisumu, Busia, Nairobi, Uganda, and Congo. Most of the fish is sold in dried or salted form. However, there are efforts to promote selling of fresh fish. The county government in collaboration with development partners such as German International Cooperation for Development (GIZ) have supported capacity building and infrastructure such as freezers. Cooperatives buy the fish from the fisher folks and sell to the market. Prior to these interventions, the fisher folks used to sell the fish mostly to individual traders from outside markets at low prices as their bargaining power was low.

The main challenges to the fishing industry in the county include lack of appropriate fish handling and preservation facilities, leading to post harvest losses and poor quality of fish and fishery products; poor state of landing sites and access roads which make marketing difficult; rampant insecurity; weak and unfavorable fish marketing systems along the fish landing sites; and limited management capacity. Because Lake Turkana is a shared resource, conflicts arise when fishermen go beyond certain boundaries. These problems are compounded by the low literacy

18 The CIDP indicates about 400 households heavily depend on fishing as a livelihood.

Agricultural value chain commodities in Marsabit



level that limit access to information or support to adopt innovations that could improve their practices. Moreover, fishing policies and rules to regulate rate of harvesting, zonation, and seasons for fishing are inadequate.

Teff

Teff is a food grain[19] with a high nutrition value as it is rich in dietary fiber and iron, protein and calcium. It grows well in altitudes of 700 to 2,200m above sea level, requires a growing- season rainfall of 450 to 550mm and a temperature range of 10 to 27°C, conditions that prevail in most parts of Marsabit. The teff value chain involves 1 – 20 percent of the population. Teff growing areas include Saku, North Horr (Hurri Hills), and Moyale. Production is rain fed and is by small-scale farmers. The average production area per farmer is 0.4 – 0.8 ha with an estimated output of 81 – 122 kg/ha. Over 70 percent of production is consumed at the household level and the rest traded, usually in the local market. Women and youth are more involved in the production than men. The input suppliers are few small agro-vet shops mostly in Marsabit and Moyale

19 Very important in Ethiopia and Eritrea, believed to be the origin of the crop.

towns. Farmers usually use own seeds from previous seasons since there are no certified seeds for teff. The use of inputs such as fertilizers and herbicides is low since farmers prefer to use this inputs on other crops than teff.

Farmers are involved in production activities such as land preparation, planting, weeding, harvesting, storing, and in some cases, transporting. The main value addition activity is milling, which is done by small-scale millers located in towns and centers around the growing areas. Traders are few in the county except in Moyale Town where there are many traders including those sourcing the teff from Ethiopia.

Challenges encountered by the actors in the teff value chain include drought and water stress, lack of seeds, changing onset of rainy seasons, poor road network, high input prices, and pests and diseases. The county government has made efforts to promote teff production through interventions such as purchase of tractors for land preparation, engaging a supplier to source seeds, and providing extension services. However, little research on the crop has been undertaken in the county.

Agricultural sector challenges

Although agriculture remains the main economic activity in the county, the sector is exposed to environmental, economic, and social constraints that affect productivity. The crop, livestock, and fishing activities register low productivity mostly due to the environmental conditions such as droughts, floods, and water scarcity, which affect production and marketability of agricultural products.

Frequent droughts have led to loss of livestock of up to 50 percent in some households. This does not only leave the households with fewer livestock but the health of those remaining is poor. The first rains after a drought incident usually affect livestock especially goats, due to hypothermia[20], which may be fatal. Frequent and prolonged droughts engender increased cases of human/wildlife conflict; wild animals destroy crops and attack livestock as pasture and water in their normal habitats are reduced. The conflict is exacerbated when humans encroach upon the areas designated for wildlife.

Resources available for development and operation in the agriculture sector are limited due to low budgetary allocations to the sector. The county allocated to agriculture 6.5 and 5.4 percent of the total budgets for the financial years 2013/2014 and 2015/2016 respectively (GoK, 2015b). The minimum allocation to agriculture suggested by the Comprehensive African Agricultural Development Programme (CAADP) is 10percentof the budget. Small budgetary allocations to agriculture adversely affect activities such as extension services, technology transfer and implementation of interventions that could sustainably improve performance of the agriculture sector. For instance, farmers resort to treating livestock on their own using indigenous knowledge. Veterinary officers are few and are not always available for emergencies especially in the rural areas.

The land tenure system, which is largely communal, reduces investment in land as farmers cannot use it as collateral to access loans. While male-headed households lead in land ownership, they also lead in access to agricultural credit. However, access to loans offered by most financial institutions may be less attractive especially to Muslim populations for religious reasons. The communal tenure regime also impedes adoption of measures such as soil conservation due to free riding[21]. Poor land or lack of land demarcation often leads to conflicts as communities fight over water and pastures.

Poor road infrastructure is a challenge especially during rainy seasons as most roads become impassable. This limits access to market for selling produce and buying inputs. Inaccessibility to markets and high prices of inputs lead to low input use, resulting in low production. Moreover, inadequate capacity to undertake value addition and lack of storage facilities further reduces returns as farmers opt to sell their produce mostly to middlemen at low prices.

The high poverty level in the county contributes to environmental degradation as there is massive destruction of forests to get firewood, charcoal, and grazing land. In addition, poverty limits the ability of farmers and pastoralists to acquire agricultural inputs such as certified seeds, fertilizers and irrigation equipment, technology, information; and financial support (loan & insurance) required to increase productivity. Low agricultural productivity leads to food and nutrition insecurity. Low productivity in one season leads to low productivity in the following season, as farmers rely on a current season to obtain money to buy inputs for the next season.

Low literacy levels and some cultural beliefs also

20 Hypothermia is a condition that arises when an animal loses more heat than it generate, causing a dangerously low body temperature.

21 Free riding occurs when an agent deliberately restrains from taking part in conservation of a common resource but benefits from the efforts of other agents conserving the resource.

hinder agricultural development. For instance, having large herds of cattle is fashionable since people with many livestock are considered wealthy and command respect in the community. This is despite the fact that overstocking exposes the livestock keepers to risks in the event of climatic shocks such as drought. Patriarchal social institutions limit the participation of women and girls in household and community decision-making (and conflict resolution) and control over productive assets and resources such as land and livestock. At the same time, it imposes a huge burden on them in carrying out domestic responsibilities such as collecting firewood and fetching water, and limits access to basic services – mainly health and education. Women and girls may also be subjected to harmful traditional practices, including female genital mutilation (FGM) and arranged/early marriage. These norms reduce their productivity in agriculture in general.

Scarcity of water is also a major challenge to agriculture in many parts of the county. Due to inadequate and unreliable rainfall, environmental degradation, poor community water management practices, and increases in human and animal population, water for domestic and livestock use is limited. The most affected areas are those along the mountain where sources such as Aite wells and Karantina have dried up, and the plains that have experienced significant reduction of water level as in the case of Bakuli. Other areas like Sololo and Moyale have few boreholes, such as those at Walda and Dabel; these cannot provide sufficient water for households and livestock. Another related factor is the development of large-scale irrigation schemes on the Omo River in Ethiopia, which contributes 80 percent of the flow into Lake Turkana (GoK, 2015b). Thus the volume and quality of water in the lake is likely to be affected, posing a threat to the fisheries sector.

Moreover, with increased drought and its consequences, pastoralism and settlements around urban areas such as Marsabit Town increase. This in turn increases poverty levels, environmental degradation, and children dropping out of school among other consequences. Resilience to climate change is reduced.

Livestock and crop diseases and pests have greatly affected productivity in the county. Common livestock diseases include Contagious Caprine Pleuropneumonia (CCPP), *Peste des petits ruminant*s (PPR), anthrax, goat pox, and Foot and Mouth diseases (FMD). Common crop diseases include Maize Lethal Necrotic Virus (MLNV) and pests include spider mites, nematodes, and *Tuta absoluta* species. Socio-economic consequences include production losses, restriction of marketing opportunities, disincentives to investment, and public-health risks, even across borders.

