Climate Risk Profile
Elgeyo Marakwet County

Highlights

- Agriculture generates revenue for more than half (78%) of the households in Elgeyo Marakwet mostly through engagement in crop and/or livestock husbandry activities. It also accounts for 66 percent of household incomes; mostly from crop related activities.
- Food and nutritional insecurity in the county is high with 73.3% of the households being food insecure and worsened by the high poverty levels, which stand at 57% compared to the national average of 46%. The youth and children are the most affected by poverty and food insecurity with 30 % of the children under the age of five years stunted due to malnutrition.
- The County has three distinct topographical zones: the Highlands, the Escarpment, and the Valley. The Highlands (49 percent of the total land area) are suitable for dairy cows, sheep for wool, potatoes, maize, wheat, and beans production. In the escarpments (11 percent of the total land area), there is cultivation of maize, millet, sorghum and beans even with high risk of soil erosion, landslides and rock falls. While in the Valley (40 percent of the total land area which is semi-arid), the farmers keep zebu cattle, poultry, goats and sheep; grow crops such as fruits, millet, sorghum, groundnuts and green grams. Most of the farmers are smallholders with an average of 1.36 ha; the few large-scale farmers have an average of 17.3 ha (GOK 2013).
- Climate hazards experienced in the county include intense rainfall, increased temperatures and extended drought periods. These hazards have affected crop and livestock yields, increased costs of production as well as increased vulnerability of women and youth.
- Surveys have shown that despite 59% of households having experienced changes in the environment and climate, adaptive capacity is still low with only 11% of households having undertaken any long-term adaptation strategies, the main strategies being tree planting and changing of crop types. There is need to increase farmers' capacity to adapt through a wide range of technologies and actions identified through inclusive participatory approaches.
- Adaptation strategies employed by livestock farmers during prolonged drought periods include feed conservation techniques such as silage making, planting drought-resistant and faster-maturing pasture varieties; keeping improved livestock breeds, use of water harvesting technologies to conserve water for future consumption and increased diversification through integration of crops with livestock.
- Crop farmers employ strategies such as soil and water conservation strategies, adjustment of planting dates and use of improved crop varieties. Off farm services, include supply of subsidized inputs (e.g. improved seed varieties), extension services and early warning systems.
- County plans and budgets seldom provide for climate change adaptation initiatives supported by the county government. Thus, the County needs to mainstream climate change in their planning and budgeting to enable successful implementation and substantial impact on agricultural production systems and communities.
- Many institutions (county, national, international, private sector and civil society organizations) exist to support agricultural development but it is important to forge stronger and better linkages among them especially on climate risk management to develop interventions tailored for local needs and eliminate duplication of efforts.

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

List of acronyms

ADC	Agricultural Development Cooperation
AEZ	Agro-ecological Zone
AI	Artificial Insemination
AIC	African Inland Church
ASDSP	Agricultural Sector Development Support Programme
CBO	Community-Based Organization
CDF	County Development Fund
EDA	Equitable Development Act
EMPCS	Elgeyo Marakwet Potato Farmers' Cooperative Society
ERA	Economic Review of Agriculture
GoK	Government of Kenya
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDA	International Development Agency
IIEC	Iten Integrated Environmental Conservation
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agricultural and Livestock Research Organization
KAPSLM	Kenya Agricultural Productivity and Sustainable Land Management Project
KCC	Kenya Cooperative Creameries
KCSAP	Kenya Climate-Smart Agriculture Project
KDB	Kenya Dairy Board
KES	Kenya Shillings
KFA	Kenya Farmers Association
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forestry Service
KMD	Kenya Meteorological Department
KVDA	Kerio Valley Development Authority
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NDMA	National Drought Management Authority
NEMA	National Environmental Management Authority
NGO	Non-governmental Organization
PSP	Participatory Scenario Planning
RVF	Rift Valley Fever
SMS	Short Message Service
TIMPs	Technologies, Innovations, and Management Practices
VCC	Value Chain Commodity
WARMA	Water Resources Management Authority

Foreword

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

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

This document presents the Climate Risk Profile for Elgeyo Marakwet County, where livelihoods are significantly threatened by climate variation. The County is vulnerable to both droughts and floods. The drought event that occurred in 2017 left countless livestock and at least 10,000 households at the verge of starvation[1]. Due to the poor body condition of livestock during the drought, a cow that previously fetched up to KES 50,000 sold for as low as KES 1500[2] . Scarcity of water and pastures most frequently lead to inter-communal feuds, which result inloss of assets. While dry spells are problematic, above-normal rains also result in losses. For instance, in 2012, landslides that came as a result of heavy rains resulted in loss of property in Simit, Kapsokom, Kaptarkom, and Toroplongon[3]. The adverse effects of the extreme events have heightened food insecurity and poverty in the County, necessitating food aid. Among other food interventions in the County, the County Government dispatched a consignment of 2,500 bags of maize and beans to seven wards following the 2017 drought. Looking into the future, climate change is likely to have extreme effects on Elgeyo Marakwet. A need therefore exists to come up with strategies to ensure resilience in the long run.

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 http://www.the-star.co.ke/news/2017/03/21/drought-in-the-north-rift-so-severe-herders-are-selling-a-cow-at_c1520149
2 http://www.the-star.co.ke/news/2017/03/21/drought-in-the-north-rift-so-severe-herders-are-selling-a-cow-at_c1520149
3 https://www.google.com/amp/s/www.standardmedia.co.ke/mobile/amp/article/2000073887/10-killed-in-marakwet-landslides

Agricultural context

Economic relevance of farming

Elgeyo Marakwet County borders West Pokot to the North, Baringo to the east, Trans-Nzoia to the north-west, and Uasin Gishu to the west. Agriculture is the main economic activity in the County, contributing 66 percent to household income and absorbing 53 percent of the labor force. An estimated 83, 46, and 77 percent of the male-headed, women-headed and youth-headed households respectively are engaged in crop and/or livestock farming (GOK, 2013; GOK, 2014a).

The County produces both food and cash crops that vary with the agro-ecological zones. In the Highlands, farmers produce crops like maize, wheat, Irish potatoes, and beans while in the Lowlands they produce drought-tolerant crops like sorghum, millet, groundnuts, cowpeas, and fruits that include mangoes, pawpaw, watermelon, oranges, and bananas. The Highlands are suitable for dairy, poultry and sheep farming while the Lowlands favor, Zebu cattle, poultry sheep and goats. The main industrial crops produced, namely tea, pyrethrum, and coffee, occupy approximately 2 percent of the arable land.

According to the agriculture production roles schedule, women and men are involved on equal basis in seedbed preparation, weeding, and marketing. Women are involved more than men in transplanting, and less than men in spraying and income control.

People and livelihoods

According to the 2009 census report, the County had 370,712 people with the males constituting 184,500 (about 50 percent) and the females 186,212 (about 50 percent). The total projected population is 460,092 in 2017, 228,982 being male and 231,108 being female. The population of Elgeyo Marakwet County is majorly rural, at 91 percent (335,835) (KNBS 2009). The County has four sub-Counties namely Keiyo North, Keiyo South, Marakwet East and Marakwet West. The population distribution is across the four sub counties in the ratio of 20, 30, 21, and 29 percent respectively.

Fifty-seven percent of the total population lives below the poverty line. The situation is worse for residents of the Kerio Valley where estimation of poverty levels are as high as 67 percent. Among the poor populations, 56 percent are from rural areas and the remaining 44 percent are in urban areas. Twenty-six percent of the County's households have access to potable water. Tap water connections are still low with only 10 percent of the households having access to piped water. On average, the residents walk 2.75 km to access water for domestic use (GOK 2013).

The County has a literacy level of 49 percent; this is much lower than the national average of 67 percent. The males' literacy levels are slightly higher (50 percent) than the females' (47 percent). The transition from primary to secondary school is 72 percent and the completion rate for secondary schools is 62 percent. Fourteen percent of the women completed secondary school while 12 percent had some tertiary training; 21 and 15 percent had secondary school and some tertiary education respectively. Eighty-four percent of the population uses firewood as the main source of fuel for cooking. Forty-three percent of the households have electricity connections; they use it mainly for lighting, with only one percent using it for cooking. A paltry one percent use it for cooking (GoK, 2013).

Fifty-five percent of the population in Elgeyo Marakwet suffers food poverty. Unavailability of food for the County is seasonal and influenced mostly by rain fed production coupled with poor storage and distribution systems. A considerable amount of food produced during the rainy season is lost through post-harvest losses as there are inadequate storage facilities. Because of the bad roads, farmers have difficulties in getting their produce to the market and traders who offer very low prices exploit them. Unpredictable and insufficient rains coupled with limited use of yield-enhancing inputs lowers productivity. Food insufficiency manifests through the health of the people, especially the children. Statistics indicate that stunting and wasting affected approximately 30 percent of the children below 5 years in the County (GOK 2014b). According to the health survey, stunted children are 30 percent while 7 percent are severely stunted. Four percent of the children in the County were wasted and 1 percent was severely wasted (GOK 2014b).

The main source of livelihoods is income from both livestock and crop farming. In the Highlands, farmers keep dairy cows and sheep for wool and produce potatoes, maize, wheat, and beans. In the Valley, they keep goats and sheep and produce fruits, millet, sorghum, groundnuts, and green grams. Approximately 80 percent of the population is involved in informal employment; the unemployment rate stands at 8 percent (GOK, 2013). Other key off-farm livelihood strategies include sand harvesting, charcoal burning, sports (athletics) and trading.

Agricultural activities

The County covers a total area of 3029.9 km^2. It is divided into three distinct zones: the Highlands, the Escarpment, and the Kerio Valley. The Highlands rise as high as 3,300 meters above sea level while the Lowlands are as low as 900 meters above sea level. This indicates very steep escarpments as you descend from the Highlands to the Lowlands. The Highlands constitute 49 percent of the County's total area and have a higher population density compared to the Escarpment and the Valley. River Kerio originates from the Southern Highlands of the County and drains into Lake Turkana; it is a key resource of this County. The Highlands have the most suitable conditions for agriculture, receiving 1200-2000 mm of rainfall per annum. The Lowlands (Kerio Valley) and the Escarpments are mainly for livestock rearing and subsistence farming because of steep topography and low rainfall (850-1000 mm per annum). Seventy-two percent of the County's land area is arable and is used for crop production and livestock rearing. The farmers practice mixed farming that involves crops and livestock. The County has 16 gazetted forests occupying 88,428 ha (GOK 2013).

