

Climate Risk Profile Baringo County

Highlights

- Agriculture is the mainstay and primary source of livelihoods in Baringo County, with livestock and crop farming being the major economic activities and providing income and employment for 80% of the population. Mixed farming and pastoralism dominate the highlands and lowlands respectively, while other activities include beekeeping, aquaculture and fishing from Lake Baringo.
- The contributions of youth-, male-, and female-headed households in crop activities are 53, 23, and 20% respectively while those in livestock activities are 27, 51 and 19% respectively. Fishing activities are mostly in male-headed households and contribute 20% of household incomes.
- The climate-related challenges affecting agriculture include; drought, floods, high temperatures, erratic rainfall and uncertainty in the rainfall season onset and duration. Projections for the period 2021-2065 indicate the likelihood of increased heat stress, prolonged moisture stress and increasingly variable rainfall. The population in the Lowlands are more vulnerable to floods, drought, and high temperatures.
- The socio-economic factors that exacerbate vulnerability to climate hazards include; high poverty and illiteracy levels, communal land tenure system, poor infrastructure, insecurity, low technology adoption, high input prices, and undeveloped markets.
- Women and children are most vulnerable to climate hazards despite the women providing the highest family labour for crop and livestock production. The impacts from such hazards include; increased household burden for women, food and nutritional insecurity for children and lack of alternative sources of income and productive assets for use in income generating activities for the youth.
- Strategies adopted by farmers to respond to climatic challenges include water harvesting, value addition, soil and water conservation, on-farm diversification, and change of livestock type and crop varieties to more drought-tolerant ones. However, financial and technical capacity limitations inhibit the adoption of new technologies and coping strategies.
- These coping strategies include irrigation; agricultural extension and research services, market information, seeds, fertilisers, pesticides, water storage in tanks; use of tractors for ploughing, veterinary services; early warning systems; and financial services such as credit and insurance.
- The institutional support in regard to adaptation strategies is availed by; national government agencies; county government; local and international non-governmental organisations; faith-, community-, and farmer-based organisations; and private partners. However, these actors' capacity to deliver accurate, easy-to-understand, and timely information to farmers is constrained by human, technical, and financial resources. Moreover, farmers are not fully involved in such support efforts except in the planning stages.
- To achieve effectiveness in the implementation of climate-change strategies and enhanced resilience, there is need for improved coordination, and technical capacity of extension agents on climate change adaptation as well access to information on climate risks and hazards and ensuring the appropriateness of such strategies. These should also include institutional awareness creation concerning the farmers' financial and physical needs such as appropriate tools and equipment.

Foreword

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

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

This document presents the Climate Risk Profile for Baringo County that has a climate change vulnerability index of 0.446¹. The county continues to suffer extreme weather events that adversely affect the livelihoods of the people. Evidence from historic climate data sources show that the drought frequencies and duration in the county increased from four droughts every 10 years in the 1980s to 8 droughts every 10 years in the 2000s². The consequences of these

events include food insecurity, where approximately 29.5% of the children below 5 years suffered from malnutrition according to the dietary household survey of 2014, and about 21,300, 72,600 and 59,600 people relied on food relief in 2013, 2014, and 2015 respectively³; and 24,000 families relied on food relief in 2017⁴. This was largely due to crop failure and livestock deaths. For instance, the 1988-1992 droughts resulted in 88% loss reduction in maize production whereas that of 2017 resulted in the death of approximately 1,500 livestock. Perceptions are that such droughts are the major cause of the historical inter-communal conflicts over pastures and water, an example being the wrangles of 2017, which resulted in huge losses⁵. Similarly, to droughts, floods are equally disastrous in the county, an example being the floods of 2013 that displaced 300 families and swept away 37 goats. Following these events, Baringo County has attracted a number of humanitarian interventions from organisations such as the Red Cross besides interventions by the county government. Although such interventions are necessary, there is need to structure measures that can increase the people's resilience to climate variation and sustainably increase agricultural productivity. Investing in equitable delivery of amenities and sustainable resource management is also a viable pathway for improving the quality of life in the county during times of weather anomalies.

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

1 Source: GoK; UNDP (2013).

2 Source: Kosonei et al. (2017)

3 Source: WFP (2015).

4 Source: http://www.the-star.co.ke/news/2017/01/18/1500-livestock-die-in-baringo-due-to-prolonged-drought_c1488

5 Source: <http://mobile.apanews.net/en/news/11-dead-from-inter-clan-clashes-in-kenyas-rift-valley>

Agricultural context

Economic relevance of farming

Baringo County is in the Rift Valley Region. It borders Turkana and Samburu Counties to the north, Laikipia to the east, Nakuru and Kericho to the south, Uasin Gishu to the southwest, and Elgeyo-Marakwet and West Pokot to the west. It is located between longitudes 35° 30' and 36° 30' East and latitudes 0° 10' and 1° 40' South. The county covers 11,015.3 km² of which 165 km² is surface water⁶. Altitude varies between 700 and 3,000m. Key features include Kerio Valley on the west and Lobo Plain on the east. Tugen Hills are on the north south and mainly consist of volcanic rocks. The county has 65,280.4 ha of gazetted forests⁷.

Baringo County divides into three major ecological zones: the Highlands, the mid and the Lowlands. The Highlands are in the modified tropical zones with soils that are generally well drained and fertile. This zone has high-potential areas for agricultural and improved livestock development. In the Tugen Hills, coffee grows on a small scale alongside food crops like cereals, fruit trees, and horticultural crops. Large-scale farming of cereals and horticultural crops is practised in the south-west of the Kerio Valley where there is also potential for cotton production. The Lowland is a semi-arid area with complex soils and essentially a rangeland with scattered and isolated pockets of dry subsistence agriculture and small-scale irrigation in Marigat, Kolowa, and Barwessa.

The varied altitudes result to different levels of rainfall of 1000– 1500mm per annum in the Highlands to 600mm per annum in the Lowlands. Temperatures range from a minimum of 10°C to a maximum of 35°C. Climate varies from humid Highlands to arid Lowlands.

Livestock and crop farming; are the key sources of livelihood for the people and the main economic activity in the county. The county is largely semi-arid with a few pockets for intensive agriculture. Mixed farming is mainly in the Highland areas and pastoralism in the arid regions.

In 2016, the livestock population composed of 160,529 dairy cows, 345,242 beef cattle, 393,250

sheep, 901,879 goats, 1,012,193 indigenous chicken, 14,792 donkeys, 10,208 camels, and 165,861 bee hives (Annex 1). Area under crop production was dominated by maize (34 960 ha), beans (17, 788 ha), (millet 2,301 ha), and Irish potatoes (2 013 ha) (Annex 2). Livestock production contributed about KES 2,810,409,526 in 2016 from sale of livestock products and KES 926,959,700 from sale of live animals contributing about (Annual Livestock production report 2016). While crops contributed KES 10.03 billion in 2015(Annual crops report, 2015)

Agriculture employs 80% (GoK, 2013) of the population. About 46% of the heads of households are engaged in agriculture (crop and livestock farming) as a primary occupation⁸. More male-headed households are engaged in the sector compared to youth- and female-headed households (32, 10, and 6% respectively). However, adult female members of households provide the highest share of family labour for crop (46%) and livestock (44%) production; hired labour for crops (42%) and livestock (50%) is mostly provided by youth (GOK, 2014).

Livestock and crop enterprises contribute the bulk of on-farm income for the households. Crop activities contribute the highest income to youth-headed households compared to male-and female-headed households (53, 23, and 20% respectively). Livestock activities contribute the highest income to female-headed households (compared to youth- and male-headed households* (51, 27, and 19% respectively). Fishing activities are also a major contributor to household incomes but confined to male-headed households where the contribution is about 20% of household income (GoK, 2014).

People and livelihoods

Baringo County's total population⁹ Projection in 2017 was 723,411 persons, comprising 363,399 males and 360,012 females (GOK, 2013). The youth forms about half of the population. Majority of the population (90%) reside in the rural areas while 10% reside in the urban areas. Major urban centres are Kabarnet and Eldama Ravine. However, Timboroa, Marigat, Maji Mazuri, and Mogotio are also growing urban centres.