Poor distribution of marketing points for livestock in the county makes market access difficult.Livestock keepers travel very long distances in search of market. The livestock become emaciated along the way especially during drought,hence their value drops drastically.

Insecurity poses a challenge to livelihood, especially pastoralism in Marsabit County. Incidences of insecurity resulting from cattle rustling (cattle raids and retaliatory attacks) are common between the Turkana and Samburu communities living in Laisamis sub-County. Tribal conflicts mainly due to political competition occur. One such conflict was experienced in Moyale sub-County in 2013. Possible strategies for reducing insecurity include enhancing education and strengthening peace committees through peace-building initiatives and conflict resolution both within the county and across borders[22]. Strengthening community policing, opening up more security roads, and improving communication infrastructure for rapid response by the security agencies could go a long way in reducing insecurity.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

Marsabit County remains highly vulnerable to extreme weather events such as drought and occasional intense rains. Drought has resulted in losses of up to 60% of the county's livestock in recent years[23]. This is compounded by the fact that there are no perennial rivers in the county and most households rely on boreholes, springs and wells for both productive and domestic water. At the other end of the spectrum, flash floods also occur as a result of high rainfall intensity, often resulting in the washing away of livestock such as sheep and goats.

Analysis of temperature trends in the county over 25 years (1980 to 2005), showed that both first

22 Communities within the county and in neighboring counties of Samburu and Turkana are prone to cattle rustling.

23 https://www.wfp.org/sites/default/files/Marsabit%20CGNA%20-%2028062016_V2.pdf

and second season temperatures have increased moderately over the years (approximately 0.5°C and 0.25°C respectively). Analysis of rainfall over a 35 year period (1980-2015) showed a decrease in average first season rainfall by about 30mm and a similar increase in second season rainfall. The increase in second season rainfall has been accompanied by an increase in the length of the growing season and a decrease in the number of heat stress days, however second season rainfall variability from year to year has also increased and there are still constant high levels of drought risk. On the other hand, the decrease in first season rainfall combined with the increase in temperatures has resulted in decreased season length, an increase in heat stress days and a moderate increase in drought risk. Despite some differences in the changes in rainfall between the two seasons, rainfall in both seasons has become increasingly erratic and unreliable posing a significant threat to crop and livestock production as well as overall economic development of the county.

Looking ahead to the period 2021-2065, climate projections based on two representative concentration pathways (RCPs[24]) indicate various possibilities. Under both scenarios there is expected to be a continued increase in temperatures in both seasons, however these increases are expected to be greater under RCP8.5. Under RCP 2.6 there is expected to be a moderate increase in the length of the growing season however under RCP8.5 there is expected to be a large decrease in the length of the second growing season. The number of consecutive dry days under both scenarios are expected to increase. These projections of future climate change under the two climate scenarios, show some differences, but generally show similar trends and point to increasing climate risks to crop and livestock production in Marsabit County.

Climate Perceptions by the farmers

Farmers in Marsabit observe that there is remarkable climate change and variation. Weather patterns have become more erratic and unreliable compared to the past. According to the farmers, droughts have become more frequent and extended while rainfall is erratic and poorly distributed in both time and space, sometimes resulting in floods. However, the explanation for the cause of climate change varies from 'divine' where the frequent harsh climatic events are viewed as punishment for transgressions against God, to the conventional cause of destruction of forests and other natural causes.

Climate information is delivered through different channels in the county. These include radio, TV, print media, internet, local people who use indigenous knowledge to predict weather, research institutions such KALRO, seminars, personal experiences, training, and community meetings. According to a study by ASDSP in 2014, farmers indicated that the main sources of climate change information were indigenous technical knowledge (ITK) (100 percent), Radio and TV (63 percent), NGOs (15 percent) and government extension officers (12 percent) (GoK, 2014).

The prolonged droughts have resulted in long-term environmental changes including deforestation, drying up of rivers and wells as in the case of Songa and Moyale, reduction of water volumes, incidences of new pests such as *Tuta absoluta*, diseases, soil degradation, and increased wildlife –human conflict. These affect the quality of life, livelihood resilience of most communities, and the capacity to respond to the impacts. They remarkably challenged production of some crops in the county. For instance in 1982, Marsabit region had surplus maize production that was even exported to Malawi as relief food. Currently, the county is food insecure and a large proportion of the population depends on relief food.

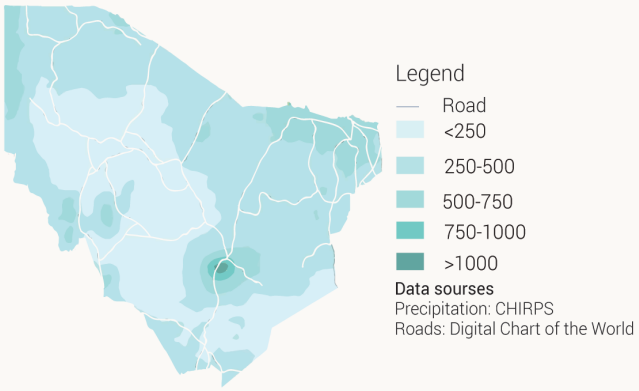
The erratic nature of rainfall makes it difficult to predict the weather unlike in the past when the rainfall pattern was definitely bimodal. This has affected farmers' timing in relation to land preparation and planting, factors that have negatively affected agricultural productivity. The rains also fall in portions. Even within a small area, there may be rain in one portion while another is totally dry. There is also the phenomenon of intense rains in the mountainous areas, causing flash floods in the lower areas such as North Horr and in particular Mikona and Arge, along Chalbi, Malgis Basin in Laisamis, Sololo (in particular DF), Moyale, Anona, Kinisa, and Godoma. The floods destroy crops and kill livestock and sometimes people. An example is the 2013 incident, which killed 10 people and destroyed roads and schools, affecting marketing of agricultural commodities and learning.

Significant temperature variation has also been experienced by the farmers/pastoralists. Increases in temperature have led to a shift in agricultural zones. Plants that used to grow only in the low lands (arid plains) such as weeds like *mogore* (invasive of the *aspillia spp*) now grow in the mountainous areas that used to

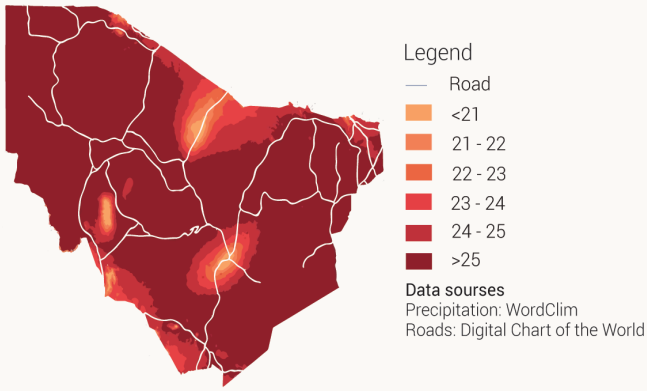
24 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m2, respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible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

Past and future impacts of climate hazards in Marsabit

Historical annual mean precipitation (mm/year)



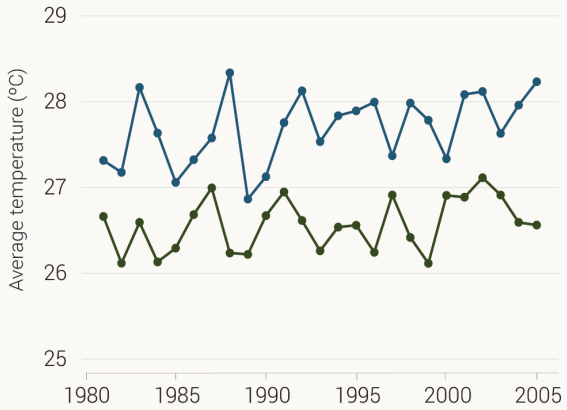
Historical annual mean temperature (°C)