Land ownership in the County is both communal and individual. Approximately 53 percent of the farmers have title deeds. Most of the land on the Escarpment and the Lowlands is communally owned and thus has no title deeds. The average land holding is 2.08 ha; male-headed households own an average of 2.36 ha, while female-headed households own an average of 2.08 ha. Youth-headed households have an average of 0.92 ha (GOK, 2014a). The smallholder farmers own an average of 1.36 ha while the large-scale farmers have an average of 17.3 ha. The biggest proportion of the land (88,639 ha) is used for crop production. Of this, 4,004 ha are under fruit trees and cash crop production and 1600 ha are under organic farming. As already mentioned, land along the Escarpment is vulnerable to soil erosion and degradation because of its topography therefore 12,010 ha of the land is under soil conservation. The Escarpment has one ranch that measures 220 hectares, and on which breeds such as Zebus, Borans and Sahiwal are reared. The main farming systems are characterized as small, medium, and large scale; the systems are evenly distributed across the County. Agricultural production is for either commercial or subsistence purposes or both. Industrial crops are grown mainly in pure stands whereas food crops are grown mainly in mixed stands.

There are two major seasons where use of yield-enhancing inputs like fertilizers, improved seed, and pesticides varies between seasons. In the long rain season, 80 percent of the farmers use improved seeds. Eighty-one percent of male-headed households use improved seed compared to 74 percent for female-headed households. Fifty-three percent of the farmers use basal fertilizers in the long rain season where fifty-five percent of the male- and 43 percent of the female-headed households use fertilizer in the season (GOK, 2014a). Less than one percent of the farmers use irrigation. Two irrigation schemes have been established on 6070 ha in Arror and Korober areas (GOK, 2013). An average of 5 and 7 percent of the male- and female-headed households use pesticides respectively (GOK, 2014b). The local agro-vet shops situated in the shopping centers across the County are the main suppliers of the fertilizers and seeds. The government is also a key provider of the subsidised fertilizers through County agricultural offices. Potatoes are a key crop in the Highlands; the farmers source clean certified seeds from KALRO Tigoni and Kisima Farm in Nanyuki.

Livelihoods and agriculture in Elgeyo Marakwet

Demographics

1% Of Kenya´s population

370,712 inhabitants

91% Live in rural areas

50% 50%

Access to basic needs

57% of the population lives in **absolute poverty**

Potable water	26%
Electricity for cooking	0.9%
Electricity for lighting	43%
Education (youth literacy rate)	ND

Food security

55% of the population suffers from **food poverty**

ND of household **income spent on food**

ND People **undernourished**

30% Children **stunted**

4% 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 2,171km² 72%

53% of the population employed in agriculture production

53% of farmers have title deeds

ND are women

Farming activities

Food crops 46%

Cash crops 2%

Of county´s agricultural land

Livestock

0 Group ranches

1 Company ranches

Farming inputs

Water uses

ND ND ND

Fertilizer types (% of households)

NPK

11% Organic manure

53% Planting fertiliser

17% Top dress fertiliser

Pesticide types (% of households)

7% Field pesticides

13% Storage Pesticides

21% Herbicide

Agricultural value chain commodities

A broad diversity of agricultural commodities are 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)[4]; resilience to current weather variability and future climate change[5]; and number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth, and the poor[6]). The VCCs selected are: dairy, Irish potato, beans, and local chickens. Potatoes can only thrive in the Highlands while the rest of the value chains can flourish across all the agro-ecological zones (AEZs) with local chickens and beans being the most desirable for the lowlands.

Cattle (milk)

Cattle are predominant in the Highlands due to the suitable conditions and availability of fodder for most part of the year. Over 80 percent of the households keep dairy cows for food and income, and also cultural attachment. Majority of the farmers are medium scale smallholder farmers who keep crossbred animals. Zero grazing (intensive), semi-zero grazing and the extensive systems (free range) are the major production systems practiced in the County. The dominant system is the semi-zero grazing medium scale; farmers keep more than five cows (KDB, 2016). Zero grazing is mainly for commercial purposes while semi-zero and extensive (free range) grazing are for both commercial and subsistence purposes. All these systems are practiced on the Highlands and across the four sub-counties. However the free-range system is dominant along the Valley and the Escarpment where land ownership is communal. Zero grazing is mainly concentrated in the Highlands. Dairy is a key enterprise for women and youth; they are heavily involved at the production stage and in milking. They feed and water the animals; however, their role in marketing and value addition is limited.

The Department of Livestock estimates a population of 204,433 dairy cattle in the County. In 2016, a total of 49,148,118 liters of milk with a value of K.sh. 1,965,924,720 was produced. Milk production varied between dry and wet seasons and also depended on the breed. During the wet season, milk production was 3.5, 7.2, and 8.8 liters per cow per day for the local, crossbred and exotic breeds respectively. In the dry season productivity was lower across the three breeds at 2.9, 5.6, and 7 liters per cow per day for the local, crossbred and exotic breeds respectively (GOK, 2014).

Inputs are supplied by small-scale agro dealers located in the nearby shopping centers. The County Government also plays an important role in providing extension services and regulating AI services. Farmers mostly use family labor and local casual labour in their neighborhoods. The milk is marketed through formal and informal channels; the formal channels are through the farmer groups and cooperatives or individually to processors. Informal channels involve small-scale milk traders and direct consumers. Milk aggregation centers have been established and coolers have been provided at the centers by the County Government. The New Kenya Cooperative Creameries (KCC) has revived its processing plant at Kamariny, providing market for raw milk.

Irish Potatoes

The Irish potatoes value chain engages approximately 41-60 percent of the people of Elgeyo Marakwet County. The crop thrives in the Highlands where annual rainfall ranges between 1200 and 1800 mm. The value chain is important to youth and women since they are the major chain actors with active participation across the value chain stages. Women are mostly engaged in input acquisition, on-farm production, and marketing. The enterprise involves more youths during harvesting and marketing as it requires much energy. The main production systems are mixed farming and pure commercial production. No large scale potato farmers exist. Medium-scale farmers are mainly found in Kipkabus, Sengwer, and Lelan. Small-scale farmers are the dominant in all the potato-producing areas of the County. In the long rain season, the crop is produced on an average of 0.3 ha while in the short rain season, it is produced on an average of 0.9 ha. The crop has two production seasons but discussions

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

5 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.

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

with the farmers revealed that the short rain season is becoming unreliable due to inadequate and erratic rains. In the long rain season, it potatoes are produced by 23 percent of male-, 30 percent female- and 22 percent youth-headed households. In the short rain season, they are produced by 20 percent of male- 8 percent of female-, and 15 percent of youth-headed households (GOK, 2014a). Data from the Department of Agriculture indicate a growing trend in production since 2012; it increased from 10 mt/ha in 2012 to 19 mt/ha in 2015. In 2015, the County produced 279,938 mt of potatoes worth KES 3,513,557,696.

Seed and other input suppliers are key actors in the potato production value chain. The farmers alternate between recycled own seed and clean improved seed. The main sources of improved certified seed are KALRO Tigoni, ADC Molo, and Kisima Farm in Nanyuki. The other major inputs are fertilizers and pesticides, whose main suppliers are the local agro dealer shops. The farmers use casual labor for planting, tending the crop, and harvesting. Actors at the product marketing stage include traders, the County Department of Agriculture, and farmer associations. The main markets are urban centers in Nyanza and western part of Kenya; some are exported to Tanzania and Uganda.

Chicken (local)

Local chicken are kept by over 80 percent of the households across all the agro- ecological zones of the County. Compared to other livestock enterprises, involvement of women and youth is high (40 percent) especially in decision-making. The women and youth are actively involved in farm activities such as feeding and marketing. The main production systems are pure free range, mixed and deep litter system. Mixed and free range systems are evenly distributed in Keiyo North and Keiyo South; the free-range system is dominant in Marakwet East and West. The deep litter system is intensive and mainly involves rearing of broilers and the Kuchi breed around Sambalat in Marakwet East. The free-range system is the most common as it requires minimum supplementation of feed and housing. Supplementation is mainly household food leftovers and garden waste. It is an important enterprise for the vulnerable (marginalized), women, youth, and the poor since it provides nutrition in the form of meat and eggs that can also be easily sold to generate income (GOK, 2014a).

The most important inputs for this enterprise are chicks, supplemental feeds, and housing. The farmers hatch their own eggs or procure chicks from neighbors. The feeds are bought from local agro-dealer shops situated in the shopping centers around the County. The chicken and eggs are sold locally in the shopping centers and nearby urban centers, Iten and Eldoret. The County Government is the main provider of extension services whereas KALRO is an important supplier of chicks for the improved Kenbro chicken. Some farmers acquire the Kuchi breed from Lamu County.