The poverty level¹⁰ in the county is relatively high (58.5%)

6 Lake Baringo, Lake Bogoria, and Lake Kamnarok. The three lakes total 165 km²

7 Established plantations cover 13,940 ha while 51,340.4 ha is natural forest.

8 About 60% of the households have one source of income while 40% had two income sources (GoK, 2014)

9 According to the 2009 National Population and Housing Census: Population in 2009 was 555,561 persons (279,081 males and 276,480 females). It was growing at an annual rate of 3.3%, which is higher than the national average of 3%. Population was projected to 613,376 persons (308,124 males and 305,252 females) in 2012 and 677,209 persons (340,189 males and 337,020 females) in 2015

10 With 58.5% poverty rate, Baringo contributes 1.5% of national poverty..

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

with that in the urban areas being higher compared to that in the rural areas (57 and 20% respectively) (GOK, 2013). Poverty is predominant among the pastoralists, small-scale farmers, female-headed households, and people with disabilities, the landless and youth-headed households. Literacy level in the county is low at 34.5% (GOK, 2013). Main causes of poverty are inadequate and unreliable rainfall, lack of employment opportunities, inadequately organised markets for agricultural produce, poor road infrastructure, and low agricultural productivity.

Access to various utilities is high in the urban areas compared to the rural areas. According to Kenya Power and Lighting Company (KPLC), over 49,000 households connect to electricity; of these, 10% use electricity for cooking. Firewood is a major source of cooking and lighting fuel (87 and 28% respectively) (GOK, 2013). Access to water is limited, with 14% of the households accessing piped water while 52% use streams (GOK, 2013).

Food security is also a challenge, with 57% of the population experiencing food poverty¹¹ (GOK, 2013). Disaggregated by gender, more female-headed households are food insecure compared to male- and youth-headed households. Dependence on limited sources of income, and especially livestock activities, exposes female-headed households to food insecurity. This exacerbates due to limited ownership of resources including land¹². The result is nutritional challenges, especially among children where 34% are stunted while 12% are wasted (GOK, 2013). Poverty and seasonality in food production are major contributors to food insecurity in the county.

The primary occupation of the household heads includes crop and livestock production (46%) followed by self-employed business (21%) and working as farm labourers (9%). Average on-farm income is highest in male-headed households compared to youth- and female-headed households (KES 30,000, 16,000, and 10,000 respectively) (GOK, 2014). The male-headed households often have more than one source of on-farm income in addition to ownership of productive resources including land, in conformity with the patriarchal structure in pastoral communities.

The main sources of income off-farm income include salaried employment, business, and renting out equipment. The most important sources of off-farm income for female-headed households are business (33%), farm labour (29%), and remittance from children (29%). Non-farm labour employment (35%) and farm

labour wages (24%) are the most important sources of off-farm income for youth-headed households; employment (26%) and business (24%) are the most important for male-headed households. Average off-farm income is highest in male-headed households followed by youth- and female-headed households (KES 73,000, 28,000, and 23,000 respectively) (GOK, 2014).

Agricultural activities

The main agricultural activities in the county are crop production and livestock rearing, bee keeping, aquaculture and fishing. Arable land covers 109,500ha, representing 9.9% of the total land area in the county and about 1.9% of the national arable land (GOK, 2013). Total acreage under food and cash crops represents about 8% of the arable land (GOK, 2013). Livestock production consists of pastoralism and dairy farming. Fishing is mostly in Lake Baringo and in fishponds.

The main crops grown in the county are maize, finger millet, sorghum, beans, cowpeas, green grams, garden peas, Irish potatoes, and sweet potatoes, as well as coffee and rice. Livestock types include East African Zebu cattle, poultry, dairy cows, goats, sheep, rabbits, camels, pigs, and donkeys. There are several group ranches within the county.

Average farm size is 2.5 ha with variations in landholding from one sub-county to another. Small-scale farms average 1.5 ha while large-scale farms average five ha (GOK, 2013). About 40% of landowners – mostly in Koibatek sub-County - have title deed. Land in other parts of the county is still communal. For land with title deeds, a larger proportion of female-headed households have title deeds than male- and youth-headed households (56, 40, and 29% respectively) (GOK, 2014).

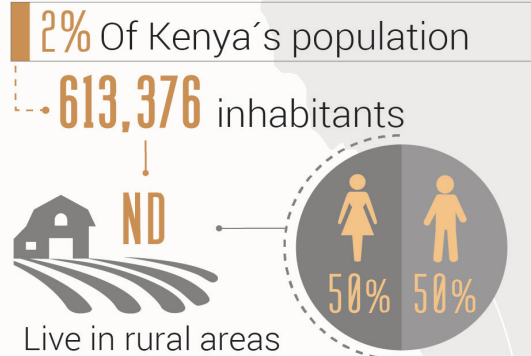
Use of agricultural inputs varies with seasons and households in the county. Inputs include seed, fertiliser (basal and top dress), pesticides, herbicides, and irrigation water. More inputs are used in season 1 (March to August) than in season 2 (August to February). In addition, more production activities are in season 1. In season 2, only 5% of households used agricultural inputs in 2013 (GOK, 2014). In season 1, the inputs used mostly are seeds (97%), basal fertiliser (66%) and topdressing/ nitrogen fertiliser (43%) (GOK, 2014). More male-headed households use inputs compared to youth- and female-headed households. According to farmers, the major constraints to use

¹¹ Food poverty is the inability of individuals and households to obtain an adequate and nutritious diet, often because they cannot afford and/or lack access to healthy food.

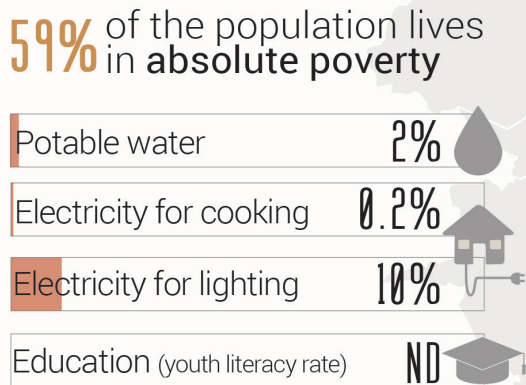
¹² In most pastoralist communities, land ownership dominated by male as patriarchal structures is common.

Livelihoods and agriculture in Baringo

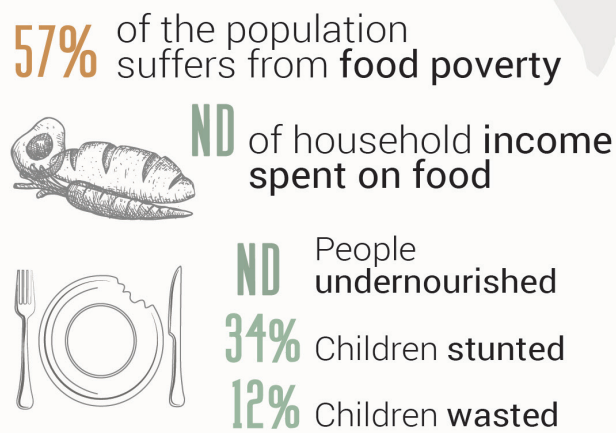
Demographics



Access to basic needs



Food security



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



61% of the population employed in agriculture production

35% of farmers have title deeds

ND are women

Farming activities

Food crops



0.4%

Cash crops



0.0003%

Livestock



2 Group ranches

0 Company ranches

Of county's agricultural land

Farming inputs

Water uses



Fertilizer types (% of households)



Pesticide types (% of households)



of inputs include high prices, access to inputs at the right time, and distance to the market. Adult males dominate decision making over crops in season 1 targeting the market (53%) while adult females make decisions on crops that meet the subsistence needs of the households. Youths make decisions on a few crops such as cowpeas (100%), green grams (33%) and sweet potatoes (33%) (GOK, 2014).