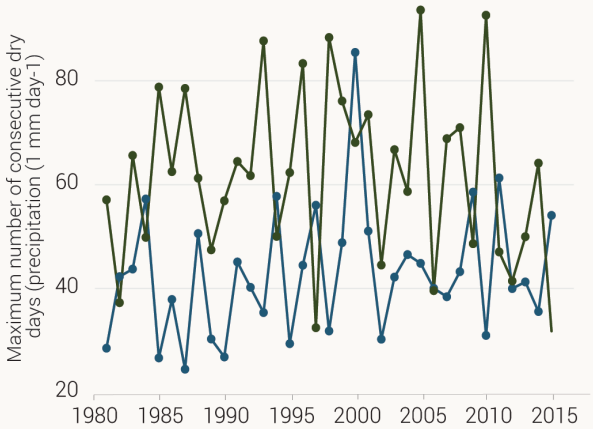
Heat stress hazards

Drought hazards

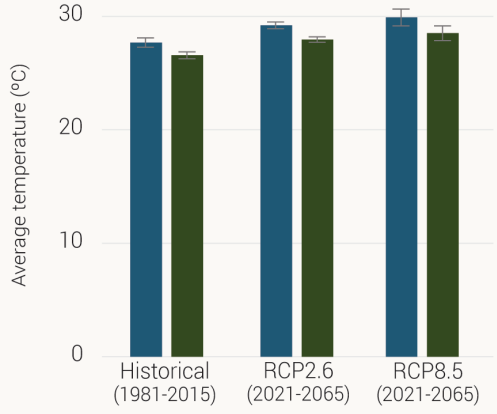
Historical extreme heat stress events



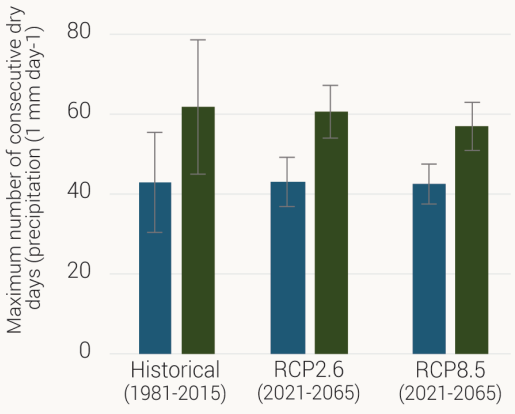
Historical drought stress events



Historical and expected extreme heat stress events



Historical and expected drought stress events



January - June July - December

be cooler. Moreover, the increased temperatures are also associated with higher incidences of pests. These include spider mites, nematodes, and Tuta absoluta species, which affect tomatoes in Moyale, and diseases such as the maize lethal necrotic virus (MLNV). The decline in maize yields and poor performance of pastures are attributed to increases in temperature.

Farmers note that climate change influenced change in social and economic structures of the communities in Marsabit. For instance, women have to travel long distances (over 6 km return distance against less than 3 km before) in search of water due to the drying up of water sources such as springs and boreholes. This affects their other household responsibilities. Men on the other hand have to spend more time moving with livestock in search of pastures and water. The frequent and prolonged migrations contribute to food insecurity among women and children who are left at home since the men move with the milking herd. Some households lose most of their livestock after drought, making it hard to recover by restocking. Sometimes men move to urban areas in search of alternative livelihoods that have more economic benefits than agriculture; this results in family disintegration and higher school dropout rates. These changes have resulted in occupation of the arable, high potential areas next to urban centres. For instance, some settlements have been developed around Marsabit Township. Poverty levels have increased as a result.

Climate vulnerabilities across agriculture value chain commodities

Across the county, climate change and variability pose serious threats to the identified value chains. The most important hazards that were identified include drought, high temperatures, and floods. The following section highlights the major climate risks faced by key value chains.

Goat (meat)

Drought and high temperature are identified as the most important hazards for goat (meat) production in Marsabit County. Drought causes both water and pasture scarcity, increasing incidences of diseases due to poor feeding. The resource-poor farmers are more affected as they cannot afford medication or fodder due to high costs especially when droughts become frequent and prolonged. Moreover, women and youth do not own significant resources that they can sell to sustain other livestock. They depend mostly on goats as they have limited access to land due to the patriarchal institutional arrangements common in most pastoralist societies. The old, sick, and disabled are affected more as their mobility is limited. Children are also affected by the frequent migration that result in dropping out of school[25]. The effect of drought varies from moderate to severe along the value chain.

High temperatures affect all stages of the goat value chain. Delivery of veterinary services is affected by high temperatures as storage of drugs becomes problematic; most of them require low temperatures to remain effective. The small-scale suppliers, especially those who supply drugs, are the most affected; high temperatures coincide with vaccination campaigns where government subsidizes the inputs, leaving the suppliers with low sales. At the production stage, the youth and women are affected more as they are involved in grazing and watering animals under the high temperatures. Goats are not able to feed well when temperatures are high. At the same time, they require more drinking water. This means more time under the shade to protect them from high temperatures. Incidences of pests such as ticks and diseases such as goat pox increase. Farmers incur high costs of replacing equipment such as Knapsack sprayers and syringes damaged by high temperatures; the poor farmers are therefore not able to replace the equipment effectively. At the post-harvest stage, women and youth are affected more as they have to move animals to bulking sites. Mainly youth are involved in transporting livestock to markets, which are in most cases far. High temperatures coupled with poor road infrastructure and undeveloped markets also affect the body condition of the goats, reducing sale prices. Transporters, especially to terminal markets, are also affected by high temperatures as animals arrive at markets when very weak, sometimes dead. The effect of high temperature ranges from moderate to severe along the value chain.

To cope with these hazards, the farmers migrate in search of better pastures, increase purchase of drugs and stock them, and buy water and fodder. Other interventions with potential to mitigate climatic challenges include establishing more drug stores, enhancing capacity on range management, establishing feedlots at the bulking sites, and standardizing market prices of inputs and outputs.

25 Primary education is supposed to be free but the extra costs levied are still high for some people.

Kale

Drought and high temperature are the most important hazards for the kale value chain. The consequences of drought include: reduced access to extension services, shortage of seeds and reduced availability of capital at input provision stage, reduced acreage planted, insufficient water for irrigation, and increased prevalence of pests and diseases at the production stage. Diseases of economic importance include Black rot (Leaf spot), alternaria leaf spot (Black spot, Gray spot), Anthracnose, Downy mildew, Root-knot nematode, and Cabbage looper. Pests include beet armyworm, Cutworms, flea beetles, thrips (Western flower thrips, Onion thrips), cabbage aphid, large cabbage white (Cabbageworm), and diamondback moth. The diseases and pests can be controlled using available agro-chemicals. However, the high costs of agro-chemicals limit their use. At the post-harvest stage, perishability is accelerated, reducing volumes of produce. This factor, coupled with high transport costs, leads to reduced incomes. The severity ranges from minor to moderate at the harvesting, storage, and marketing stages. Effects on provision of inputs and on-farm production are major to severe.

At the input provision stage, high temperatures lead to reduced extension services and moderate reduction of seed viability. At the on-farm stage, moderate to severe effects are experienced through reduction of working hours, high evapotranspiration, and increased pest and disease prevalence. The post-harvest stage suffers moderate to major effects due to reduced quality of produce; marketing is costly and reduces returns.

To counter the consequences of the identified hazards, extension providers use mass media and mobile phones to disseminate information while farmers use recycled seeds from previous seasons to counter seed shortages. Farmers harvest in the cool hours of the day and sprinkle water on the harvest when temperatures are high to maintain quality. Potential adaptation strategies include capacity building of actors, support for water harvesting, and promoting utilization and value addition of kales. Extension providers to promote growing of the right kale varieties for the different AEZ. This will benefit the farmers, especially the poor, disabled, and widows.