Bean

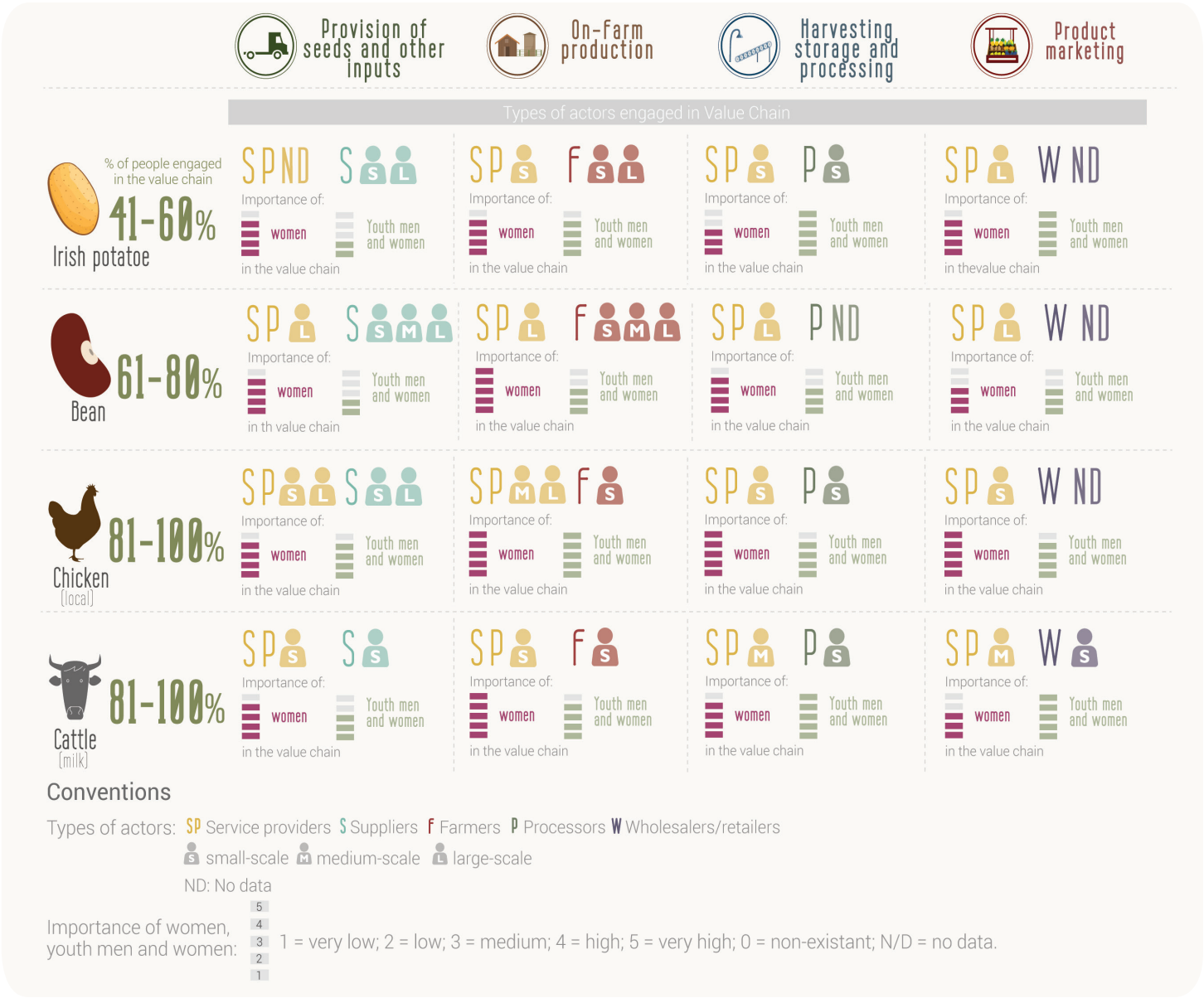
Beans are grown in both the Lowlands and the Highlands. It is estimated that 61-80 percent of the farmers are engaged in this value chain. The crop production is in two seasons. In the long rain, the average land size is 0.5 ha while in the short rain season it is 0.7 ha. The farms engage more women and youths than men. Eighty percent and 61 percent of women and youth respectively plant the crop in the first season. In the short rain season, 50 percent of women and 60 percent of youth plant the crop. Of the beans produced, female-headed households sold 38 percent, male-headed households sold 18 percent, while youth-headed households sold 11 percent (GOK, 2014a).

The bean value chain has moderate benefits to the women; they are very heavily involved in field production activities and play an important role in harvesting, processing, and marketing. The youth are also involved moderately in the production, harvesting, and marketing stages through provision of labor in the fields during production, threshing, bagging and transporting at the harvesting and marketing stages. Production statistics indicate that in 2015 the County harvested 15,702 mt of beans from 20,377 ha. The beans had a value of KES 1,417,604,800.

The main input suppliers are local agro-vet stores that supply the farmers with fertilizer and pesticides. The farmers mostly use own recycled seed or buy it from neighbours. Beans are sold in the trading and urban centers in the County; the centers include Iten, Kapsowar, Chepkorio, and Kapcherop. Kenya Seed Company, KFA, agro-dealers, and Egerton University provide improved seeds. Egerton University is working with International Crops Research Institute for the

Semi-Arid Tropics (ICRISAT) to increase adoption of drought-tolerant bean varieties in the Valley. Due to their small-scale nature, the farmers do not have quality-handling equipment like threshing machines, winnowing equipment, and driers. Manual threshing and winnowing is tedious and takes much time, resulting in poor-quality beans during wet seasons, since the farmers rely entirely on the sun to dry their beans. Some of the beans rot and aflatoxin sometimes accumulates in the harvest.

Agricultural value chain commodities in Elgeyo Marakwet



Agricultural sector challenges

The major challenges affecting the agricultural sector in Elgeyo Marakwet County cut across all the value chains. The County, especially the Valley, experience frequent and long droughts that result in crop failure and severe scarcity of fodder. This leads to food insecurity and general loss of key sources of livelihood. Due to steep topography along the Escarpment, there is serious erosion and in extreme cases there are landslides. This results in soil degradation as nutrients are transported towards the lowlands and rivers. Thus productivity of the land in the Highlands and the Escarpment is reduced. Landslides result in destruction of crops and loss of livestock, other property, and even lives. The soil eroded from higher areas is deposited in rivers, causing siltation and reduction of river volumes. There is no proper enforcement of environmental conservation laws and regulations; moreover, coordination among the institutions mandated to tackle environmental issues is limited, frustrating efforts to control soil erosion.

There are also increased incidences of crop diseases such as blight and bacterial wilt as well as potato cyst nematode. Increased incidences of Rift Valley fever (RVF) in cattle and ovine rinderpest in sheep and goats have been observed. This has led to increased use of chemicals and drugs, thus increasing production costs.

Less than 10 percent of the County roads have bitumen; 27 percent are earth roads, making transportation problematic (GOK 2013). Access to inputs, extension services, and market is therefore difficult in both rainy and dry seasons. For instance, it takes two hours to travel from Iten to Kapsowar, a distance of about 50 km; it takes almost four hours to travel from Biretwo to Chesogon a distance of about 130 km. This reduces farmers' income.

The telecommunication networks do not cover some parts of the County. This, coupled with poor roads, limit access to information and extension services. The farmers do not have adequate post-harvest handling equipment for their produce. This in many cases results in losses as the produce is sold at low farm gate prices. Insecurity is also a critical challenge in the County; this affects production as the farmers flee from their homes and are unable to work on their farms. The situation has resulted in abandonment of Tot-Koloa Irrigation Scheme. Adding to the challenges, the County has inadequate value addition and agro-processing facilities limiting farmers' returns.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

Elgeyo-Marakwet climatic conditions range from cool on the highlands, mild on the escarpment to hot in the valley/lowlands. There is high rainfall variability across the County due to its topography. Average annual rainfall in the county ranges from 400mm in the lowlands to over 1500mm per year spread over two rainy seasons[7]. Rainfall in the county is largely influenced by altitude that ranges from 900m a.s.l. in Kerio River Valley in the East to over 3000m a.s.l. in the northern and southern parts of the highlands. Average annual rainfall is below 500mm in the North Eastern lowlands, increasing to between 1200 and 1500 in the central highlands (plateau), and to above 1500mm in the north western corner and some southern parts of the county[8]. The county thus shows a trend of decreasing rainfall from west to east with the Eastern low-lying parts of the county generally having lower and less reliable rainfall and most at risk of droughts. Temperatures are fairly uniform over the County with mean annual temperatures being less than 22°C over most of the county. The mean annual temperatures are lowest in the Elgeyo-Marakwet Escarpment that covers most of the western and central parts of the county; and highest in the eastern lowland areas.

The escarpments in the central and western parts of the County sometimes experience intense rainfall that results in flash floods, severe erosion and landslides which affect agricultural production and food security in the County. On the other hand, the lowland areas in the east are vulnerable to drought which often results in the drying of rivers and streams, and reduction in the quantity and quality of forage and pastures. These sometimes result in reductions in crop production and crop failure as well as livestock weight loss, emaciation and sometimes death. The highland areas, while having high rainfall, often have challenges

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

8 http://www.elgeyomarakwet.go.ke/index.php/about-us

of water storage with ground water levels and drying of shallow wells occurring in times of drought or low rainfall. In early 2017 for example, prolonged drought in the County resulted in livestock weight loss and emaciation, and cattle prices fell as farmers tried to sell and reduce losses[9].

Analysis of temperature trends in the county over 25 years (1980 to 2005), showed that average long rain season temperatures have increased slightly but average short rain season temperatures have remained relatively constant. On the other hand analysis of rainfall trends over 35 years (1980-2015) showed an increase in annual rainfall with both long rain and short season average rainfall increasing by approximately 50mm. Further analysis indicated that the increases in rainfall have come with an increased risk of flooding, particularly in the long rain season. However, rainfall variability has also increased with rains becoming more intense and the risk of dry spells remaining high. Rainfall variability from year to year has also increased and drought risk for the county has increased slightly as a result.

Looking ahead to the period 2021-2065, climate projections based on two representative concentration pathways (RCPs[10]) indicate various possibilities. Under both scenarios there is expected to be a significant increase in the drought stress, with the number of days with moisture stress more than doubling from just over 20 consecutive days based on historical data to approximately 50 consecutive days each season. Under both scenarios there is also expected to be a reduction in the length of the first growing season, however under RCP6.5 there is likely to be a greater decrease in season length along with a marked delay in the onset of both seasons. Under RCP2.6 there is likely to be an increase in the amount and intensity of rainfall in both seasons similar to historical trends, while under RCP8.5 there is expected to be a reduction in rainfall quantity and intensity. Under both scenarios however, the trends in extreme precipitation do not change significantly; the number of days expected to exceed the 95th rainfall percentile remaining around 22 days per season. 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 Elgeyo-Marakwet.