Agricultural value chain commodities

A broad diversity of agricultural commodities are grown in the county. Of these, various value chains have been prioritised 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: prioritisation in county frameworks and programmes; economic value (KES /bag or KES /livestock or KES /unit livestock product)¹³; resilience to current weather variability and future climate change¹⁴; and number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor¹⁵). The VCCs selected are goats (meat), cattle (dairy), maize and indigenous chicken.

Goat (meat)

Baringo County is one of the major producers of goat meat. Although rearing of goats is county wide it is mostly in the Lowlands (Mogotio, Emining, Marigat, Chemoligot, and Arabal). About 41-60% of the county population is involved in goat production, largely under an extensive system with both local and exotic breeds rearing. The two main goat breeds are the Small East African and the Galla. Goats are useful for wealth accumulation and insurance, trade, easy source of cash, and a recovery strategy after droughts, thus contribute to both income and food security at household level. In 2016, the goat population was 901,879 goats, producing about 1,260,062 kg of meat valued at KES 504,024,748 (Livestock report, 2016).

Important management practices in goat farming consist of improved breeding, housing, nutrition, health management, value addition, and marketing. To ensure good breeds, castration of bucks controls

in breeding. Castration also contributes to rapid weight gain among the bucks, which result to higher market prices. Housing for kids reduces infestation by ectoparasite and related mortality rates witnessed during prolonged dry spells because of a build-up of fleas and lice. Thus, housing contributes to resilience among pastoralists since they are able to rebuild flocks after droughts using animals that survive. Nutrition is crucial in the ASAL areas as feeds and water are scarce during the dry season. Farmers can supplement feeding by conserving fodder in form of silage from hay and crop by-products such as maize stalks, as well as from forages such as leucaena, calliandra, gliricidia, clitoria. In addition, use harvested seedpods, especially those of *Acacia tortilis* and *Prosopis can* as feed supplements. Various diseases including Peste des Petits Ruminants (PPR), East Coast Fever (ECF), goat pneumonia, tetanus, and pulpy kidney attack goats. To reduce health-related losses, there is need for early detection of diseases, timely vaccination, deworming, and control of pests such as ticks, fleas and lice.

The key actors involved in the value chain are - input suppliers, farmers, middlemen processors, wholesalers and retailers all operating at small and medium scale. At the input supply level, private practitioners play a key role; county government also supports farmers through extension and veterinary services especially during vaccination and disease control. On-farm production is mostly medium scale. Since goats rearing is on communal land, free-range grazing practices are common. Post-harvest activities include collection, bulking, transportation, and slaughtering. Most goats sell as live animals to markets outside the county with a few some slaughtered within the county. Value addition at the household level includes salting, drying, smoking, and differentiation of parts. Marketing includes sale at the farm level or at the auctions such as those at Kimalel, Mogotio, and Emining. Market infrastructure, including the auction yards, needs improvement and more yards established to enhance accessibility. Contractual marketing is low. Women and youth are moderately involved in the value chain especially in labour provision. Men dominate decision making especially at production and marketing. The actors are not organised and there is potential to improve the value chain especially in marketing where the middlemen exploit the producers.

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

14 Resilience is as defined in IPCC (2012), where we consider the general risks posed by climate change in the county. Value chains that 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 more resilient.

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

Dairy (cattle)

Dairy production is the second largest livestock enterprise after meat production in Kenya. Constraints to this sector include low productivity; poor breed characterisation, inadequate breeding services, poor animal husbandry, inadequate extension and advisory services, inadequate feeds and feeding, disease challenges, high cost of inputs, poor access to markets, and inadequate integration of industry players (GOK, 2013).

The management practices in dairy farming include breeding, housing, feeding, and animal health management. Several breeding options are available including: Replacement of in-calf heifer and cull cow, Artificial insemination (A.I.), bull services, and Assisted Reproduction Technology (ART). Housing for dairy cows can be zero grazing units or the normal enclosures free range-grazing animals. Feeds and feeding ensure that dairy cows receive balanced diet. Thus, feed conservation for the dry season is important. These include cereal crop residuals as well as fodder shrubs and herbaceous legumes through agroforestry systems. Apart from fodder and economic benefits, the system has a great potential for climate change mitigation and adaptation. Animal health in dairy is largely dependent on nutrition, which has a large effect on the occurrence and severity of many diseases of dairy cattle. Major diseases include East Coast Fever (ECF), Rinderpest, Foot and Mouth disease (FMD), Black Quarter, and Anthrax. Recommended management practices include routine vaccinations, tick control as well as treatment of sick animals for management of such diseases. In addition, deworming ensures that infestation by worms does not compromise the health of the animals.

Dairy farming is in the whole county at small scale. However, most of the production is in the highlands, dominated by exotic breeds (Friesian, and crosses)¹⁶ raised mostly under zero grazing. About 61-80% of the population is involved in the value chain. In 2014, the population of dairy cattle stood at 153,099, and produced 24.4 million kg of milk valued at about KES 854 million (GOK, 2015).

The value chain actors in the county include input suppliers, farmers, middlemen, processors. Apart from the processor, i.e., New Kenya Co-operative Creameries (KCC), which is categorised as large scale, the others are either small- or medium-scale. Input suppliers are mostly private practitioners who provide inputs such as veterinary services, feeds,

and Artificial Insemination (AI) services. Feeds form a major component in dairy production in addition to water and good animal health support. The county government supports farmers through extension and provision of feed especially during drought. Farmers observe that input prices are high. Involvement of women and youth at this stage is low to medium. At the on-farm production level, producers are small to medium in scale of operation. In the Highlands, where most dairy production is practised, farmers own about 20 cows per household on average, while the average in the Lowlands is two cows per household. Key activities involve milking, feeding, and disease and pest control. The involvement of women and youth is medium to high at this stage. Post-harvest activities involve bulking, transportation, and processing. Farmer organisations such as cooperatives have contributed immensely to these activities except processing, which is outside the county. Generally, there is ready market for milk. However, infrastructure including road and lack of electricity is a constraint to exploitation of the potential of the industry.

Maize

Maize is a major food and cash crop across Baringo County. Over 80% of the households are engaged in the maize value chain with majority being in production. In 2014, the county had 34,960 ha under maize, producing 388,444 bags (GoK, 2015). Productivity is low due to poor rainfall distribution and crop husbandry. Maize performs best on well-drained, well-aerated and deep soils containing adequate organic matter and other nutrients. Manure and fertiliser are required for growth and development of maize. Certified seeds¹⁷ are available from Kenya Seed Company and other distributors accessed through local agro dealers and NCPB.

A wide range of pests and diseases can attack maize at various stages of growth. Major pests include helioverpa (corn earthworm), maize stem borer, and fall armyworm (*Spodoptera frugiperda*). Cultural methods that include; planting early and adhering to the regional planting calendar, avoiding late and off-season planting, avoiding planting new crop near infested plants, using recommended fertilisers, and keeping fields weed free to boost plant vigour are recommended. Major diseases include Maize Streak Virus (MSV) and Maize Lethal Necrosis Disease (MLND). Management practices include planting early and using certified seeds, use manure and/or basal fertiliser, and/or top dressing fertiliser, regular scouting for insect vectors, early detection of diseases

¹⁶ Friesian-Sahiwal crosses are good for Baringo. They are available from KALRO (Naivasha) as well as in large-scale farms in Nakuru.

¹⁷ High-yielding Highland maize varieties: High Altitude Composite (HAC) (KH600-11D, H600-15A, KH600-16A, KH600-14E, KH600-17A, KH600-18A, KH600-19A, H600-20A, KH600-21A, KH600-22A, H600-23A, KH600-24A, KH600-25A, H600-26A, KH600-27A, H6218, H6213, H6210, 614D, H625, H626, H627, H628, and H629).

and chemical control. Mainly the maize weevil causes high post-harvest losses in maize; large grain borer and fungal infection that leads to aflatoxin are major destructive pests of stored maize. To reduce these losses, farmers can invest in modern storage facilities such as household metallic silos; they may also use AgroZ and PICS storage bags that do not require use of chemicals before storing cereals, as well as pesticides.