Teff

Drought and intense rain are the most important climate hazards for the teff value chain. Drought, which is also closely associated with moisture stress, limits extension services at the input provision stage as farmers have to walk long distances in search of water and pasture for livestock. Access to financial services is also hampered by frequent droughts, especially in view of the high production risks and lack of insurance schemes for crops. Though financial institutions are scarce, some finance is provided largely through credit by the Muslim community. Other inputs such as fertilizers, herbicides, and pesticides become prohibitively expensive for the farmers; this is due to high transaction costs occasioned by poor roads, few input suppliers, and low demand for the inputs as the purchasing power of the farmers is eroded by drought. Availability of seeds is affected by drought since farmers depend on recycled seeds from the previous season. At farm level, drought causes delay in land preparation, planting, and weeding. As a result, yields are low and sometimes the crop fails. Post-harvest operations and marketing are affected by low volumes available for processing, price increases, and low linkages due to reduced volumes.

Intense rain on the other hand results in flooding that destroys infrastructure, including roads, rendering access to inputs difficult. Extension services are also unavailable as the extension agents cannot access the farmers. Intense rain effects on-farm production activities such as planting, weeding, and, to some extent, harvesting. The rains delay planting, make weeding difficult and more labor-intensive due to faster regeneration of weeds, and impair harvesting due to lodging and rotting. Farmers are more affected by this hazard especially at the on-farm production stage due to their low resilience. To cope with these challenges, farmers prepare land after emergence of weeds. This allows destruction of the germinating weeds. To minimize losses during harvesting, the farmers cut and dry teff on raised beds. Potential adaptation strategies include mechanization, establishment of on-farm retention ditches, cut-off drains and soil conservation structures, use of herbicides, and timely harvesting.

Women, youth, and the illiterate are the most affected by the climate hazard. Women and youth have limited ownership to productive resources like livestock, hence rely on crops such as teff at production, harvesting, and processing for income. The illiterate are also most disadvantaged as they have limited options for alternative livelihoods.

Fish

High temperatures and drought are the most important hazards in the fish value chain in Marsabit County. Consequences of high temperatures along the fish value chain vary from stage to stage. At the input provision stage, it causes increased demand for the fishing gear due to damage caused by high

temperature. Reduced activity causes low demand of inputs such as fishing gear, affecting incomes. Volumes of fish caught are low and breeding decreases. Because of the high temperatures, monitoring of the fishing activities[26] is impaired. Some fishermen take advantage of this decreased monitoring to use inappropriate fishing nets and catch even the small fish. This compromises sustainability of the value chain. High temperatures cause faster spoilage of harvested fresh fish, necessitating high storage costs and reducing market value. On the other hand, high temperature has been used as a cost-effective means for fish processing especially sun-drying.

The consequences of drought are in many ways similar to those of high temperatures mentioned above. The adaptive capacity of the actors in the value chain, especially the fisher folks, is limited due to lack of alternative livelihood. Their literacy level is generally low as they become engaged in the value chain very early in life due to demand for labor.

Adaptation to climate change and variability

The capacity of pastoralists and farmers to adapt to changes in climate is impeded by various climatic, biophysical and institutional factors. Agricultural productivity in Mandera County is first and foremost challenged by water scarcity and pressure on the natural resource base. The arid and semi-arid nature of the county provides limited options for farmers to diversify their crop enterprise due to the fewer choices of crops that can survive the harsh climatic environment and the saline soils. Overstocking of livestock is a common underlying factor in the county, as livestock are regarded as a sign of wealth while cultural inhibitions restrict the sale of animals even during drought. The poor road infrastructure network

On-farm adaptation practices

At the farm level, the strategies adopted by farmers depend on various factors such as type of climatic hazard, education, income, location, availability of technology, and level of extension services. According to the survey by ASDSP in 2014, about 84 percent of all households adopted at least a strategy to the perceived climate change. The main adaptation strategies adopted include water harvesting, value addition, increased soil and water conservation, and tree planting. In livestock production, changing livestock type and value addition dominates. Generally, more youth-headed households have adopted more strategies to address climate change risks compared to male-and female-headed households. This is partly because the youth-headed households have more access to climate change information relative to the male- and female-headed households (95 percent, 86 percent and 81% respectively) (GoK, 2014).

Water harvesting strategies, especially in crop production, are practiced by about 65 percent of households (GoK, 2014). The strategies include roof tops water harvesting, fog harvesting, water pans, shallow wells, desilting of the existing dams, and use of water tanks. These initiatives are mainly supported by donor agencies, farmer groups, and the county government.

Value addition is more common for livestock products than for crop products. For livestock, 67 percent of households add value to meat, mainly by converting it into *Nyirinyiri* [27]. Fifty-five percent of households ferment milk and 22 percent make ghee. Almost half of the households process hides and skins by salting or sun-drying. Overall, 49 percent of households undertake value addition as a strategy against climate change with more youth-headed households using the strategy compared to female- and male-headed households (58, 57, and 45 percent respectively) (GoK, 2014). Constraints to value addition include poverty, undeveloped markets, inadequate skills, and limited access to utilities such as electricity.

Increased soil and water conservation is adopted by 47, 29, and 28 percent of youth-, female-, and male-headed households respectively. Soil and water conservation strategies include crop rotation, minimum tillage, intercropping, mulching, and terracing. Tree planting is also related to soil and water conservation. About 32 percent of the households practice tree planting, being42, 30, and 29 percent of youth-, male-, and female-headed households respectively. Kenya Forest Service (KFS) has been instrumental in promoting tree planting in the county. However, adoption of this strategy is influenced by scarcity of water and the land tenure system, which is largely communal.

Change in livestock type is common in livestock production; the households' preference is hardy livestock such as goats and camels. These are also browsers and perform well with the diminishing grazing land experienced in the county. About 11 percent of the households have taken up the strategy, being14, 11, and 11 percent of female-, youth, and

26 The County Fisheries Department is responsible for monitoring, and is complemented by the Ministry of Agriculture, Livestock, and Fisheries at national level.
27 *Nyirinyiri* preserving meat by frying and keeping in fat

male-headed households respectively). Given the higher number of challenges that face women-headed households, adoption of goat is viable since it requires less resources.

Other strategies adopted by the farmers include feed conservation, diversification of enterprises, planting of fodder fruit trees, early planting (dry planting), and destocking. They also change crop type especially to more drought- resilient varieties such as Katumani, DH04, and Nduma for maize, and other crops such as teff, sweet potato, cassava, millet, cowpeas, green grams and *miraa*[28]. However, these strategies are not widely adopted in the county due to lack of skills and social norms that limit especially female mobility. Poverty is another challenge limiting adoption of the strategies.

These strategies are inadequate considering the community at large since they are undertaken by individual farmers and pastoralists in an uncoordinated manner. In exploring desired or potential strategies with highest returns for future climate effects, the farmers and pastoralists propose appropriate planning, training on climate change, increasing water harvesting to include mega dams, enhancing destocking programmes, tree planting, commercial farming and promotion of drought-resilient crops. Other initiatives should include investing in small-scale irrigation, engaging in non-farm income activities, diversifying herd composition, practicing agroforestry, investing in livestock insurance, and undertaking water harvesting. However, both current and future strategies are constrained by poverty and lack of capital, inadequate policies, unreliable climate information, and inadequate knowledge on other livelihood options. These constraints can be alleviated through creation of awareness on climate variability, support to existing and potential livelihood strategies, access to market information, access to credit services, and adoption of conflict management strategies.

Off-farm adaptation practices

Off-farm services either support on-farm adaptation practices or improve preparedness for and resilience to climate shocks. These services include finance, infrastructure (especially irrigation), climate and agricultural services including early warning systems. The providers of these services are mainly government and private institutions including non-government, faith- and community-based agencies. Majority of households (67 percent) access these services from the private sector while 33 percent access them from the government. Due to the expansive size of the county coupled with the limited financial and human resources, the private sector is more accessible than the public sector. Disaggregated by gender, (40, 34, and 21 percent of the youth-, male-, and female-headed households have access to services from the government. Conversely, 79, 66, and 60 female-, male- and youth-headedhouseholds respectively have access to services from the private sector.) (GoK, 2014). This may be because female-headed households are targeted for particular off-farm services.