Climate Perceptions by the farmers

The farmers testified that climate change was real and they were experiencing the effects. Precipitation, temperatures, and wind flows were the main weather conditions they indicated had changed significantly. Both Highland and Lowland farmers acknowledged the changing patterns and intensity of rainfall. They agreed that currently it is very difficult to predict the onset of rains and in many cases it delays. Experience from the past was that the long rains would start by end of March and planting would begin in April. However, currently unpredictable rains have altered routine planting dates. Over and above the delay and unpredictability, the farmers observed changes in the intensity of rains. They indicated that rains are short and intense, resulting in heavy runoff that causes erosion. The erosion is moderate in the Highlands but very severe along the Escarpment because of the steep terrain. This results in flooding in the Lowlands and siltation of rivers and streams. The rains also end before the season, leaving the crops vulnerable and occasioning reduced productivity and possible crop failure. The farmers in the Highlands observed that the second season of potatoes is not guaranteed these days.

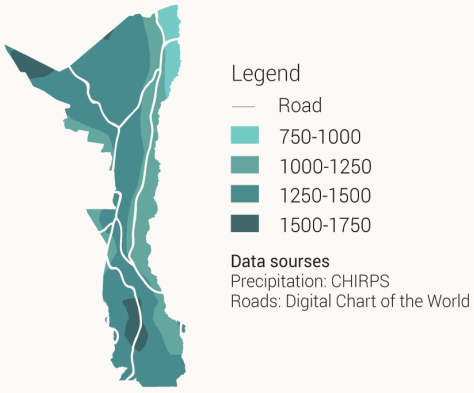
In the Valley, increased dry spells have become very common; the traditional weather forecasters revealed that the droughts that are common these days used to come after long periods, as in 1973 followed by 1984. They also indicated that temperatures have increased slightly. The prolonged drought periods have caused the drying of rivers and streams with permanent rivers such as Torok, Kerio, Perese, Kapkure, Etyo, Charar, and Tilio drying up or becoming seasonal. In the Highlands, there is evidence of reducing water table, as many shallow wells in the area have gone dry. The farmers are now suffering due to scarcity of fodder and water for their livestock. They have to travel long distances to fetch water for household use and also to water the livestock. The situation is dire in the Valley as the families travel distances of approximately 7 km that take an estimated 4 hours to fetch water. The water is not sufficient and thus the animals have a watering schedule where they are given water after every two days. The women are the ones who are affected the most because they are the ones who are responsible for fetching water. For men, because their main tasks

9 http://www.the-star.co.ke/news/2017/03/21/drought-in-the-north-rift-so-severe-herders-are-selling-a-cow-at_c1520149

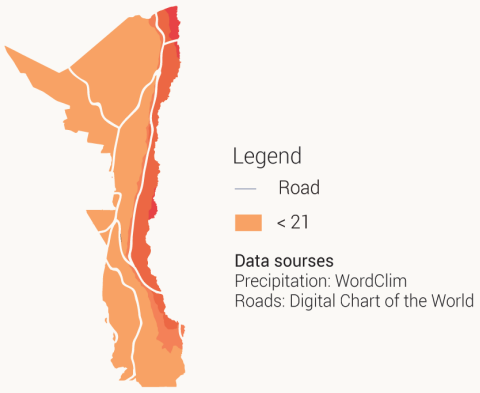
10 The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m2, respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible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

Historical annual mean precipitation (mm/year)



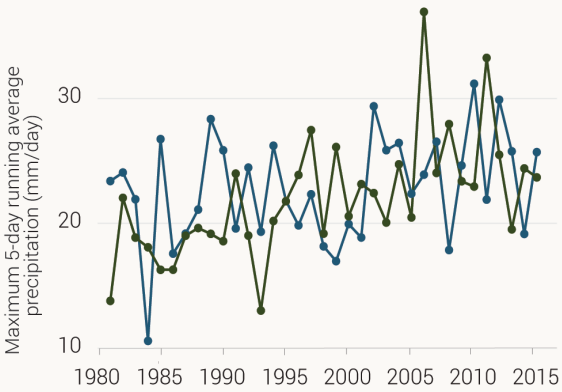
Historical annual mean temperature (°C)



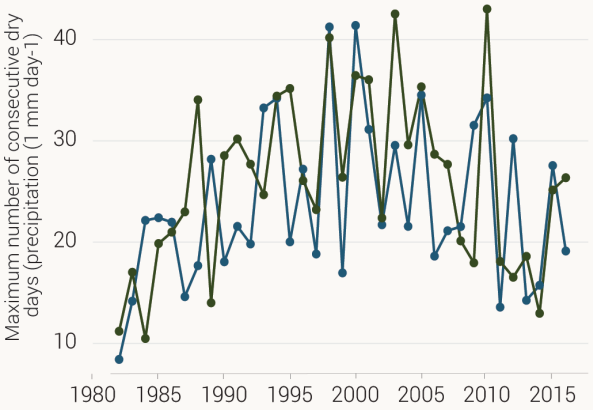
Flood hazards

Drought hazards

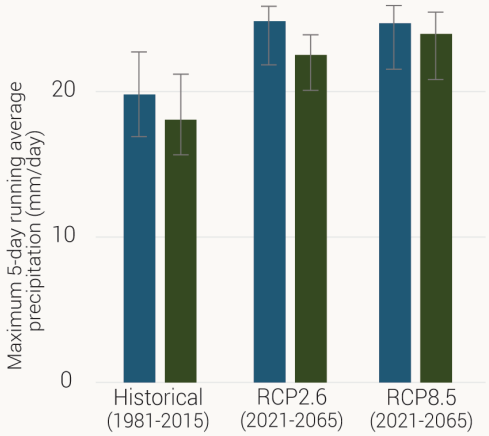
Historical extreme flood events



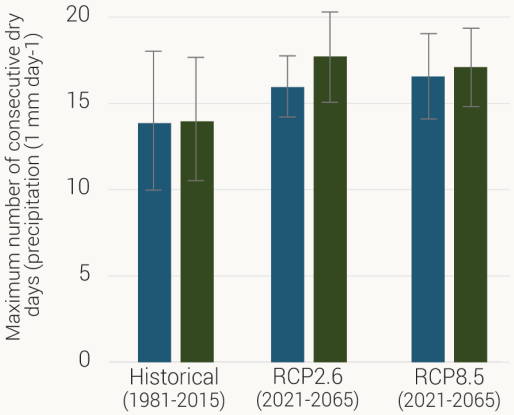
Historical drought stress events



Historical and expected extreme flood events



Historical and expected drought stress events



January - June July - December

are in the fields and there is no rain, they end up being idle as they have nothing else to do. The farmers in the Valley also said they were experiencing increased wind intensity. The increasing temperatures have resulted in increased animal disease incidences; diseases such as Rift Valley fever, ovine rinderpest, bacterial wilt, blight, potato cyst nematode and red mites, which were for the Lowlands are now experienced in the Highlands.

The farmers also indicated that due to changing weather, some birds like the crown hornbill that signaled the onset of rainfall have disappeared. The instability in the weather patterns and disappearance of such birds have made it difficult to use indigenous African knowledge to forecast the weather. The farmers acknowledged that human activities like encroaching into natural forests, wetlands, cultivating very steep areas, and failure to practice conservation farming have contributed to and exacerbated the consequences of climate change.

Climate vulnerabilities across agriculture value chain commodities

As already stated, Elgeyo Marakwet County has three distinct zones: the Highlands, the Escarpments, and the Lowlands. The Highlands are more densely populated than the Lowlands and the Escarpments due to better conditions for agriculture. Distinctly different types of climatic conditions and hazards are experienced in the different zones. The main climatic hazards for the Highlands are uncertainty in season (onset and duration) and frost. Heavy rainfall events in the Escarpments have caused erosion due to runoff and landslides in extreme cases. The lowlands experience prolonged droughts resulting in crop failure, and scarcity of fodder and water. The other extreme event is floods, which cause siltation of rivers and streams due to heavy rains in the Highlands.

Cattle (milk)

Wet conditions hinder access to inputs and services such as AI. There are difficulties in milk bulking because of impassible roads. For marketing the impact is moderate and is mainly on pricing and distribution of processed milk. The amounts of milk produced during wet seasons are much higher than those produced in the dry season. The oversupply leads to reduced prices, hence lower incomes. Poor transportation due to wet roads results in poor distribution of milk and in some cases leads to milk spoilage, further reducing incomes. Incidences of outbreak of diseases like the RVD also increase in very wet conditions increasing farmer vulnerabilities.

Increased drought incidences affect the different activities at the different stages uniquely. On acquisition of inputs, it severely reduces the feed supply both at farm level and in the market. It immoderately reduces the demand of AI services because the animals have poor fertility due to poor nutrition. However, the farmers have increased demand for extension services so they incur more costs, but they indicate that this has a moderate impact on their spending. Drought increases costs of production as farmers have to spend more on purchased feed supplements and concentrates. Expenditure on disease control increases due to increased prevalence of diseases. For instance, dry spells are conducive for ticks that cause tick-borne diseases.

Drought has a major impact on the quantities of milk produced, quantities available for bulking and consequently processing. This is because of inadequate feed or feed with poor nutritional value that leads to low milk production. On marketing, drought mainly affects distribution and pricing; the depressed supply of milk results in increased milk prices. The processors have less milk to process and thus little for distribution.

The dairy farmers' capacity to cope with effects of climate change is limited because they are smallholder in nature and lack resources. Their literacy levels are low; this, coupled with financial challenges, limits abilities to access and use feed preservation technologies. Capacity to store feed for use during times of scarcity is limited. The poor, youth, and women are the most vulnerable in the dairy value chain. Women and youth are the ones who are engaged in the daily chores of rearing the cows, so they are the hardest hit by drought. Drought affects the Valley and Escarpment more than the Highlands, while intense rains affect both the Highlands and the Lowlands. The people with low incomes are also disadvantaged as most of the consequences of the hazards can be reduced with availability of adequate financial resources. The farmers in the County have not strongly embraced collective action; they operate as individuals in procuring inputs and marketing milk, which puts them at a disadvantage also in terms of pooling of resources and collective bargaining.