Various stakeholders in the county are involved in the maize value chain. At the input supply stage, the service providers include the county government (Department of Agriculture, Livestock and Fisheries (DoALF), Kenya Plant Health Inspectorate Services (KEPHIS), seed growers such as Kenya Seed, and agrochemical shops. The stakeholders provide inputs and extension services. The input suppliers include National Cereals and Produce Board (NCPB), Agrochemical shops, and seed growers who provide inputs including seeds, equipment, fertiliser, and chemicals. These are mostly medium to large scale. Small-scale farmers who depend on rain-fed agriculture dominate the farm level. Medium-scale millers dominate the post-harvest and processing stages while intermediaries play a key role at the marketing stage. The involvement of women and youth is high especially at the production and processing stages through provision of family and hired labour. Farmer-based organisations lack proper governance and coordination and should be improved to reduce exploitation of the farmers by the intermediaries (brokers).

Indigenous Chicken

Indigenous chicken production is in all parts of the county. Over 80% of households are engaged mostly in the production stage, mainly for domestic consumption. However, there is trade involving live birds for meat and eggs as major products. In 2014, the population of indigenous chicken was at 1,183,108 birds valued at KES 354.9 million. Over 200,000 live birds valued at KES 60 million (GOK, 2015) were traded in 2014.

Indigenous or local chicken is an important source of food, income, and employment. The poultry industry also has linkages with other sectors of the economy that include input suppliers, feed manufacturers, breeders, transporters, processors, traders, and consumers. However, the industry continues to be constrained by various challenges, among them loss of genetic diversity, low productivity, predation, diseases, poorly organised marketing structures, poor and high cost of inputs, and inadequate funding to the value chain development, all these resulting to fluctuations in production levels.

Important management practices, technologies, and innovations enhance the indigenous chicken industry in the county. These include adequate feeds and feeding, appropriate housing, breeding, disease and pest management/control. Feeding of indigenous chicken with a balanced diet is important in order to increase production of meat and eggs. Lack of feed and water will reduce resistance to diseases and parasites, and lead to increased mortality rates. Apart from free range, feeding, commercial feeds are available from various manufacturers. In addition, farmers can make on-farm feed formulations using available feed resources. Housing protects chicken from predators and bad weather and is cleaned and disinfected regularly with appropriate chemicals to kill pests and parasites. Breeding management is crucial and ensuring the right ratio of hens to cocks and replacing them every 2 years controls inbreeding. Hatching can involve serial hatching, synchronised hatching, or use of artificial incubation methods. Better-managed chicks increase survival rates and to sustain productivity.

Various diseases including New Castle Disease, pullorum disease, coccidiosis, and fowl typhoid also attack indigenous chicken. Vaccination and isolation of healthy birds from sick ones and proper disposal of dead birds can prevent spread of diseases. Improved sanitation, fumigation of egg nests as well as treatment of infections. Worm infestation is also a challenge controlled through application of anthelmintic when the risk is high.

The actors in the value chain are small scale. At the input stage, the main input is breeding stock that sourced from other small-scale farmers. Extension services are critical but the limited county extension staff available means there is a gap in terms of technological transfer. Production is small scale and characterised by a free-range system for subsistence purpose. Due to low volumes of products, selling is at farm gate. Moreover, linkages of the farmers to markets is poor or non-existent as well as processors and farmer-based organizations.

Agricultural value chain commodities in Baringo



Provision of seeds and other inputs



On-farm production



Harvesting storage and processing



Product marketing

Types of actors engaged in Value Chain



% of people engaged in the value chain
41-60%



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



% of people engaged in the value chain
61-80%



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



% of people engaged in the value chain
81-100%



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



% of people engaged in the value chain
81-100%



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4



Importance of:
women: 3
Youth men and women: 4

Conventions

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

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

ND: No data

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

Agricultural sector challenges

The agricultural sector in Baringo County faces challenges that limit full exploitation of its potential. Poverty affects agriculture, as farmers are unable to purchase inputs for crop and livestock production. This results to low productivity, late land cultivation, and loss of produce due to poor crop and animal husbandry. Low literacy levels limit farmers from diversifying their sources of income to alternatives that could cushion them from the shocks of climate change, whose effects are high on poor households due to their limited resources. Main causes of poverty are associated with inadequate and unreliable rainfall, lack of employment opportunities, inadequately organised markets for agricultural produce, poor road

infrastructure, and low agricultural productivity. There is thus a need for strategies to reduce poverty.

A large part of Baringo County is semi-arid and many farmers depend on rain-fed agriculture. The semi-arid areas of the county receive inadequate rainfall, which results in depressed productivity. Erratic and unreliable rainfall implies that farmers are unable to plan accordingly; at the same time, it is difficult to implement proper agricultural practices such as land preparation, planting, and harvesting. Soil erosion and continuous cropping constrain agricultural activities, leading to low productivity. Large stocks kept by farmers coupled with rainfall torrents, a characteristic of rainfall in the semi-arid areas, significantly contribute to soil erosion.

Limited budgetary allocation towards agricultural development efforts and few frontline extension staff hinder the required support, adoption of various technologies that can improve productivity and development of modern information management systems. Shortages of extension service providers hinder farmers from receiving the necessary information such as that on appropriate inputs and good agricultural practices. However, some farmers do not follow the recommendations on ploughing, weeding, and post-harvest management.

Limited access to farm inputs due to low farm skills, high input prices, few stockists, and long distances to available stockists increases transaction costs of inputs. Thus, farmers opt to recycle seed, which reduces productivity and could carry over pests and diseases.

Inadequate financial services such as insurance and credit facilities is a limiting factor in agricultural investment. Farmers are not able to get credit facilities for inputs necessary for production such as fertilisers, labour, and value addition. Insurance for livestock and crops can enable the farmers recover from climate change hazards including livestock deaths and crop failure.

Land tenure poses a challenge to agriculture especially in the communal land systems. Lack of ownership to land hinder farmers from accessing credit due to lack of collateral. Similarly lack of land ownership demotivate farmers from adopting long term agricultural practices such as tree planting and soil conservation practices.

Poor trade, low market prices and lack of adequate markets and marketing systems for agricultural produce is also a key challenge in the county Other challenges include; lack of knowledge on value addition techniques, poor access roads and limited farmer-based.

The communities also uphold retrogressive cultural practices such as Female Genital Mutilation (FGM), early marriages, moranism, and cattle rustling. Girls undergoing FGM are usually married off early, thus denying them an opportunity to attend school. Boys joining moranism mostly do not attend formal education and some get involved in cattle rustling that has become a security issue. Thus interventions involve enhancing education and strengthening peace committees through peace building initiatives and conflict resolution both within the county and across

borders. Other measures include strengthening community policing, opening up more roads, and improving communication infrastructure for rapid response by security agencies.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

The climate of Baringo varies from humid highlands to arid lowlands, with some regions exhibiting characteristics between these two extremes¹⁹. Mean annual temperatures range from below 21°C over most of the southern, south eastern and south western parts of the gradually rising to over 25°C towards the central lowland parts of the county, with two corridors in between these areas and smaller corridor in the north west of the county having temperatures between the two extremes. Rainfall distribution in the county shows a north-eastern to south-western pattern of increasing rainfall. A small pocket in the northeast receives annual average rainfall of less than 500mm, while the south-western and western corridor has a rainfall average of above 1000mm per year, the area between these two zones having average annual rainfall ranging from 500 to 1000mm. Despite the relatively medium climate, the county is prone to various climate related hazards including drought, floods, forest fires and landslides, which all pose a risk to agricultural production in the county. Water shortages for domestic and agricultural use, including for livestock, are common in some of the drier parts of the county such as the Lake Baringo-Bogoria basin, parts of Kerio Valley, Mogotio, the western slopes of Ng'elecha (Mochongoi) and the entire area of East Pokot (Kollowa to Tangulbei)²⁰.

Analysis of historical temperature in the county over 25 years (1981 to 2005), indicate a moderate increase in both first and second season mean temperatures by 0.5°C and 0.4°C respectively. On the other hand, rainfall trends over a 35-year period (1981-2015) showed an increase in the mean rainfall for both the first and second seasons by approximately 50mm and 100mm respectively. This increase in rainfall has resulted to increased extreme weather events, to include drought, number of heat stress days and floods particularly in the first rainfall season. In addition, there has been a moderate increase in the number of heat stress days in the first season although the number of heat stress days in the second season has remained constant.