Agricultural services and infrastructure include extension, research, veterinary services, and dipping, accessed mainly from the public sector by approximately 62 percent of the households. More male-headed households access most of these services compared to female- and youth-headed households. For instance, 75 percent of male-headed households' access extension services compared to only 17 and 8 percent of the youth- and female-headed households (GoK, 2014). Similarly, access to veterinary services is high in male-headed households (50 percent) than in youth- and female- headed households (40and 12 percent respectively). However, access to dipping is high in youth-headed compared to male- and female-headed households (50, 38, and 13 percent respectively). Cultural patriarchy is one of the reasons explaining why males have better access to the services compared to females and youth. Extension services are offered by many organizations. They teach farmers the importance of using good agricultural practices that promote soil and water conservation; high-yielding, early- maturing crop varieties and animal breeds; and value addition. However, current demand-driven approaches in extension marginalize most farmers from accessing the services due to high costs.The vastness of the county coupled with insufficient human and financial resources, low technology adoption rates, and poor infrastructure add to the factors hindering access to the services.

Financial services available in the county include agricultural credit, insurance, and money transfer, mainly provided by the private sector. Credit enables farmers to undertake adaptive measures such as water harvesting, buying inputs, value addition, and fodder conservation. However, with most farmers relying on livestock, credit access is low as livestock is considered risky. Access to agricultural credit is high in male-headed households compared to both female- and youth – headed households (50, 25, and 25 percent respectively) (GoK, 2014). Male-headed households access more credit as they have more

28 Miraa is a stimulant. Although it is a commercial crop, its negative effects on consumers outweigh the benefits, hence little has been done to promote it. The effects include wastage of labour as the users spend much valuable time chewing miraa.

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

Kale

	Provision of seeds and other inputs	On-farm production	Harvesting storage and processing	Product marketing
Droughts	Reduction in stocks of suppliers due to low demand; reduced extension service delivery	Insufficient water for irrigation; Low affordability of labour services; reduced and weak family labour; low aquifer yield; high concentration of pests	High moisture loss after harvesting; accelerated perishability; low harvest per unit area; high transport cost	Consumers demand is high due to limited supply; reduced income by cooperatives
Magnitude of impact	Severe	Moderate	Moderate	Major
Farmers' current strategies to cope with the risks	Purchase from stockists; information through mass media and mobile phones; purchase from input suppliers	Start early before the season and early in the day; using of harvested water from micro-catchment; use of traditional IPM methods for pest control	Harvesting in the early morning and late evening; soak in water after harvest; transported in plastic bags on wheel barrows, motor cycles, bicycles and other informal vehicles	Use of mobile phones to make orders; use of word of mouth during selling; sale as individuals and small groups
Other potential options to increase farmers' adaptive capacity	Promote saving and seed sourcing through cooperatives; capacity building of stockists; establishment of farmer field schools; savings and sourcing through cooperatives	Subsidized vegetable production equipment and services; construction of mega water harvesting structure; support capacity building on IPM	Capacity building on post-harvest handling; establish cold rooms at bulking sites; road infrastructure development and maintenance	Use mass media to share market information; promotion on utilization and value addition; formation of large marketing groups (cooperatives); training on commercial village model
Increased temperatures	Reduced seed viability; Reduced mobility of extension services	High temperatures affect working hours; increases in irrigation water loss and plant transpiration; high concentration of pests in the few existing and productive areas	High moisture loss leading to reduced quality; increased field heat during bulking; high moisture loss during transportation; reduced stability of leaves	High cost of promotion; low production and contribution of providers; reduced income
Magnitude of impact	Moderate	Major	Major	Moderate
Farmers' current strategies to cope with the risks	Preservation of local seed varieties; use of mass media and phones to share weather information; individual procurement from input suppliers	Working early in the morning and only for a few hours per day; reduced watering intervals, mulching and watering during cool hours; use of cultural methods to control pests and diseases	Harvesting done during cool hours and water sprinkled during hot hours; use of plastic bags for storage; transport to market using informal transport	Use of mobile phones to get market information; use of word of mouth to promote their products; sale as individuals and small groups
Other potential options to increase farmers' adaptive capacity	Encourage seed conservation. Promote collective procurement of seed and other inputs (particularly during droughts).Scale up farmer field schools	Working early in the morning and only for a few hours per day; reduced watering intervals, mulching and watering during cool hours; use of cultural methods to control pests and diseases Support subsidized mechanized vegetable production (land tilling); support use of water efficient technologies e.g. shade nets, greenhouses, drip irrigation; support capacity building on solarisation of soil and IPM.	Capacity building on post-harvest handling; support purchase of equipment for drying of vegetables; support establishment of cold chains in established production sites; training on kale value addition technologies like solar drying	Invest in use of mass media for marketing information (local dialect); support formation and capacity building of new and existing marketing associations; support feeder road construction and maintenance

Teff

	Provision of inputs	On-Farm production	Harvesting storage and processing	Product marketing
Intense rainfall	Farmers not able to access extension officers and inputs (seeds) from the market due to inaccessibility of roads; poor access to credit and financial institutions	Rotting of seeds; wash away of seeds; regeneration of weeds making weeding difficult; lodging and rotting making harvesting difficult	No harvesting takes place and roads to transport for processing are inaccessible; poorly stored produce get affected by water; rotting of produce	Difficulty in accessing markets due to poor road networks; low market supply; hiking of prices
Magnitude of impact	Moderate	Moderate	Moderate	Moderate
Farmers' current strategies to cope with the risks	Use of stored seeds from previous crop harvest; use of indigenous technical knowledge; use of own resources (land, preserved seeds, labour)	Sow seeds 2 weeks after onset of rains or wait till first torrent rains are over; prepare land and sow seeds after weeds have emerged	Processors source produce from alternative markets; store on straw i.e. delay processing; use of donkeys to transport; cut and dry on beds arranged in apex form	Keep produce for domestic consumption; increase price due to low volumes; purchase from other markets
Other potential options to increase farmers' adaptive capacity	Provision of certified seeds to farmers during dry spell; research on suitable seed variety; provision of extension services to farmers during dry spell; establish a financial package suitable for financing teff farming	Establishment of on farm retention ditches, cut off drains and other soil and water conservation structures during dry spell; use of pre-emergence chemical weed control	Establishment of cottage processing centers near the farms; provision of portable processors; construction of good storage facilities during dry period; timely and mechanized harvesting; use of driers	Upgrading (tarring) of roads connecting to other markets; support traders financially to procure teff from Ethiopia and other markets
Droughts	Farmers unavailable for trainings due to having moved in search of livestock pasture and water; reduced seed availability; reduced finance availability	Delayed planting while awaiting rains; delayed weeding during dry spells; low crop production due to moisture stress	Low production causes low volumes available for processing. Reduced harvests	Little produce is available for outside markets; prices increase due to low supply
Magnitude of impact	Moderate	Major	Moderate	Major
Farmers' current strategies to cope with the risks	Use of seeds stored from previous seasons; use of indigenous agronomic knowledge	No planting; no weeding to prevent excess moisture loss; timely harvest	Source produce to process from other markets; limited storage; sales directly to consumers	Sales to middlemen and local markets; transport to better markets using informal transportation (mostly donkeys)
Other potential options to increase farmers' adaptive capacity	Provision of certified drought tolerant seeds; development of drought information and awareness materials; establishment of demo farms for drought resistant varieties; establishment of teff financing mechanisms; subsidized inputs	Early/dry planting; establishment of micro water harvesting and irrigation structures; use of pre emergence chemical weed control	Provision of portable processing machines to farmers; support packaging and labelling; construction of appropriate storage facilities; establishment of cottage industries for processing near farms	Formation of marketing cooperatives; establish teff drought insurance scheme; improve teff advertising (e.g. posters); contract sales to institutions e.g. hospitals, schools