Most of the farmers preserve crop residue (maize stalks) for use during dry seasons. This however can be improved through feeding strategies like planting disease-tolerant Napier grass and alley cropping using fodder trees. These should be combined with feed/fodder preservation techniques like silage and haymaking. The farmers can also take advantage of

mixed farming by feeding cows with poultry waste. With available extension, the dairy farmers can be trained and encouraged to make home-made rations to increase milk production. There are already a number of efforts to improve breeds in order to enhance productivity; these should continue, and include breeding characteristics for tolerance to harsh conditions.

Irish potatoes

The two critical hazards associated with the potato value chain are intense rains and moisture stress. Intense rains are more likely to occur around Kipkabus, Chepkorio, and Nyeru in Keiyo South. A big part of Marakwet West including Lelan, Kapyego, and Sengwer in Marakwet East are also susceptible to heavy rains. Keiyo North and South are more prone to moisture stress; the high risk areas include Kaptagat, Kaptarakwa, Kamariny, and Kapchemutwa.

Intense rains affect acquisition of inputs by rendering the roads impassable and making it difficult to buy and transport inputs. This is a major challenge in buying and transporting fertilizer and seed. The rains also create a conducive environment for bacterial wilt and blight, thus leading to increased use of pesticides. Intense rainfall severely impacts land preparation, planting, and weed control. More time and labor are required to plough and work heavily moist soils. Planting is equally laborious and more time-consuming. Because control of weeds with a hoe is slower, farmers often resort to spraying. The frequency of spraying increases on such soils, hence production costs are higher.

The intense rains have a major impact on harvesting and marketing of potatoes. They slowdown harvesting because the soils are heavy. This also affects the quality of potatoes harvested as they are muddy. Transporting the harvest is difficult because the roads are muddy and impassible in some parts. Potatoes harvested under such conditions have compromised quality that affects them during storage; they tend to rot faster. The farmer ultimately incurs postharvest losses and loses income due to poor quality produce. At the marketing stage, the main effect of intense rainfall is reduced prices due to a glut of cheap potatoes in the market.

Moisture stress does not affect acquisition of inputs but greatly affects farm operations. Planting is delayed and germination is poor, leading to low vigor and poor yields. Moisture stress also leads to poor weed and pest control. A weak crop can easily be destroyed by pests and diseases and is easily overpowered by weeds. The use of pesticides becomes ineffective because the stand is not uniform and has gaps between plants. Moreover, the active ingredient in pesticides doesn't work efficiently in stressed crops. Moisture stress has minor advantages during harvesting, processing, and marketing. Though the yield might have been reduced due to poor germination and inadequacy of moisture during growth, the potatoes harvested are clean and of good quality. They are easy to sort, grade, and transport to the market or collection points. This is because the soils are dry and easy to work. Moreover, the roads are dry and the potatoes can be transported faster for collection and marketing. The diminished supply raises prices- a positive impact for producers. Poor growth results in low-grade potatoes that are not suitable for processing, so the supply of potatoes for processing also decreases.

These hazards have the greatest impacts on the poor, women, and youth. The poor farmers who are not part of organized farmer marketing groups are more vulnerable; they lack the resources to cushion themselves against high costs of production, inputs, and market access. If seed and fertilizers are not in the nearest shopping centers, they end up recycling their own seed or buying from neighbors and either planting without fertilizer or using manure. The farmers also employ more labor to help work on the difficult dump soils and hasten land preparation and planting. They may also spend more on the purchase of chemicals to protect their crop against pests and diseases. Inadequacy of storage facilities and impassible roads make the farmers sell the potatoes in the field (farm gate), sometimes at throw-away prices. Since moisture stress seriously reduces yields, little remains for household consumption.

The farmers need to be advised on the appropriate varieties that can tolerate moisture stress, such as Shangi that gives high yields and has short dormancy. Blight is a risk during intense rains, so Kenya Mpya variety will be ideal for such situations. The farmers ought to be trained on seedbed preparation and appropriate management practices that can reduce loss of soil moisture; they should also increase use of manure.

Chicken (local)

Drought spells and intense rainfall with a risk of flooding are the two priority hazards associated with this value chain. Drought spells are more likely to occur in areas along the Kerio Valley across all the four sub-Counties. The areas include Biretwo, Kobulwo, Cheglilet, Arror, Chesitan, Tot, and Cheblil. On the other hand, the Highlands and the Escarpment are at risk of intense rains, erosion, and in extreme cases,

landslides. Simit and Kalwal are at very high risk of experiencing mudslides.

The key activities affected by intense rains and flooding at inputs acquisition stage are acquisition of chicks, and purchase of housing materials and feeds. This hazard affects mainly production of chicks; cold and dump conditions are favorable for worms and diseases like brooder pneumonia. It also increases the cost of production as it necessitates improved protection, for instance raising the housing above the ground, using waterproof material, and disease control. Feed procurement becomes a challenge due to impassable roads that hinder access to agro-dealers' shops. The impact on feed procurement and housing costs was considered minor. At the on-farm production stage, intense rains have a moderate to minor impact. The farmers decrease the use of commercial feeds as there are many insects, vegetation, and food leftovers. The favorable conditions for diseases result in increased vaccinations and medication, thus increasing costs. Because diseases are rampant under such conditions, brooding and raising of chicks are moderately slowed down. Many chicks die; those that live use much energy to generate heat, so growth decreases.

In harvesting and marketing, the hazard affects sales, which are mainly at the farm gate or nearest shopping centers. The rains lead to impassable roads so the buyers find it difficult to get to the farms while travel by farmers to far-away markets is hampered. The main activities at the marketing stage are market survey, advertising, and sales. Advertising and sales are conducted at shopping centers near the farms.

Drought affects feed procurement and feeding in the local chicken value chain in many ways. It affects purchase of feeds as the farmers have to buy more commercial feeds from agro-dealer shops. It positively but moderately affects acquisition of chicks; during this period the chicks are raised easily and are thus available at affordable prices. This increases feeding, disease control, brooding, and raising chicks. It results in scarcity of locally available feeds like natural vegetation, food leftovers and insects that the chickens scavenge. Supplementation with commercial feeds thus increases, increasing production costs. Dry periods are unfavorable for diseases, so purchase and use of vaccines and drugs decreases; however, this is considered a minor impact. Drought has a major positive impact on the production of chicks as the conditions are favorable for faster growth and mortality is low.
During dry conditions, the quality of eggs is high as the eggs collected are clean and in good condition for storage. Because feeds are scarce, the supply of eggs and poultry decreases, increasing demand and thus raising incomes moderately. Drought has a moderate, positive impact on market surveys, sales, and advertising. Because of reduced supply and high demand, the cost for market survey and advertising are reduced moderately and sales increase.

Local chicken is a value chain that involves the poor and women to a great extent. They are on many occasions constrained by financial resources and land, which is a fundamental factor of production. Chickens are kept by almost all the households; over 80 percent of the households are involved and it cuts across all the three zones. Their versatility and low cost of inputs make them an ideal venture for poor farmers.

Most of the farmers share their houses with the chickens; others keep them in the kitchen at night, where they also lay eggs. They use traditional medication such as a mixture of aloe vera, tobacco, and red pepper. This can be boosted by vaccination and strategic worm control with guidance from the livestock extension officers. Drought results mainly in scarcity of feed. During drought, farmers increase supplementation with food leftovers like kale and cabbage stalks and grains. The chickens are left to scavenge more for insects like termites. To improve the diet, the farmers should be trained on methods of making protein-rich feeds such as insect rearing and making home rations.

Bean

Beans is an important value chain, involving about 61-80 percent of the population. The critical hazards affecting the crop are intense rains and drought. Intense rains, erosion, and landslides are more prone on the Highlands and along the Escarpment. The steep terrain on the escarpment and exposed young soils make them particularly susceptible to erosion. Parts of Keiyo North and South are prone to intense rains and floods; places like Simit have the possibility of experiencing landslides. Some areas in Marakwet East and West face risks of erosion and flooding during rainy seasons and droughts during dry seasons.

Intense rains affect acquisition of seed and fertilizer as they make the roads muddy and impassible. The effect on acquisition of seed is moderate as the farmers mostly use recycled own seed or buy from neighbors. The challenge of acquiring fertilizers was considered major because the farmers have to source them from the shopping centers. The farm activities affected by intense rains are: land preparation, planting, and weed control. Too much rain makes the soils soggy and thus land preparation becomes difficult and slow. At planting, seed and fertilizers are sometimes washed

away. Heavy rains also result in leaching of nutrients. They delay weed control both manually and through use of herbicides.

Rains lead to delays in harvesting. The wet conditions also lead to severe losses as the beans rot while still in the field. Threshing requires beans to be dry so that they easily come out of the pods; wet conditions make this difficult. The beans end up with a high moisture content that leads to development of aflatoxin or rotting during storage. At the marketing stage, transportation, packaging and selling are affected. Beans with the high moisture content cannot be packaged for selling. The farmers try hard to dry the beans with the little sunshine; in some cases the beans end up rotting, severely reducing the quality and quantity as well. Transporting the beans becomes difficult because the roads are muddy and impassible.

Acquisition of seeds and fertilizers is easy during dry spells as the roads are in good condition and shopping centers can be accessed easily. Land preparation is affected in two ways: when drought is moderate, some soils will be lighter and thus easy to work. However, extended drought causes pans on some soils, making them difficult to plough. This is likely to happen in fields that were used for grazing and the soils are therefore compacted. Dry conditions lead to delayed planting as moisture is critically essential for germination and growth of beans. Drought causes moisture stress for both crops and weeds; growth of weeds is suppressed, so less time and effort are required to control them.

Dry conditions have advantages in harvesting and processing; the beans are easily uprooted and threshed. However, minor losses are incurred in the field as some pods burst when dry. Threshed beans dry within a short time, hence their quality improves and they can be stored easily. The downside is that the risk of infestation by storage pests such as bruchids is high. In marketing, properly dried beans are easy to package for selling; the roads to the markets are easily passable, so access to the market is easy.