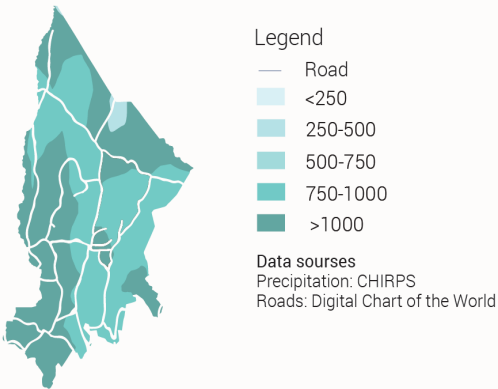
18 Communities within the county and those from neighbouring counties of Samburu, Elgeyo Marakwet and Turkana are prone to cattle rustling

19 <https://cog.go.ke/images/stories/CIDPs/Baringo%20.pdf>

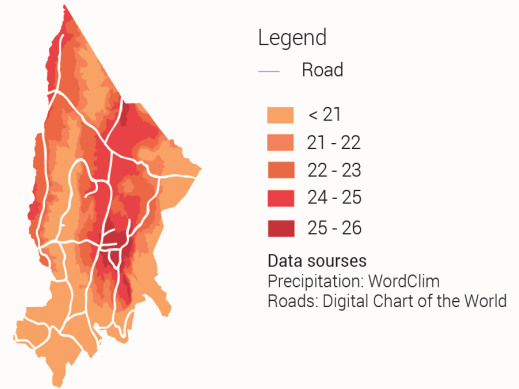
20 https://www.wfp.org/sites/default/files/Baringo%20CGNA%20_28062016_V2.pdf

Past and future impacts of climate hazards in Baringo

Historical annual mean precipitation (mm/year)



Historical annual mean temperature (°C)

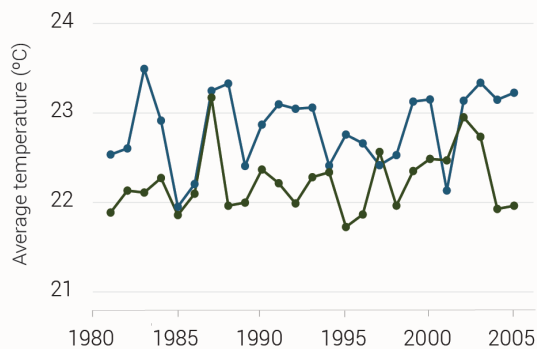


Heat stress hazards

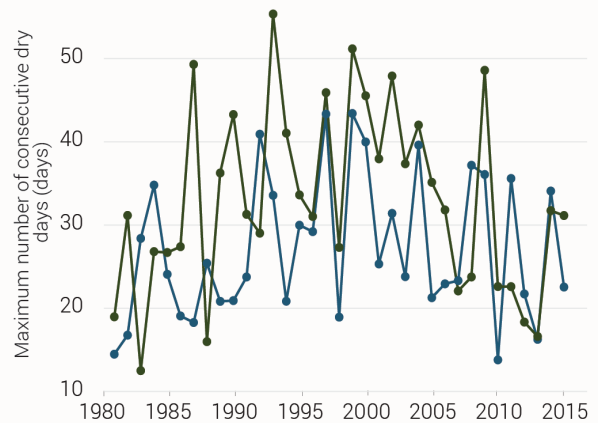


Drought hazards

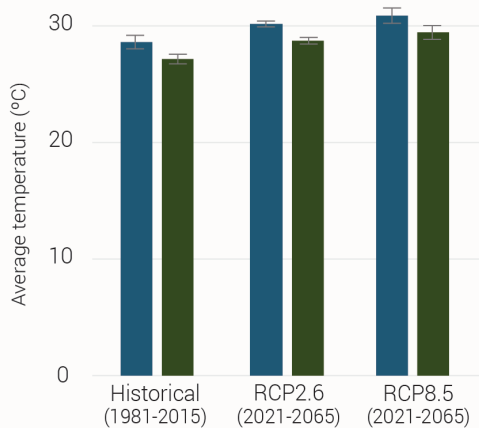
Historical extreme heat stress events



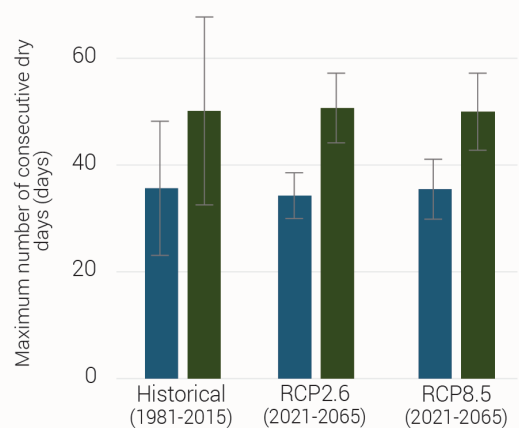
Historical drought stress events



Historical and expected extreme heat stress events



Historical and expected drought stress events



■ January - June ■ July - December

Episodes of torrential rain causing floods, alongside episodes of heat waves and prolonged dry spells have thus become more common in the county.

Looking ahead to the future, climate projections based on two representative concentration pathways (RCPs²¹), the mean temperatures will continuously increase

The number of heat stress days²² rises significantly as a result, particularly in the second season from approximately 9 days to over 35 days in the low emissions scenario and as high as 50 days in the high emissions scenario. Mean first season rainfall is expected to decrease by about 20% from the historical average, a stark contrast to the historical trend of increasing rainfall, although second season mean rainfall is expected not to change significantly under both scenarios. Season onset is also expected to shift backwards under both scenarios, particularly in the second season. These changes are more severe under the high emissions scenario, although changes expected to occur regardless of which emissions pathway is taken. Drought spell length²³ remains relatively constant under both scenarios; however, moisture stress²⁴ is expected to increase significantly in the first season. The projections under the two GHG emissions scenarios show some differences, however both indicate the likelihood of increased heat stress, prolonged moisture stress and increasingly variable rainfall.

Climate Perceptions by the farmers

Farmers in the county observe that there has been climate change. Manifestations are through decreased rainfall amounts, erratic and unreliable rains, increasing temperature, and increased frequency of droughts and floods over time. The causes of this climate change are associated with human activities such as deforestation, charcoal burning, overstocking, inadequate conservation of soil and water, and massive deforestation in the county as well as other counties that serve as catchment areas for the region.

These activities have resulted to: drying of wells and rivers; frequent droughts and floods; erratic and unreliable rains; soil degradation causing the formation of deep gullies; emergence of new diseases and pests such as *Tuta absoluta* pests that affected Perkerra Irrigation Scheme in Marigat for the first time in 2014 (KNA, 2014); and reduction of water volume

in the rivers. Lake Baringo depends largely on river recharge; its depth has decreased from a high of 8 m to below 4 m (Odada *et al.*, 2006). Other observations include emergence of new plants and animals. Bees and *Proposis juliflora* increasingly sighted towards the Highlands because of the rising temperatures. Heavy rainfall coupled with deforestation is increasing the frequency of landslides. Incidences of conflicts over resources have increased.

The consequences of climate change affect the livelihoods of the people of Baringo in various ways. Heavy rainfall and flooding cause damage to crops and hamper income-generating activities such as renting farm equipment, resulting in a general decline in income. Food security is hard to achieve due to poor harvests and reduction in food availability. High temperatures affect dairy production as it leads to poor body condition and even death of animals hence loss of income.