Goat (meat)

	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
Droughts	Lack of finances for veterinary services; unaffordable equipment due to low income (poor prices)	Reduced feed and pasture availability; lack of water; no breeding due to poor body condition; increased labour costs for water and feed provision	Reduced bulking due to movement of animals and farmers for water and feed; increased slaughtering; reduced transport service	Poor animal body condition; uncertainty in availability and prices for consumers; reduced markets for skin; poor quality hides; low prices for live goats
Magnitude of impact	Moderate - Major	Moderate - Major	Major - Moderate	Major
Farmers' current strategies to cope with the risks	Storage of vet drugs at home; watering at community wells; women and children feed the weak animals at home	Migration to areas with good pasture and water; home diagnosis and treatment of sick animals; mass vaccination by government	Herding goats to sales point; slaughter small and weak animals; use of informal transport of animals to market	Selling directly to buyers and bypass middlemen; skin used at home as saddle; home consumption
Other potential options to increase farmers' adaptive capacity	Decentralized vet drug stores and mobile clinics at watering points; training on benefits of re-usable needle and syringes; improve water services (boreholes, dams); destocking	Capacity building on grazing planning and fodder bulking; introduce superior breeds; controlled breeding; evidence based treatment; capacity building on routine vaccination	Construction of holding areas and feed lots at bulking sites and marketing points; improvement of slaughtering facilities	Promote sales by weight and introduce standardization system; livestock auctions, goat marketing days and mobile markets at grazing points; improve markets for byproducts (e.g. goat skin); improve market information
High temperatures	More vet service required (drugs for stress); spoilt drugs; labour input increases hence the costs	Poor quality of feed and pasture; animal stress and poor body condition; cost of treatment increases	Meat spoilage; goat deaths during transportation; increased time for trekking of goats	Increased supply; high spoilage and less quality of the skin hence reduced prices
Magnitude of impact	Minor - Major	Moderate - Major	Moderate - Severe	Moderate - Major
Farmers' current strategies to cope with the risks	Home storage of drugs; spraying animals using tree branches; borrowing of equipment; division of labour (family members are assigned different task/duties); increase animal watering intervals	Migration in search of good forage; sending people to look for reliable grazing zones; cutting down of tree branches for feed; non evidence based treatment; government vaccination (at irregular intervals)	Early and late evening and night transportation; early slaughtering of goats when temperature are cool; trekking of animals at morning, nights and late evening; increased slaughtering	Watering interval reduced to improve body condition; immediate selling of skin; traditional market without facilities
Other potential options to increase farmers' adaptive capacity	Establish drugs stores & mobile clinics at convergence zones; use of modern spraying methods (e.g. dip, spray race); use of generator to pump water; improved breeds (galla); drought awareness raising	Grazing zone conservation; rangeland mapping; establish grazing management committees; capacity building on breeding management, feed production and conservation; evidence based treatment (laboratory diagnosis)	Establish improved (shaded) holding/resting areas; improve slaughtering facilities e.g. storage; invest in ventilated and refrigerated transportation	Organised marketing channels with market facilities; setting aside marketing days; establishment of feedlots at strategic marketing points

Fish

	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
High temperature	Degradation of fishing gears (fishing nets, life jackets); reduced activity; high temperature affects movements	Reduced catch as fish move to deeper waters; high temperatures leads to slow sexual activity among the fish; monitoring activities reduced; heat affects fisher folk productivity	Reduced gutting activities; ice in cold chain melts faster; high refrigeration costs; high cost of transportation; rotting of fish	High temperature contributes to high maintenance cost of refrigeration; when the catch is low, marketing or promotion activity is low; low market supply
Magnitude of impact	Moderate	Moderate	Major	Moderate
Farmers' current strategies to cope with the risks	Fishing using baskets, rafts/canoes and spears; use of non-standard fish nets; borrowing nets & equipment from community members	Fishing in the cool morning/evening hours; fishing in deeper offshore waters; allowing children to conduct shore fishing	Use of ice and small fridges for storage; sun drying of fish	Promotion of fish eating culture; sales at local markets; sales to traders/ middle men from other regions; reduce prices
Other potential options to increase farmers' adaptive capacity	Use of modern fishing gear &motorized boats; county specific skills development using local language; support microfinance access for fishers	Use of motorized boats with cooler boxes/ice packs; restrict fishing in breeding areas; enforcement of fishing net size standards; routine inspection to be undertaken by BMVs and KWS and fisheries staff	Research on fish population movements; invest in local cold storage facilities; invest in local fish processing facilities; improve sanitation at landing sites	Encourage group (refrigerated) transportation; identification of high value markets; improve market information (price & market shocks)
Droughts	Low acquisition of fishing gear (affects equipment suppliers); all resources re-directed to emergency and recovery; microcredit reduced	Reduced catch since fish migrate to deep water; fishing in breeding sites; use of illegal net sizes increases drastically	Reduced use of gutting slabs; increased ice melting; less fish will be transported	High (refrigerated) transportation costs; little catch leading to less marketing activities; less supply to markets
Magnitude of impact	Moderate - Major	Major	Moderate	Moderate
Farmers' current strategies to cope with the risks	Use of dhows; natural way of doing the business (traditional way of passing message); story telling in the morning and evening; borrowing from family members	Fishing at night during cool hours of the day; do fishing in breeding zone unknowingly; no standardized nets among fishing community	Reduction of labour and closing of gutting slabs; on site fish drying before transportation; establishment of cold rooms	Sales of dry fish in Kisumu and western region (bulking of daily catch can take two weeks); on-site marketing as opposed to transporting to market
Other potential options to increase farmers' adaptive capacity	Use of motorized boats &modern nets; training on modern fishing technologies; support access to formal finance for fishers	Night fishing using motorized boats; breeding site protection by BMV and fisheries staff; KWS and marine deployment at Sibilio National Park (to reduce poaching); regulate minimum fish size allowed; control pollution of the lake	Purchase of gutting equipment to enable standardized processing and increase value; build cold rooms in fish landing sites; strengthen cooperatives (equipment and training)	Improve traditional fish marketing systems; mapping of new markets; support to access new, high value markets

resources than female- and youth-headed households. The Kenya Livestock Insurance Programme (KLIP) has piloted the Index Based Livestock Insurance (IBLI) in the county with the objective of cushioning farmers from unforeseeable climate risks. IBLI[29] is offered by UAP, Apollo and Pan Africa (APA) Insurance and Takaful, which are private institutions. IBLI is also adopted across households though uptake is still low due to lack of knowledge about the insurance and unfavorable pricing among other factors. Campaigns for the insurance are on-going. The government in collaboration with donors assists the poor households in insuring at least five tropical livestock units (TLUs) for free[30].

Input and output markets play a critical role in promoting the on-farm adaptation strategies. Input markets include the agro-vet shops which supply the chemicals and seeds together with farm tools. Output markets are largely the livestock markets due to dominance of the sub-sector. The county government together with donor partners have established various markets across the county, including those in Olturot, Moyale, Merille, Illaut, Korr, Sololo, Turbi, Arge, Dabel, Forole and Jirime.

Climate-related information includes weather forecasts mainly provided by the Kenya Meteorological Department in collaboration with the Department of Agriculture, Livestock and Fisheries, and NDMA. Disease outbreak warnings are provided by the Veterinary Department; they inform farming plans and improve preparedness. However, 95 percent of the households access the information from the private sector. Fifty, 25, and 25 percent of male-, female-, and youth-headed households access the climate-related information. Probably due to the culture, where men make most of the household decisions. However, resource constraints limit farmers' and pastoralists' response to the information in time.

Policies and Programmes

In recognition of the challenges posed by climate change, Kenya has enacted various policies, legislation, and strategies to address them and meet international obligations. These include national and local policies and strategies in addition to various programmes supported by various actors including international, local, and community organizations.