To reduce some of these consequences, the farmers procure seed from their neighbors. If they find it extremely difficult to access markets to buy fertilizers, they plant without. Due to intense rains and limited sunshine, the farmers try their best to use the limited sunshine to dry the beans. This requires much time and effort as the beans have to be spread in the sun whenever it shines and taken back to a shelter when it starts raining. The farmers also use information on early warning systems; if the forecast predicts heavy rains especially during harvesting, they opt not to plant beans. Chemicals are used to preserve beans; some farmers sell their beans immediately after harvesting to avoid losses during storage.

Adaptation to climate change and variability

On-farm adaptation practices

Dairy farming is highly impacted by intense rains and drought; intense rains seriously affect infrastructure, thus hampering access to inputs and market for milk. The farmers use locally available feeds as there is plenty of grass and forages at the homesteads. They reduce on the concentrates they give to the cows and sometimes borrow feeds from neighbors. In cases where roads are impassable for vehicles, they use donkeys, tractors, and motorbikes to deliver milk and buy feeds. During extended dry periods, the farmers feed their cattle on crop residues like maize stovers, they graze the cows in the forests, and provide cheap supplements such as soda ash. In extreme dryness especially in the Valley, they feed the cows on tree leaves and migrate some to relatives living in areas that are not seriously affected by drought. They sometimes feed their animals on home-made rations, which they make using available ingredients; the farmers ought to invest in fodder production, including production of disease-tolerant Napier grass and fodder trees. The farmers need to be trained on how to preserve this fodder as silage or hay.

To reach fellow farmers and extension workers, and other service providers such as AI personnel, the farmers use mobile phones. Wet conditions are favorable for diseases; thus, during wet periods, farmers spray, dip, and deworm their livestock frequently. They either skip inseminations if AI services cannot be reached or use bulls. They also use indigenous technologies and knowledge to treat their animals.

Drought leads to scarcity of feeds and low milk production. Some farmers use breeds that are versatile and can withstand drought but have lower production. These are mostly crosses between indigenous and exotic breeds. During wet periods, the supply of milk increases so prices decrease. Because poor roads hamper access to markets, the farmers sell milk to brokers at farm gate prices. Surplus milk is fermented at home and consumed.

For potatoes and beans, intense rains cause difficulties in accessing markets for inputs because of impassible

roads. The farmers resort to using recycled own seed or buying from neighbors. More experienced farmers procure inputs, especially fertilizers early and keep them at the farm awaiting planting. Some farmers use farm manure instead of inorganic fertilizers. To avoid the challenges of preparing wet soils during heavy rains, the farmers prepare land early and some do dry planting. For potatoes, intense rains create favorable conditions for pests and diseases; the farmers therefore increase the intensity and frequency of spraying.

Off-farm adaptation practices

Besides adaptation at farm level, other initiatives are undertaken to reduce the impact of climate change on agriculture. The ASDSP project in collaboration with the Kenya Meteorological Department (KMD) has been implementing the participatory scenario planning (PSP) to provide farmers with early warning information. Departments associated with agriculture are given weather forecasts for the seasons ahead. They then design appropriate farming plans taking into account the timing of farm activities, and the types and varieties of crops to be planted. This information is then disseminated to farmers through a number of channels. The information helps farmers to prepare for the season by buying inputs in time, preparing land and planting the right crop varieties in good time.

Efforts are under way to encourage farmers to adopt crop varieties and livestock breeds that are climate smart. ICRISAT and Egerton University are working with farmers in the Valley to promote production of dryland crops like sorghum, millet, and beans. Existing appropriate crop varieties developed by the research institutions should be promoted. The Department of Livestock is promoting camels and gala goat breeds, which are adapted to dry conditions. For dairy they are promoting dual-purpose breeds that can produce milk and meat.

Challenges related to acquisition of inputs and access to markets affect the poor smallholder farmers. Dairy farmers have started cooperatives that help them to market their milk. More importantly, the cooperatives help to bring quality inputs near the farmers. There are over 13 dairy cooperatives in the County with coolers to help manage quality.

Potato farmers operate in farmer groups that build capacity and ease access to extension services. There are two apex farmers' organizations in the County: Elgeyo Marakwet Dairy Farmers Association and Elgeyo Marakwet Potato Farmers' Cooperative Society (EMPCS).

During intense rains, the farmers find it difficult to access extension services and shopping centers to buy feeds. They do not have enough space to store feeds during times of plenty, which they can use during prolonged droughts. The cooperatives operate feed stores that bring feeds closer to the farmers at affordable prices. However, this collective action is not widespread; only dairy and potato value chains have strong organizations. However, their services do not reach most farmers in the County. Only four percent of crop and nine percent of livestock farmers are associated with marketing through collective action or formalized contractual arrangements (GOK, 2014a).

In the Highlands, the farmers are engaged in livestock feed preservation by making silage and hay. The Department of Livestock Development is responsible for giving extension services to farmers to adopt this technology. For crops, especially in the Valley, the Irrigation Department and Kerio Valley Development Authority (KVDA) are helping to establish irrigation infrastructure. Arror, Korober, Ematu-Emkong, and Olkabulwo irrigation projects have been established to reduce dependence on rain fed agriculture. The Department of Gender, Youth, Sports, and Social Services is working with women and youth to encourage them to establish off-farm income-generating activities like event management by women groups to increase income diversification. They support youths to establish business startups and also venture in sports, especially athletics, which is popular in this County.

The County Government is also trying to promote protection of water towers as a means of both adapting to and mitigating climate change. The County has established the County Agricultural Development Committee whose mandate is to develop strategies to mitigate climate change effects. The committee has not done much since it was established but it is an important initiative to strategically deal with effects of climate change. The challenge in implementing these initiatives is insufficient extension services to support adoption of the technologies, for example forage preservation for dairy farmers. Provision of information to farmers is hindered by low coverage of the communication infrastructure; some places in the County have no phone and radio communication networks. Extension workers should work together to develop farmer capacity in training and finance to enable them adopt new varieties and climate smart production technologies. Additionally, farmers should be exposed to the available technologies, crops varieties, and livestock breeds.

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

Bean

	Provision of seeds and other inputs	On-farm production	Harvesting storage and processing	Product marketing
Intense rains	Poor accessibility to seeds, transport of fertilisers from shops/stores to farms due to impassability of roads	Delayed land preparation and planting; washing away of seeds; leaching of fertilisers	Delayed harvesting; difficulty in threshing and winnowing; high moisture content generates vulnerability to moulds and rotting; drying increases production cost	Hampered packaging; increased costs of transportation due to impassable roads; reduced product quality leading to poor prices
Magnitude of impact	Moderate - Major	Moderate - Major	Severe	Severe - Major
Farmers' current strategies to cope with the risks	Use of donkeys, porters, tractors and human beings to transport seeds and other inputs from the market to the farm; opting for an alternative enterprise	Minimum tillage by use of herbicides; manual land preparation and weed control (by uprooting or cutting-back); late planting	Piecemeal harvesting to facilitate drying and minimize losses; immediate disposal to the market	Spreading out seeds in open spaces; selling the produce at farm-gate; immediate disposal to nearest market; local consumption
Other potential options to increase farmers' adaptive capacity	Stocking of seeds and facilities within the locality through stockists and farmer cooperatives; improve roads to all-weather status; availing information on weather	Early land preparation; restoration of soil and water conservation structures; continued use of early warning information for decision making; use of county agricultural machinery services; draining seed beds properly; encourage crop rotation	Encourage appropriate small-scale drying technologies; alternatively encourage selling of green beans when waiting for fully maturing	Bulk transportation to maintain product quality hence good price; encourage formation of farmer groups or associations; promote market information and linkages for better prices; improve roads to all-weather status
Increased drought spell	Prolonged drought leads to diversion of seed and fertilizer funds to other immediate pressing needs, affecting the vulnerable group in the society	Some areas may experience hardpans, affecting land preparation; delayed planting due to inadequate soil moisture; delayed weeding	Dry spell leads to pods opening thus spilling the beans (crop losses); forced maturity of beans leading to poor quality (shrivelled and small); harvesting might be difficult due to the soil compaction; increased storage pest damage	Excessive loss of moisture reduces product weight hence the income; pest damage risk; prolonged drought will lead to price speculation
Magnitude of impact	Minor	Moderate - Minor	Minor - Moderate	Minor - Moderate
Farmers' current strategies to cope with the risks	Use of recycled seeds, planting without fertilizer o sometimes using manure	Postpone land preparation; planting during the onset of rains; irrigation; postpone weeding	Harvest crop early in the morning to reduce shattering (pods splitting open); immediate disposal of the produce	Immediate disposal of the produce; disposing without sorting; price taking (disposing at the proposed/offered price from the buyer)
Other potential options to increase farmers' adaptive capacity	Timely and accurate information services on drought-resistant varieties	Land preparation after harvesting to avoid formation of hardpan; early warning systems; use of early-maturing varieties; use of drought-tolerant varieties; efficient irrigation systems; integrated weed management	Further research on varieties that do not shatter (burst) when dry); use of hermetic bags (polythene-lined)	Use of hermetic bag (polythene-lined); training on pre- and post-harvesting management techniques