Climate vulnerabilities across agriculture value chain commodities

Climate change and variability pose serious threats to agriculture in Baringo County. Climate change increases the intensity and frequency of the climatic hazards including floods, landslides, high temperatures, and drought. The Highlands are more prone to landslides than the Lowlands while floods are common in the Lowlands because of the terrain. The impact of these hazards is higher on the vulnerable segments of communities who lack the ability to adapt or recover after the hazards. The sections below highlight the major climate risks faced by the major value chain commodities

Goat (meat)

Goats are versatile and have adaptable feeding habits. However, extreme climatic shocks affect their productivity in terms of feeding and diseases. In Baringo County, the climatic hazards identified as most problematic are low rainfall in the first season and drought. First season rains (March–May) lead to good animal health due to availability of forage. Consequently, proper goat health leads to fertility improvement and enhanced conception. Thus, kidding occurs between June and October when the does can feed on the forage that result from the first rains. Drought or dry spells result in shortages of forage and water, which affect the feeding of goats; as a result, the

21 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 <https://co2.go.ke/images/stories/CIDPs/Baringo%20.pdf>

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

23 Maximum number of consecutive dry days (precipitation < 1 mm day⁻¹)

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

body condition deteriorates, affecting breeding and milk for the kids. Does have lower productivity as they will not turn on heat uniformly.

These hazards affect the goat (meat) value chain with different severity levels at various stages. The effect of drought varies from moderate to severe along the value chain. During dry spells, incidences of diseases such as East Coast Fever (ECF), Foot and Mouth diseases, Rift Valley Fever (RVF), Contagious Caprine Pleuropneumonia (CCPP) and, *Peste des petits ruminants* (PPR) increase. This requires more extension services as well as increased costs for disease control including vaccination and dipping. Resource-poor farmers are more affected as they cannot afford drugs or fodder due to high costs, especially when droughts become frequent and prolonged. Such farmers include women and youth, since they do not own appreciable resources, including large number of livestock, which they can sell to sustain those that critically in need of support. Limited access to land due to the patriarchal institutional arrangement common in most pastoralist societies makes more women and youth depend on goats.

Dairy (cattle)

Climatic shocks affect dairy farming leading to variations in productivity and health of animal. In Baringo County, various stakeholders including farmers identified increase in temperature (high temperature) and decrease in rainfall in first season as major hazards.

High temperature causes dairy cows to reduce feed intake; it also increases disease incidences, thus increasing the demand for veterinary services. At the same time, demand for Artificial Insemination (AI) decreases as the animals' health deteriorates due to reduced feeding. Demand for supplementary feeds also decreases. Veterinary Services Department (inadequately staffed) provides the veterinary services, however, private practitioners, whose cost is prohibitively high for the farmers, also provide these services. At the farm level, reduced feed intake leads to low production. Consequently, the volume of milk available for marketing is low; hence, the costs for bulking and transport per unit of milk increase. Spoilage of milk increases due to high temperature. The severity of the impact of high temperature ranges from moderate to high across the value chain.

Decreased rainfall in the first season is a major challenge as it leads to reduced availability of fodder. Consequences of decreased rainfall are similar to

those of high temperature, especially on animal health and milk production due to poor feeding. Poorly fed animals become more susceptible to diseases, increasing cost of veterinary services. Animals fail to go on heat in time, resulting in delayed calving. The impact of this hazard is moderate to severe across the value chain.

The most vulnerable would be the less educated, the resource-poor farmers, women and the youth. Farmers in these categories have little access to resources and information that is required to cope with the challenges caused by the hazards.

Maize

Production of maize in Baringo County affected by the uncertainty of the start of the rainy season and moisture stress. The impacts of these hazards affect the whole value chain with varied degrees of severity.

Uncertainty of the start of the rainy season affects the key activities at the input stage, notably sourcing, stocking, and delivery of inputs. Moisture stress affects the extension service since selection and packaging of information to be disseminated on the most appropriate varieties is compromised and in some cases conflicting. The timing of application of inputs such as fertiliser, pesticides and other chemicals for disease control leading to low sales at the supply side. The impact of the hazards range from severe on sourcing and delivery of inputs, and between minor to major in severity for extension and training activities.

Key activities identified at the on-farm production stage are land preparation, crop establishment, and control of pests and diseases. Uncertainty about the start of the season leads to conflicting information on the most appropriate time for land preparation. This leads to untimely land preparation, which in turn leads to poor crop establishment. Late onset of rains and moisture stress leaves the plants very weak and thus vulnerable to pests and diseases. Key among them being armyworms (*Spodoptera frugiperda*), Maize streak virus (MSV) and Maize Lethal Necrosis Disease (MLND). All these results to poor harvest and post-harvest challenges particularly infestation by weevils and large grain borer.

The output market stage for the maize involves market sourcing, selling, and transportation of the produce. Uncertainty of the start of season affects market sourcing due to timing, volume and quality produced. Thus, price and transportation costs fluctuate affecting farmers' incomes. In the same way, moisture stress

during the growing period affects volumes and quality of produce, leading to an uncertain market, fluctuating prices as well as high transportation costs. The severity of the hazards at this stage varies from moderate to major.

Poor harvests affects the follow up agricultural activities such as the need to replant and ability to procure more farm inputs. Resource-poor farmers are the most affected.

Indigenous chicken

Drought and high temperatures are the most important hazards for indigenous chicken in Baringo County. The effects of these hazards are across the value chain although the severity varies across the different stages.

At the input stage, drought and high temperatures affect some key activities. The aspects affected include breeding stock²⁵. Drought causes reduction of both feed and water availability. Consequently, production of both meat and eggs decreases. Thus, there is reduced demand for extension services, breeding stock and building materials. Likewise, high temperatures reduce the time available for extension services, as it would be too hot for meetings; delay procurement of the breeding stock. When temperatures are high, the chicken eat less, as they spend most of the time in a shade. Hence, egg and meat production decreases, leading to low demand of feeds. However, the severity of drought impacts on this stage is minor to moderate while that of high temperature is major.

At the on-farm stage, drought and high temperatures cause poor body condition of chicken, reducing the effectiveness of the vaccines. These hazards cause shortages of water and increase water for drinking for the birds affecting their growth and productivity. The severity of the effect varies from minor to moderate and moderate to major in the case of drought and high temperature respectively.

At the post-harvest stage, drought and high temperature affect the sorting and grading, market research for output market, and transportation. Need for market information, sorting and grading reduces since the volumes produced are low. When supply is low, the buyers will be willing to buy whatever is available; this eliminates the need for sorting and grading. Transport costs increase due to low volumes. The severity of the effects vary from moderate to major for both drought and high temperatures.

At the output market stage, drought and high temperature reduce linkages of farmers to buyers, as quantity produced is low; market prices and off-take are low due to reduced weight, hence profit margins are low. The severity of the effects vary from moderate to major and major to severe in the case of drought and high temperatures respectively.

The most vulnerable include the women who have to spend much time fetching water for domestic use during drought and high temperature; youth whose resources are limited; and the illiterate who cannot use alternative sources of extension services and market research such as print and electronic media.

Adaptation to climate change and variability

On-farm adaptation practices

Farmers supported by various organizations continue to adopt strategies that help them to respond to climate risks. Farmers respond through various strategies. However, there are strategies that farmers would like to adopt but challenges including skills, resources, and policy support limit adoption. For instance, high seed prices limits use of certified seeds, which increase productivity. Moreover, given the various strategies that can be adopted, farmers and other stakeholders such as county government can identify those that have high return if implemented as discussed in this section.

Crop farmers face climate risks including uncertainty of start of season and moisture stress. The consequences include untimely land preparation, conflicting information such as that on the most appropriate time for land preparation, and poor crop establishment due to poor germination, which in turn affects all the crop management practices. Currently, farmers respond by adopting strategies that include use of Indigenous Traditional Knowledge (ITK) especially traditional weather forecasts as the weather especially rains remains erratic. Uncertainty of rains means farmers delay ploughing as they wait for light showers to soften the ground. In addition, farmers plant at the onset of rains, and minimise weeding as well as replanting to ensure high plant density when the rains are erratic. Due to unavailability and high prices of outsourced agricultural inputs in the county, farmers normally use manure and uncertified seed

²⁵ Breeding stock is sourced from other farmers, the Department of Livestock and NGOs such as World Vision and private enterprises such as Kuku Chicks; and building materials for constructing housing, available from local hardware shops or sourced from outside the county.

from previous harvest, and diversify to other crops such as pulses; they also keep bees as a source of income to mitigate low yields and crop failures. Service providers disseminate information through *barazas* (gatherings of locals convened by local leaders such as Village Heads or Chiefs) and other social gatherings to reach farmers. Inadequate extension services lead to some farmers resorting to copying practices from neighbours including ploughing after neighbours start ploughing. Due to inadequate marketing systems and low volumes produced, farmers sell the produce individually or in groups to intermediaries at the farm gate at low prices. Holding the produce at household level for some time for prices to improve is also a strategy when prices are very low.