The National Climate Change Response Strategy (NCCRS) was launched in 2010 as first guide to addressing climate change. It aimed at enhancing understanding of the global climate change regime and the impact of climate change to ensure a climate-resilient Kenya. The strategy highlighted various measures addressing climate change adaptation and mitigation in all sectors of the economy (CIFOR, 2014). In agriculture, the strategy proposed application of a range of innovative technologies such as irrigation, early-maturing and high-yielding crop varieties, drought- and pest-resistant crop varieties, and disease-resistant livestock types. It also advocates diversification. The National Climate Change Action Plan (NCCAP) 2013–2017 was developed in 2012 to operationalize the NCCRS by guiding the country's development so that it is on a climate-resilient and low-carbon path. This includes planting trees as also advocated by the Constitution of Kenya 2010, which provides for maintenance of at least 10 percent forest cover of the land area. Consequently, the Kenya Vision 2030 targets planting of at least seven billion trees to address food, water, and energy security (GoK, 2013b) As a result, various institutional and legislative arrangements can be identified in Marsabit County to provide for implementation of the actions identified.

The Forest Act of 2005 established the Kenya Forest Service (KFS) and mandated it to develop, manage, and conserve the forest resources in Kenya. In Marsabit County, KFS continues to protect the forests and promote tree planting in collaboration with other stakeholders. KFS and the Department of Youth Affairs and Sports, through the *Kazi Kwa Vijana Programme*, have been involved in afforestation campaigns and provision of tree seedlings to institutions. KFS also promotes agro-forestry and protects gazetted forests. However, a major challenge to tree planting is the harsh weather conditions coupled with limited resources. Other constraints include deforestation and encroachment upon forests due to dependency on firewood and overgrazing; moreover, enforcement of environmental provisions such as restriction on charcoal burning is weak.

The Environmental Management and Coordination Act of 2009 established the National Environmental Management Authority (NEMA). NEMA is tasked with guiding and overseeing enforcement of the legislation on the environment. NEMA promotes measures to conserve soil and water especially in riparian areas. It enforces regulations such as the distance allowed from a water body for settlement or cultivation. For instance, farmers are encouraged to plough 30m away from

29 The insurance project was developed in partnership with the Nairobi-based International Livestock Research Institute (ILRI), Cornell University and the Index Insurance Innovation Initiative programme at the University of California. Commercial partners Equity Bank and UAP Insurance Ltd implement the programme. The IBLI project is funded by the United States Agency for International Development, the European Union, the British Government, the World Bank, the Micro insurance Facility, and the Global Index Insurance Facility.

30 *One unit represents one cow, 10 goats, 10 sheep, or 0.7 camels, with the payout per unit set at KSH 14,000 (US$140). The amount is based on how much it would cost to keep animals alive rather than replace them.*

rivers to avoid soil from being swept downstream into the rivers. The legislation is aimed at protecting the environment, including water catchments[31]. To protect these catchments, trees are planted along the rivers and lakes; human settlements are discouraged around these areas. Other collaborating agencies are the Water Department, the Irrigation and Drainage Department, the Ewaso Nyiro North Development Authority (ENNDA), and the Water Resource Users Associations (WRUAs). They collaborate in safeguarding the wetlands and sensitizing the public on environmental conservation. Farmers are expected to participate in conservation of the environment, including water. NGOs, CBOs and FBOs provide support through capacity building of farmers in environmental planning and management in addition to provision of tree seedlings. However, implementation of the Act by NEMA faces challenges including inadequate staff and resources, poor attitude by communities towards environmental conservation, over-exploitation of forest resources, illegal charcoal burning, and inadequate training facilities.

The Agricultural Sector Development Support Programme (ASDSP) was formulated by the national government and operates in all counties[32]. In Marsabit County, ASDSP continues to support farmers to be resilient. The interventions target various value chains including camel milk, meat goat, and honey. The activities include capacity building in collaboration with other partners in areas such as dissemination of weather information together with local people, NDMA, KMD, and extension officers. Some of the challenges hindering effective implementation of the programme include lack of proper coordination on related activities at the county level; lack of clear policy; inadequacy of information including data to inform policy decisions; lack of funding for climate change interventions such as payoffs and rewards for environmental conservation; and limited sharing of information among partners. Thus there is need to improve coordination by identifying and supporting leading actors; increase funding; and set up sustainable interventions to mitigate climate change.

The national land policy aims to streamline land management and administration; review existing land laws and address past problems including inequalities in access to land, land tenure issues, underuse or abandonment of land, and overexploitation and unsustainable use of land. This also includes management of trust lands with significant forest resources in line with the Constitution of Kenya 2010. The County Land Adjudication Board continues to facilitate land demarcation. Cultural attachment to communal land coupled with insecurity still pose a challenge to land demarcation.

The Crop Act (2013) seeks to accelerate the growth and development of agriculture, enhance productivity and incomes, improve investment climate and efficiency of agribusiness, and develop agricultural crops as export crops. The Ministry of Agriculture carries out its interventions with the aim of meeting the requirements of the Act. Thus, the interventions include providing certified seeds and fertilizers for crop production; promoting drought-resilient crops; sensitizing communities on diversification; training farmers on utilization of emerging food crops; introducing seed-bulking sites; sensitizing and training farmers on the use of quality and certified seed; training farmers on soil conservation techniques; rehabilitating and re-seeding pasture land; training farmers on use of alternative draught animals such as donkeys and camels; and training farmers on modern farming technologies. However, implementation of the Act faces challenges including persistent drought; lack of inputs; insecurity; wildlife menace; conflict between agro-pastoralists and pastoralists; lack of knowledge on utilization of some crops such as sorghum and cassava; limited sources of quality and certified seeds; soil degradation; lack of modern farming tools; and underutilization of modern farming technologies.

The National Environment Policy (2013) aims for a better quality of life for present and future generations through sustainable management and use of the environment and natural resources. Specifically, one of the objectives of the policy is to strengthen the legal and institutional framework for good governance, and effective coordination and management of the environment and natural resources. Institutions including NEMA, KFS, and county government especially DoALF drive implementation of these legislative documents. However, attitude towards environmental conservation coupled with weak enforcement reduce the effectiveness of the interventions.

The Energy Act (2006) aims at helping to mitigate climate change by encouraging the use of energy- efficient equipment and renewable energy sources. Also, the Forest Conservation and Management Act (2016) aims at helping mitigate climate change by encouraging the use of energy-efficient equipment and renewable energy sources. Marsabit County has developed the Marsabit County Energy Development Act 2016 to provide for renewable energy and serve related purposes. These efforts aim at reducing pressure on forests and natural vegetation to tame effects of climate change while improving the welfare of the people. However, implementation of these legislative efforts is

31 The major water catchment areas are Mt. Marsabit and Mt. Kulal.

32 *This discussion is not exhaustive of all the programmes and projects in the county. See http://kenya.droughtresilience.info/counties/marsabit for a detailed overview of the on-going resilience programs and projects in the county.*

limited by high poverty levels. Another limiting factor is that most land is under communal land tenure, discouraging adoption of the recommended strategies. The strategies include reducing firewood use while adopting other forms of energy such as solar energy and wind power.

The National Drought Management Authority Act (2016) established the National Drought Management Authority (NDMA). NDMA is an agency of the Government of Kenya mandated to establish mechanisms which ensure that drought does not result in emergencies and that the impacts of climate change are sufficiently mitigated. In Marsabit County, NDMA interventions include production and dissemination of Early Warning Systems in collaboration with other organizations such as KMD, ASDSP, and local communities, mainly traditional forecasters. These interventions are effected through Participatory Scenario Planning (PSP). NDMA is also involved in distribution of drought relief food. However, due to frequent droughts, most of the interventions then remain mitigation at the expense of sustainable ones.