Irish Potato

	Provision of inputs	On-Farm production	Harvesting storage and processing	Product marketing
Intense rains	Difficult transportation due to wet roads; high transport cost; intense rainfall increases disease incidences; increased cost of pesticides	Wet soils make ploughing difficult; difficulty in planting leading to increased cost; high frequency of spraying and weeding increasing production costs	Delayed harvesting; due to wet conditions high wastage and poor quality; increased cost of transportation; during harvesting wet conditions tubers carry a lot of soil hence poor storage quality	High rainfall could lead to more production hence market glut; low prices due to high supply
Magnitude of impact	Major	Severe	Major	Moderate
Farmers' current strategies to cope with the risks	Using farm saved seeds; early procurement; early acquisition of fertilizers; use of organic manure; some cooperatives help farmers in bulk purchase	Spraying with herbicides; increased labour; early land preparation; dry planting; increased labour; use of meteorological information; earthing up soil; spraying to control pests	Harvested tubers are left to dry before selling/storage; use animal draught/power and human labour to transport the tubers; sale immediately after harvest; delayed harvest	Middlemen play the roles of linking the farmer to the market; selling to middlemen; transporting and selling direct to the market and export to Tanzania and Uganda
Other potential options to increase farmers' adaptive capacity	Having seed multipliers closer to farmers; stocking of seeds; taking the fertilizer to the farmers at ward level/ build fertiliser stores at ward level; strengthen cooperatives; introduce disease-resistant varieties	Mechanized farming before the rainy season; mechanized planting at the onset of rains; share information from the relevant departments to many farmers; apply pre-emergence herbicides; introduction of pest- and disease-resistant varieties	Strengthen cooperatives to acquire cleaning and drying machineries; improve feeder roads to make them all-weather; encourage storage to attract better prices; construction of cold storage facilities	Strengthen marketing associations and cooperatives to add value; promote information platforms; contract farming; invest in processing factories
Moisture stress	N/A	Not enough moisture for good germination; lack of uniformity and one cannot spray stressed crops	Clean tubers, sorting and easy grading and transportation; roads are passable	Poor yields hence less produce for sale; low supply hence high prices; tubers lack processing qualities
Magnitude of impact		Major	Minor	Major
Farmers' current strategies to cope with the risks	Storage of seeds from previous season; early purchase of fertilisers	Early planting	Delayed harvesting waiting for better prices	Linkage by middlemen; individual farmers are trying to access the market; selling through middlemen
Other potential options to increase farmers' adaptive capacity	Sharing of weather forecast information from meteorological information to the farmers; sharing of information from met department; capacity building on pesticides use	Farming God's way (conservation agriculture) minimum or zero tillage; supplementary irrigation; conservation agriculture and mulching to conserve soil moisture; mechanization in planting; introduce drought-tolerant varieties; irrigation	Mechanized harvesting and sorting; set up collection centres and stores; construction of more cold storage facilities	Empowerment of marketing association and cooperatives; introduction of SMS platforms; strengthening of cooperatives and marketing associations; construction of processing plants; capacity building on value addition

Chicken (local)

	Provision of seeds and other inputs	On-farm production	Harvesting storage and processing	Product marketing
Intense rains/ Flooding	Extreme cold and water logged areas kill the chick; increased maintenance cost; roads to the shopping agro-vets become impassable	Supply of commercial poultry feeds decrease; disease incidences increases hence costs of control goes up; cold weather is not conducive for brooding	The roads become impassable hence accessing the market becomes difficult	Roads to markets and advertising places become impassable; low sales and income; ads and posters are washed away by the rains
Magnitude of impact	Minor - Moderate	Moderate - Minor	Moderate	Minor
Farmers' current strategies to cope with the risks	Buy chicken/chicks from the neighbourhood/local farmers; farmers staying with chicken in the same house and use of portable traditional made chicken coup; use of kitchen and garden waste	Full free range system -Use of local herbs e.g. Aloe vera, pepper; sell chicken once there is an outbreak of diseases; use of enclosures (homemade) to protect the chicks from cold/rain and predators	Storage facilities; increase number of eggs incubated per bird	Selling poultry and its products locally; individual to individual marketing
Other potential options to increase farmers' adaptive capacity	Group approach for poultry production i.e. introduce hatcheries to produce as a group; build a well-designed chicken coup using locally available materials; group approach to poultry production	Training on homemade poultry feeds and supplementation; use of group approach in sourcing drugs/vaccines for chicken; synchronise the periods for vaccination; training on housing and disease management	Group marketing for egg selling	Group strategy to marketing and to come up with technology to storage; promote internet marketing especially for youth; opening outlet at strategic places
Increased drought spell	During dry season chicks survive and hence sold cheaply; local feeds are depleted	Feeds become depleted hence expensive	Low egg production; reduction of green vegetables increases demand for eggs and chicken	Increased market outlets; low advertising because poultry and its products are sold with ease
Magnitude of impact	Moderate - Major	Minor - Moderate	Minor - Moderate	Moderate
Farmers' current strategies to cope with the risks	Improvising on locally available feeds (remnants and plant residues)	Reduce the stock by selling so that they will not die; use locally available materials for housing	Destocking and use of alternative sources of feeds; market the surplus	Quick sales of produce once it has been harvested in an uncoordinated manner between farmers
Other potential options to increase farmers' adaptive capacity	Familiarise with management of poultry to increase survival of stock for the new farmers; group strategy to buy as a group from millers	Organised farmers to sell the poultry in bulk and train them on homemade feed rations; use of savings as an insurance measure.	To be trained on feed preservation (when plenty) for use during scarcity	Organise group marketing; improvise on market pricing; advise farmers to save on other hard times

Cattle (milk)

	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
Intense rains	The infrastructure is affected, difficult to reach feeds, delayed feeds; mobility of extension officers and Artificial Insemination services (AI) are affected	High moisture spoil/reduce quality of animal feed; high pests and disease prevalence then high cost of treatment; low milk production; inaccessibility of AI breeding services	Reduced milk quality, production and income; becomes more difficult to reach milk collection/bulking points; less milk supply for processing and storage	Low milk prices; high milk spoilage and wastage; reduced income; limited demand
Magnitude of impact	Moderate	Moderate	Moderate	Moderate
Farmers' current strategies to cope with the risks	Use of locally available feed materials and mineral licks; borrowing from neighbours; calling for extension advice; use of available bull schemes; use of available subsidized ward AI service providers	Timely planting and harvesting; vaccination, treatment, spraying and dipping; from bull services to subsidized A.I. services; farmer to farmer extension	Milking in the open and poor constructed structures; collection at the road side; use of motorcycles, donkeys, tractors and four wheel vehicles; milk is sold at the formal local market; preparation of sour milk	Selling milk to hawkers and formal/informal markets
Other potential options to increase farmers' adaptive capacity	Conservation and storage of feeds; start farmer groups and cooperative societies; training, deploying more extension officers and use of ICT in extension; proper government policy; farmer organizations to store for their own service	Constructing modern feed structures; timely planting and harvesting; capacity building on feed formulation; enhanced routine vaccination, spraying, dipping and deworming; make vaccination free; add more vets; Zero-grazing units; intensify A.I. service providers up to local level; strengthen farmer organizations	Capacity build farmers on clean milk production; construction of milk parlours and zero grazing units; construct enhanced milk collection structures and improve road network; improve road network; capacity building on group milk marketing and value addition	Provision of milk coolers; improve road network; Formation, capacity building, strengthen of farmer groups on marketing channels
Increased drought spell	Inadequate animal feeds and mineral supply; high demand and cost of extension services; low animal fertility low demand for A.I.	Pasture/fodder failure hence scarcity of feed, and increased cost; high pests and disease incidences; decreased feeding will result in low breeding	Reduced animal feed supply; low milk production; low supply of milk for bulking/collection	Low volumes of milk for distribution; supply is low therefore high milk prices
Magnitude of impact	Moderate - Severe	Minor - Severe	Major	Major
Farmers' current strategies to cope with the risks	Use of crop residues, cattle salt, tree branches, forest grazing and migration to relatives in fair areas; use of indigenous technology and knowledge; use of ICT	Keep of indigenous traditional knowledge in disease treatment; irregular spraying and vaccination; use of farmer extension service; keeping of disease resistant breeds; use of bulls (natural services)	Production for subsistence; buy from other sources; source milk beyond their catchment areas; lay off workers during low season	Sales to hawkers and directly to consumers; group sales; sell milk to loyal or contracted customers; source milk from distant sources
Other potential options to increase farmers' adaptive capacity	Introduce new fodder production technologies e.g. hydroponics; pooling resources to acquire and stock feeds/ supplements; use of ICT; strengthen farmer cooperatives	Capacity build farmers on feed conservation, storage and regimes; capacity building on breed selection; improved vaccination and disease control measures and surveillance; capacity build farmers on heat detection and use of high quality mineral salts; intensify provision of extension services e.g. A.I.	Promote purchase and use of high quality stock; Capacity build on the importance of bulking and chilling; promotion of value addition	Promote milk value addition for cooperatives; promote advocacy and market research and linkage groups for sustained milk supply

Policies and Programmes

Sustainable agricultural development is anchored on good policies and programs which revolve around increasing incomes for smallholder farmers and enhancing food security. Below is a brief discussion of key policies and programs in Elgeyo Marakwet County.

The Climate Change Act of 2016 provides a framework for enhanced response to climate change. It guides the mainstreaming of climate change into national and County Government development plans. It guides the development of resilience and adaptation plans associated with climate change risks; it also promotes production of technologies that mitigate climate change. In this spirit the County proposed an agricultural development committee that has climate change risk management as one of the mandates. To this end, the County is placing concerted efforts in conserving catchment areas, reducing degradation and introducing climate-smart crops and livestock for the farmers. The Act is still new and being adopted at the County level. However, the County Government still has limited technical skills and financial facilitation for creating frameworks to domicile and fully implement this Act.

The Agricultural Sector Development Support Programme (ASDSP) is one of the key and instrumental programmes that tackle climate change risks. The programme's mandate is: capacity building, sourcing, packaging and disseminating information, documentation and coordination. In Elgeyo Marakwet County, the project collaborates with the KMD in participatory scenario planning (PSP). The process generates important information that is shared with farmers and other stakeholders; the information is on forecast weather patterns and appropriate actions to be undertaken by each of the stakeholders. They use a wide range of channels to disseminate this information; the most common is radio, SMS, public gatherings, County Commissioner's Office, and churches. The programme supports selected value chains in the different zones of the County (Highlands, Escarpment and the Valley). The project tries to address the challenge of varying weather patterns through provision of information. It also identifies appropriate technologies that can be used by farmers to tackle the effects of climate change. The project has the comprehensive value chain approach where the initiatives cut across all the stages of the value chain.