Crop farming can also adopt other strategies to enhance resilience to climate risks. Limiting factors to these strategies are finance, technology, and skills of farmers. Information gathering and sharing can be improved by: integrating ITK and scientific methods of weather forecasting; widening the avenues of information sources to farmers to include use of bulletins, radios, short message services (sms) and employment of more extension staff; and timely dissemination of integrated weather information. Supplying farmers with subsidised inputs such as certified seeds will improve access of inputs. Capacity building is critical for farmers and their organisations such as cooperatives. This includes training especially on conservation agriculture and support with farm machinery such as tractors. Promotion of traditional, high value crops that are drought tolerant as well as early maturing crop varieties improves diversification. To enhance marketing, cereal banking, training of farmers on market research, and provision of storage facilities can reduce post-harvest losses.

From the current and potential strategies, the options considered as having the highest returns if implemented include: timely supply of farm inputs; provision of subsidised ploughing; timely dissemination of information; integration of ITK and scientific weather forecast; diversification to other crops especially drought-resistant crops and varieties; adoption of conservation agriculture; expansion of irrigation schemes; formation of marketing groups and cooperatives; adoption of cereal banking; and capacity building of extension staff and farmers.

Livestock farmers and pastoralists encounter climate risks including high temperatures, which have the most significant effects on their livestock from drastic decreases in rainfall in the first season; and drought.

The consequences of the risks include increased incidences of pests and diseases; inadequate feeds; unavailability and high costs of inputs; reduced contact time for training; and low productivity. The strategies that farmers are currently practising include those adopted singly or in combination with others to respond to given risks. For control of pests and diseases, farmers use ITK on animal husbandry such as herbal medicine and restrict movement of animals to reduce contamination. They also postpone vaccination, skip spraying, isolate or slaughter animals that are sick or affected in other ways; hand spray, hand pick ticks, exercise biological control using chicken which pick ticks from the body of the animal and burn tick breeding grounds in an effort to respond to unavailability of and high prices of drugs. Limited access to Artificial Insemination (AI) leads farmers to use bulls or bucks and exchange such services with neighbours.

Training and extension contact with farmers is during cool hours especially afternoons as opposed to the mornings when most people are out in search of water. Information dissemination is through *barazas*, during ceremonies, at social points such as dips, and watering points. Inadequate feed is a major challenge and strategies include use of farm by-products such as stalks and making on-farm formulations, as well as importing inputs from outside the county. Traditional enclosures protect young animals such as kids. Value addition is very limited hence, farmers preserve their produce through strategies such as use of cold water for cooling milk and while meat is salted, dried or smoked. Farmers respond to marketing challenges arising from low productivity and poor transport infrastructure by selling at farm gate, hawking, or selling at local open markets; trekking animals to market instead of trucking; and withholding animals that are ready for the market until prices improve. They also form or merge farmers groups and cooperatives to enhance bulking and reduce transport costs. Moreover, diversification either to other crops or to activities like beekeeping is another strategy that they use.

To enhance dissemination of resilience and adaptation related information, alternative methods such as radio and bulletins can be used. Subsidising farm inputs especially AI, drugs, and feed will benefit especially the resource-poor farmers. Feed is crucial, hence there is need to promote on-farm feed formulation, pasture conservation, and management. Animal health improvement through increasing extension staff and providing them with the means to do their work, as well as training farmers and community animal health

assistants. There is also a need to establish vaccination programmes. Land demarcation to discourage communal grazing can reduce transmission of pests and diseases. To improve productivity, especially in local chicken, use of incubators and hatcheries as well as promotion and upgrading of local breeds should be encouraged. To improve breeding, especially for goats, there is need to modernise and strengthen the remote improvement centres. Capacity building for farmers and service providers will assist in adoption of better technologies and innovations including value addition. Establishing processing infrastructure such as abattoirs will promote processing while improving on disease surveillance and monitoring. Market structures and information systems development so that farmers can access information and market easily. Transport infrastructure will improve access to markets.

Farmers and stakeholders consider some of the current and potential strategies to be of highest value if implemented. These include: pasture conservation and management; subsidised inputs; improved disease surveillance; value addition; establishment of processing infrastructure including cottage industries; capacity building for farmers, service providers and cooperatives; improving local breeds; improving marketing infrastructure and establishing market linkages; and enhancing dissemination of information.

Off-farm adaptation practices

In addition to adaptation strategies at farm level, there are off-farm services that enhance farmers' response to impacts of climate change in the county. Public and/or private institutions provide these services. The services include infrastructure such as irrigation, agricultural services (extension, research, market information, and veterinary services among others), climate, and financial services. However, while public sector institutions dominate in provision of infrastructural services such as irrigation, the private sector institutions dominate in provision of agriculture, finance, and climate services.

Infrastructure services especially for irrigation are crucial for adaptation to climate change in the county as most of Baringo County is semi-arid. The services include drilling, equipping and rehabilitating boreholes, expanding and developing irrigation schemes, constructing and rehabilitating water pans, and installing roof catchment structures. About 64% of the households access infrastructure services from public institutions while 36% access them from private institutions. More female-headed households access infrastructure services from public institutions

compared to male- and youth-headed households (82, 64, and 55% respectively). However, more youth-headed households access infrastructure services from private institutions compared to male- and female-headed households (45, 36, and 19% respectively) (GOK, 2014). The Department of Water and Irrigation mandate is providing water services and developing infrastructure for irrigation water. To achieve its objective, the department collaborates with other organisations such as NIB, World Vision, DRSLP, Red Cross, CDF, RVWSB, Actet (K), KVDA, NYS, Baraka Institute, Farming Systems, Tullow Oil, Action Aid, Child Fund, and JICA. Those in the Lowlands access the services more as most of the irrigation schemes are in those areas. High temperatures here increase evapotranspiration, exacerbating the shortage of water for crop and livestock. Small-scale farmers stand to benefit most from the development of irrigation infrastructure by development partners, as in most cases small-scale farmers do not have the financial or technical resources to undertake such investments on their own. However, the uptake of irrigation as an adaptation option is lower than expected due to inadequate extension services coupled with high poverty levels. Insecurity in some parts of the county discourages donors from availing further support towards irrigation.

Agricultural services include extension, research, veterinary services, Artificial Insemination (AI), dipping, credit, and markets (input and output). Public and private institutions provide these services. In the county, agricultural services are accessed more from private institutions compared to public institutions (53 and 46% respectively) (GoK, 2014).

Extension services help the farmers to acquire skills on crop and animal husbandry in addition to advisories on information related to services and appropriate inputs, depending on area and season. Mostly the county government through the Department of Agriculture, Livestock, and Fisheries provides the services. The private sector also provides extension services, including those through seed and chemical companies such as Kenya seed Company. More male-headed households access extension services compared to female- and youth-headed households (44, 39, and 9% respectively) (GOK, 2014). Infrastructure, especially roads, and resources including personnel pose a challenge in delivery of the extension services in the county.

Provision of veterinary services by the Veterinary Services Department in the county and private service providers enables the farmers' access the services

either at the farm level or from public areas especially during vaccinations. Male-headed households dominate access of veterinary services compared to female- and youth-headed households (51, 33, and 8% respectively) (GoK, 2014). Challenges facing veterinary services include high costs, poor road infrastructure, poverty, and attitude towards modern medicine as compared to the Indigenous Traditional Knowledge (ITK). Private veterinary service providers also exist in the county. Access is high in male-headed households compared to female- and youth-headed households (57, 28, and 8% respectively) (GoK, 2014). Dipping is also an important service for disease control. Dipping is in livestock dips that constructed and maintained by the public sector although communities also support in some cases. This service is common in the communal lands and accessed mostly by male-headed households compared to female- and youth-headed households (40, 30, and 15% respectively) (GoK, 2014). Challenges encountered with dipping for disease control include the inappropriate location of the dip and inadequate technical support such as delay in operational support and supply of acaricides and maintenance works.