The Wildlife Conservation and Management Act of 2013 was established to compensate any personal injury or destruction of property by wildlife. Inasmuch as the policy clearly outlines the process of compensation, the effectiveness of this policy has often been questioned by the local people following many claims that have never been compensated. The ineffectiveness was attributed to lack of appropriate wildlife monitoring mechanisms by the Kenya Wildlife Service (KWS).

There is a range of overlapping sectorial policies at the county level; they include those on agriculture, energy, and forestry that are not fully integrated. Despite their existence, the policies do not adequately address the vulnerability of communities or their exposure, resilience, and adaptive capacity to the impacts of climate change. Similarly, they provide little guidance for the development of landscape level climate change mitigation measures. Thus, there is need for the county to formulate an exclusive and comprehensive climate change policy and legislative framework that creates, or sets out the mandate of a leading institution that will spearhead the county's efforts in climate change adaptation and mitigation. This will make it possible to mainstream climate change into all sectors of the Marsabit economy, as reflected in the National Climate Change Response Strategy and the Vision 2030.

Governance, institutional resources, and capacity

Organizations that directly or indirectly deal with climate change and related risks in Marsabit County include government (both national and county), non-governmental, community-based, faith-based, and private entities.

The national government institutions operating at the county level with activities that have climate aspects include the NDMA, NEMA, KWS, KFS, ASDSP and KMD. The county departments include DoALF, Irrigation and Drainage Department and Department of Environment among others. Parastatals include Ewaso Nyiro North Development Authority (ENNDA), KALRO, and National Cereals and Produce Board (NCPB). These organizations and departments provide support that range from infrastructure, extension, input provision, marketing, regulation, research and policy support.

NDMA is the only organization that directly deals with climate change risks. It is tasked with coordinating and harmonizing multi-stakeholder responses to drought, coordinating assessments and providing Early Warning System (EWS) information to households and other stakeholders in collaboration with the KMD. NEMA regulates various environmental projects. ASDSP provides policy support, promotes climate-smart technologies such as the greenhouse technology, disseminates the EWS in collaboration with KMD and the community; and carries out capacity building of farmer-based organizations. However, the programme is constrained by resources and sometimes the funding is delayed, affecting the planning and implementation of activities. KALRO is involved in research development and promotion of drought-resilient technologies and management practices for crops and livestock. KFS facilitates implementation of government policy, reforestation, promoting agro-forestry, and providing technical advice on conservation matters. KWS is involved in management of wildlife and conducting trainings on the importance of conserving wildlife. DoALF provides extension services, inputs such as seed, vaccination of livestock, and promotion of pasture and range management. The County Government plays the role of coordinating the various stakeholders at the county level.

International organizations that are supporting climate change activities in the county include: World Food Programme (WFP), VSF Germany, Concern Worldwide, German Technical Cooperation (GIZ), International

Livestock Research Institute (ILRI), the International Union for Conservation of Nature (IUCN), Kenya Red Cross Society, and Food and Agricultural Organization (FAO). These organizations complement government funding through various programmes. The funding supports infrastructure such as water tanks and provision of agricultural inputs and extension services. These organizations operate directly, or through government, especially relevant county departments, or local non-governmental organizations (NGOs).

Financial institutions are also involved in climate-related activities. Equity Bank collaborates with ILRI and UAP Insurance to provide Index-Based Livestock Insurance (IBLI). IBLI aims at protecting livestock keepers – particularly in the drought-prone ASALs – from drought-related livestock losses. However, the uptake of insurance is still very low partly due to lack of information about how the insurance works, high pricing, and limited scope of insurance cover. Kenya Commercial Bank (KCB) has also promoted agricultural activities such as training youth on hydroponic technology and livestock wealth creation through the livestock tagging system. Other financial institutions include APA insurance, Barclays Bank, Cooperative Bank, Bi-High Sacco and Safaricom (Mpesa) outlets.

There are local NGOs, Faith-based organizations (FBOs), Community-based organizations (CBOs) and Farmer-based organizations in the county that play a role in combating climate change[33]. They support capacity building of farmers in project identification, design, implementation and management, assist in provision of material and financial support to farmers and those in environmental conservation. Cooperatives provide farm inputs and train members on new technologies and innovation, savings, credit, and marketing.

The Private Sector acts as a source of agricultural and livestock inputs and also provides market to farmers. SIDAI Africa is the largest supplier of agricultural inputs such as drugs and equipment in Marsabit County. The organization also provides extension services to farmers. Other suppliers of inputs are general dealer shops that are mostly found in urban areas.

Coordination among these organizations exists, but only at some stages of design and implementation. Much collaboration was reported within government departments. However, other than for a few cases, NGO-to-NGO collaboration and NGO-to-government department collaboration was minimal or lacking. This may be due to the fact that most of these NGOs are autonomous. However, NGO- to-NGO collaboration and NGO-to-government department collaboration could be strengthened through joint planning and sharing of information. Local potential beneficiaries are consulted on topics related to land tenure regimes and the general acceptability of the intervention in the planning phase, yet their engagement in subsequent steps is limited.

Influence on county government departments comes from the respective national offices. Nevertheless, when it comes to planning and implementation of development interventions, the government departments in the county and NGOs have significant influence on the choice of approach and location of interventions. Some donors also have specific objectives which may not allow for adjustments at county level. The source of funding also influences operations; some sources, especially government, involve lot of bureaucracy, thus delaying operations. Besides planning for development interventions, the government departments also take part in responding to emergencies within their mandate.

In order to scale up interventions in climate change risk management, there is need for more financial and technical support to the organizations that play various roles related to climate change. Various factors impair institutions' capacity to intervene in climate change initiatives. The organizations interviewed mentioned inadequate finances as the biggest challenge; and in cases where funding was available, it was not timely. In addition to the deficiency of staff in these organizations, the available staff are less conversant with climate change issues, hence training should be enhanced. The County Steering Group is one of the avenues to foster coordination and collaboration among the various actors. Frameworks at county level that coherently describe who, and how to enforce policies for climate change are necessary.

Synthesis and Outlook

Climate change and variability in Marsabit County is anticipated to be more adverse to the agricultural sector in future, with expectation of more frequent and prolonged dry spells, high temperatures, and floods. As a result current agricultural planning and development needs to take adequate consideration of these hazards and ensure that agricultural investments (and indeed

33 Local NGOs include Horn of Africa Development Initiative (HODI), Care Kenya, CIFA, PACIDA, BOMA, and FH-K ; FBOs include CARITAS, Milimani Group, Dirib Gombo Islamic Propagation Centre, and Gabare Jabatu; CBOs include Environmental Management Committees (EMCs) and Trusts such as Jaldesa (Northern Range land Trust) ; Cooperatives include Mt. Marsabit Dairy

all county investments) are resilient to these threats.

In addition, underlying factors which affect the ability of farmers and pastoralists to cope with and adapt to changes in weather and climate must be addressed. These include high poverty and illiteracy levels, poor infrastructure, dependence on rain fed agriculture, conflicts over water and land resources and undeveloped markets.

Some of the main adaptation strategies practiced in the county include water harvesting, value addition, soil and water conservation, tree planting, feed conservation, and change of livestock and crop type to more drought-resilient varieties or breeds types. Other strategies involve seeking off farm employment, diversifying into alternate enterprises, crops or livestock species as a risk spreading strategy, and/or dropping out of pastoralism completely. However, proper planning and training on climate change adaptation, large scale water harvesting for both livestock and crops, destocking programmes, fruit tree production, commercial farming, promotion of drought-resilient crops and livestock, investments in small-scale irrigation and diversification into off-farm income activities could yield better results in terms of building long term resilience as opposed to the short term coping strategies and emergency response measures relied upon by households at present. Greater investment in processing and value addition infrastructure would be of great benefit across various value chains including livestock, fish, fruits, vegetables and staple crops.

Addressing the policy challenges and gaps through development of local level legislation and enforcement of environmental and climate change laws is crucial. Good governance, and establishment of a body responsible for addressing climate-related risks will also help to increase institutional capacity to deal with climate hazards.

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