Elgeyo Marakwet County is vulnerable to soil erosion and degradation, especially along the Escarpment. The County Government, World Vision and Iten Integrated Environment Conservation (IIEC) CBO have initiatives to promote soil conservation farming by encouraging the farmers to build terraces, avoid farming in very steep areas and plant cover crops. The County Assembly of Elgeyo Marakwet also passed a bill restricting trading in charcoal as a measure to reduce deforestation. This is in line with the National Environmental Policy. This policy has challenges in terms of enforceability as on many occasions the farmers disregard advice. Coordination between NEMA and the County Government is still weak because of the nascent nature of County Governments; they do not as yet have proper policies and structures. NEMA's mandate is mainly enforcement. The County Government therefore needs to complement it with both financial and human resources; this does not happen in many cases. The County is also encouraging agro-forestry where farmers are encouraged to have at least 10 percent of their land under trees. The target is to reduce pressure from forests especially on charcoal burning and timber.

The County is trying to develop adaptation and resilience of the residents through technologies that can withstand the prolonged droughts experienced in the County. The Livestock Department is promoting use of feed conservation and breeding, and introducing livestock breeds that are better adapted to the conditions such as gala goats and camels in the Valley. The National Livestock Policy that encourages the development of the livestock value chain in input supply production, marketing and value addition guides this initiative. Dissemination of technologies is constrained by insufficient resources to assist the government extension officers. Additionally, the farmers' low literacy and high poverty levels are diminishing the chances of adoption of the technologies. In line with the irrigation policy, the County CDF, Department of Irrigation and the Kerio Valley Development Authority have made efforts to increase land under irrigation in the County. Arror, Korober, Ematu-Emkong, and Olkabulwo are the main irrigation projects in the County. In addition, there are small-scale irrigation initiatives along the rivers. Irrigation projects are seriously affected by reducing water levels in rivers as well as inadequate resources to set up the irrigation infrastructure. Cherangany Hills catchment situated in this County is one of the water towers of the country. The Kenya Agricultural Productivity and Sustainable Land Management Project (KAPSLM) is helping to protect this invaluable resource. It is therefore necessary for a County climate change coordination framework to be developed and implemented.

Governance, institutional resources, and capacity

Climate change already significantly affects Elgeyo Marakwet County and despite initiatives by the County Government, this phenomenon is yet to become a key area of focus. Both Government agencies and non-governmental organizations are engaging in activities associated with adapting to climate change. The Department of Agriculture and Livestock has initiatives that target climate change risks but they are not planned under a focused theme of climate change. The work is guided by the Equitable Development Act (EDA) legislated by the Elgeyo Marakwet County Assembly. The Act stipulates that the development agenda should emanate from the people, thus budgets are distributed towards prioritized items in each ward. The County officers role is to develop workplans and support their implementation. The challenge is that sometimes the development priorities for the people may not consider issues related to climate change adaptation. This results in only minimal budgets being allocated to issues related to climate change. As much as the officers guide the people in prioritizing development agendas across the different sectors, the final decision lies with the community. The County government through the department of environment targets to protect all water catchment areas, disseminate proper land use practices and enforce variant acts and laws that protects the environment for socio-economic development

The government agencies involved in activities related to climate change include National Environmental Management Authority (NEMA), Kerio Valley Development Authority (KVDA), Kenya Meteorological Department (KMD), and the Kenya Forestry Service (KFS). NEMA has a mandate to supervise and coordinate issues related to the environment in Kenya. The agency has branches in all the counties and planning is participatory, engaging County Offices and the national Office. In Elgeyo Marakwet, they are more involved in rehabilitating degraded sites, regulating waste management, mapping all protected areas and ensuring they are protected. They operate on five-year plans that are broken down into yearly plans and they are derived from their 5-year strategic plan. Poor human resource capacity and inadequate funds remain major challenges within the organization. Moreover, coordination between them and other institutions e.g. County government departments and Kenya Forest Service is poor.

KFS with support from the National government works to conserve the forests that are key catchment areas. Planning is consultative, and is in collaboration with the Kenya Forestry Research Institute (KEFRI). They have a 10-year master plan broken down into yearly activity plans. KFS is fairly well financed with enough officers to execute their mandate. They however face the challenge of political interference because forests are key resources in the County, affecting many livelihoods. The KMD is a key and active player in issues of climate change. They gather the necessary information, synthesize it and share it with all departments and other stakeholders. They are involved in participatory scenario planning that provides early warning information to farmers and other stakeholders in the agricultural sector. Egerton University is collaborating with ICRISAT on pursuing research and promoting adoption of dryland crops like sorghum, millet, beans, groundnut, pigeon peas and green grams.

Non-governmental organizations have different objectives and roles within the County but those that have initiatives related to climate change include: World Vision, Tullow Oil Company, AIC Cheptebo Rural Development Centre, and Iten Integrated Environmental Conservation (IIEC) CBO. World Vision has the resilience and nutrition project over and above the child support programme. Their interventions are not directly targeting climate change but provide support during climate change disasters; they also improve livelihoods to help families cope with effects of climate change. They provide capacity building in terms of building awareness about climate change and strategies to recover from effects of climate change and in extreme cases, disasters. World Vision is involved in promoting conservation agriculture with initiatives like supporting building of terraces. They help put up water reservoirs and small irrigation infrastructure to help families in times of drought. The field offices are fully involved in planning but are restricted by lack of resources.

AIC Cheptebo Rural Development Centre, a development arm of the AIC church have set up an agricultural development center where they train farmers on the best agricultural practices. They provide demonstrations on irrigation systems that are appropriate for smallholder farmers. A board and a management team drawn from the church and the community manage the organization. Tullow Oil is an oil exploration company doing oil exploration in the County. Its activities have effects on the environment, especially land degradation. They have been involved in rehabilitating land affected by their activities. Currently, they are making a comprehensive plan for a soil conservation project with the County.

Iten Integrated Environmental Conservation (IIEC) is a community-based organization involved in environmental conservation and capacity building. They are funded through collaboration with government departments and agencies as well as NGOs. They have been involved in tree planting, environmental rehabilitation, and training on disaster management. It is evident that even though the County Government is involved in issues of climate change, this discipline has not been mainstreamed into its planning and budgeting. Moreover, there is no proper

guidance and coordination of interventions related to climate change. Important government institutions like the National Drought Management authority (NDMA) and Water Resources Management Authority (WARMA) who have the potential to address emerging issues do not have offices in the County hindering effective climate risk management efforts.

Synthesis and Outlook

The economy of Elgeyo Marakwet County depends heavily on agriculture for employment and household incomes. Various crops are grown and different livestock types are kept in the County. However, Irish potatoes, beans, dairy, and local chicken are considered priority value chains. They are resilient, pro-poor, and engage women and youth besides providing food security and income to households. Elgeyo Marakwet has been affected severely by climate change. Intense rains have led to erosion and degradation of land especially along the Escarpment. Runoff has caused flooding in the Valley, siltation of rivers and consequently reduced river volumes. Drought has resulted in crop failure, death of livestock and strife among households due to scarcity of water and food. It has also resulted in ethnic conflicts over pasture and water resources. It has led to drying of rivers and receding of water tables, thus drying shallow wells. People have to travel long distances to get water for livestock and household use.

Farmers in the Kerio Valley have been seriously affected; many of them have lost livestock and cannot grow crops sustainably. However, the farmers, the government, and other development partners have put in place strategies to manage this situation. Livestock farmers are preserving crop residues such as maize stovers to feed cattle during drought. Farmers in the Valley are growing drought-resistant crops as well as early-maturing varieties that can escape drought. These include sorghum, green grams, groundnuts, millet, and cowpeas. The County Government has embarked on introducing livestock breeds that can cope with dry conditions. Examples are Galla goats and camels in Kerio Valley. The County Government is encouraging the use of technologies that can address challenges of climate change. These include promotion of forage conservation for dairy farmers by making hay or silage. Irrigation is being used on small and large-scale farms. The County Government and the other stakeholders are promoting conservation farming especially along the Escarpment. The farmers are being encouraged to build terraces, grow cover crops, and reduce cultivation on very steep areas. Increased incidences of blight have made farmers increase the intensity and frequency of spraying.

The County Government through the Department of Agriculture and Livestock, as well as other relevant sectors is implementing initiatives that help farmers adapt to climate change. The initiatives include advising farmers on suitable crop varieties for the different zones given the prevailing conditions. The challenge is that the County's Equitable Development Act (EDA) that allocates resources towards, and the participatory planning approach that allows the people to prioritize development projects may not take into account climate-smart projects. This limits the influence of County officials to design climate risk reduction and resilience initiatives. The County officers need proper support to be able to design and disseminate the relevant technologies. However, resources for such support are insufficient. The ASDSP participatory planning initiative is invaluable as it is instrumental in equipping farmers and stakeholders in the agricultural sector with information and technologies. However, despite availability of the information, the communication network does not cover some parts of the County so they are not reached. The County, through the Agriculture Development Committee, has valuable plans to develop agriculture and set up measures to address issues of climate change. However, the committee is not entrenched in the County's planning and budgeting, so its sustainability is compromised.

Agencies like KFS, KMD, and NEMA are working towards conserving the forests, providing weather information, and protecting the environment respectively. The aim is to conserve catchment areas and prevent degradation. Weather and climate information is a key input for planning and designing technologies. However, resources for providing these services are insufficient especially in NEMA; Moreover, there is no coordination and synergy among the agencies and the County governments. The non-governmental organizations like World Vision, AIC Cheptebo Development Centre, and Tullow contribute towards reducing the effects of climate change through sensitization, capacity building, and facilitation to access relevant technologies. However, they lack proper coordination because their plans and budgets are more aligned towards their organizational objectives. Climate change is yet to be a thematic area of focus by the County Government. A need therefore exists to mainstream it in its operations, planning, and budgeting. This could be achieved through domiciling the Climate Change Act so that initiatives to deal with climate change are planned and coordinated consciously. The County Government ought to mainstream climate change in its plans and budgets. There should be more efforts to coordinate initiatives by the different stakeholders to create synergies in adapting to the effects of climate change.

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