Information on climate change including early warning system is available in the county. ASDSP in collaboration with Kenya Meteorological Department (KMD) and the communities organise participatory scenario planning that considers the projected climate variation. This aims at helping the farmers to plan appropriately in order to mitigate the impacts of climate change. Climate information is accessed mostly by male headed households compared to female- and youth- headed households (50, 27, and 23% respectively) (GoK, 2014). Challenges to climate information include low literacy levels and attitude; majority rely on indigenous knowledge.

The banks, cooperatives, and Agricultural Finance Corporation (AFC) provide credit services. Farmers for infrastructure and operational needs of the agricultural activities as well as to meet the basic needs use credit. Uptake of credit is the same in male-and female- headed households, and low in youth-headed households (36, 36, and 14% respectively) (GoK, 2014). However, limiting factors to credit access are lack of collateral especially for farmers in the communal lands, as they cannot use the land to acquire credit; distance to urban areas where most credit providers are located; poverty; illiteracy; and attitude towards credit.

Markets for inputs and outputs are off-farm services that are available in the county. Private and public institutions provide the inputs. Input markets include

suppliers of seeds, fertilisers, chemicals, and farm equipment. These are located mostly in urban centres and operate mainly at small scale. Access to input markets is highest in male-headed households compared to female- and youth- headed households (42, 33, and 12.5% respectively) (GoK, 2014). Among the constraints to accessing input markets are high prices, distance to input market, ineffectiveness of inputs, unavailability of inputs, and lack of inputs when needed.

Output markets for farm produce include yards for livestock auction and open markets for sale of crop produce. Provision of the market infrastructure is by the public institutions, in particular county government alone, or in collaboration with other institutions such as the private sector or NGOs. Farmers' cooperatives also provide output markets for products such as milk. Access to output market is highest in female-headed households compared to male- and youth-headed households (47, 27, and 13% respectively) (GoK, 2014). The small- scale farmers need these markets, as they cannot access markets that are far away such as those outside the county. Challenges limiting access to output markets include poor road network and lack of value addition.

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

Cattle (dairy)

Provision of seeds and other inputs



On-Farm production



Harvesting storage and processing



Product marketing




Moderate increase in temperature

Increased outbreak of diseases, hence demand for veterinary services will be higher; reduction in feed availability

Increased demand for vaccination services; low demand for deworming; spraying events are constant

Increase in the cost of bulking due to decrease in volume of milk; increase in transportation cost; milk spoilage

Increases in market demand; increase in price; decrease in sales of raw milk

Magnitude of impact

Major

Minor

Major

Major

Farmers' current strategies to cope with the risks

Use of indigenous knowledge such as use of herbal medicine. Use of farm by-products as feed

Restriction of movement of dairy animals; use of indigenous knowledge such as use of herbal medicine; skipping spraying days; hand spraying

Become a member of groups/cooperatives; private means of transportation; use of jerry cans; use of cold water for cooling

Creation of groups to advocate for farmers; cooperative societies merge; sale of raw milk

Other potential options to increase farmers' adaptive capacity

Training of farmers on community animal health management; veterinary drug subsidies; pasture conservation; provision of subsidized Artificial Insemination (A.I.) services, drugs and other inputs

Awareness creation through alerts and campaign programmes; establishment of vaccination programs

Strengthening cooperative societies through funding; developing an organised system of transportation; improving infrastructure; boost in cooling plants; capacity building on milk hygiene/pasteurisation

Revisiting policy control on prices; strengthen cooperative societies; sale of pasteurised milk; capacity building


High increase in rainfall (1st season)

Increase in disease outbreak and demand for veterinary services; reduction in feed availability; decrease in heat period for cows. low demand for A.I.

High demand for vaccination; low demand for deworming; no consequence; spraying is instant

Decrease in milk quantity; cost of transportation increases; reduced volume of milk for processing

Market dictates prices (processors); decreased volume of milk marketing; volume of milk decreases hence low sale of raw milk

Magnitude of impact

Moderate

Moderate

Moderate

Major

Farmers' current strategies to cope with the risks

Adoption of indigenous and traditional knowledge to (use of herbal medicine); using farm by products e.g. maize stalks; waiting for favourable conditions for cows to come on heat

Restricting animal movement; irregular deworming; skipping spraying days; hand spraying; hand dressing

Farmers join groups and cooperatives; collection and joint transportation

Sale of raw milk to open market; widening the scope of milk collection; farmers increase milk prices

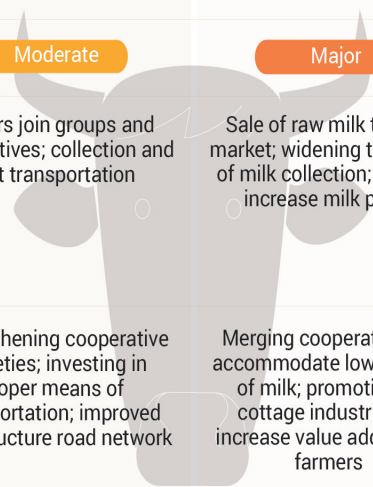
Other potential options to increase farmers' adaptive capacity

Boosting capacity building; subsidising drugs; train local veterinary services providers; on farm feed formulation; pasture conservation and management

Establishment of vaccination programmes; develop a proper regime for deworming; ensuring maintenance of cattle dips; subsidizing acaricides

Strengthening cooperative societies; investing in proper means of transportation; improved infrastructure road network

Merging cooperatives to accommodate low volume of milk; promotion of cottage industries to increase value addition to farmers



Maize



Uncertainty in start of growing season

Conflict in the type of information delivered to the farmers; untimely sourcing, stocking and delivery of inputs; untimely planning of agricultural trainings

Untimely land preparation hence affecting the overall yield; conflicting information on the most appropriate time for land preparation; poor crop density due to poor germination hence affecting yield and the entire crop management practices

Untimely preparation/cleaning of the store in readiness for harvest; pricing of the commodity could also be affected; low quality and volumes for processing; low quality of produce available for processing

Uncertain market prices; poor transport/ logistic planning; drastic changes in the commodity price

Magnitude of impact

Major

Major

Major

Major

Farmers' current strategies to cope with the risks

Use of Indigenous Technical Knowledge (ITK) especially the traditional weather forecast; planting of uncertified seeds; disseminate information through bazaars

Proper land preparation. -planting at onsets of rains; farmers use ITK on weather forecast to make decisions during land preparation; replanting and gapping to ensure high plant density

Diversify to other food crops such as pulses; use of local granaries; sell their produce to brokers who bulk the produce

Group marketing and sales to brokers/traders; farm gate sales to middlemen; waiting for prices to improve

Other potential options to increase farmers' adaptive capacity

Integration of ITK and scientific weather forecasting; timely supply of subsidised seed/inputs to farmers; use of bulletins, radios for sharing of extension information; employment of more extension staff

Provision of subsidised ploughing machinery for land preparation; timely dissemination of information and closer to the farmers; install more weather stations; use of certified seeds; use of drought-tolerant and early-maturing varieties

Promotion of traditional high value crops; provision of metal silos and hermetic bags; promotion/development of cereal banks

Adoption of cereal banking; farmers to be trained on market research; development of organized marketing groups



Moisture stress

Selection/packaging of information to be disseminated on the most appropriate crop varieties; affects timely application of inputs e.g. fertilizer and pest and disease control

Reduced/delayed land preparation especially primary and secondary ploughing; some benefits on weeds control; plant vigour affected hence the general crop performance

Ensures proper drying of produce but can increase pest infestation; poor-quality of produce available for processing

Low quality grains affecting commodity prices and ultimate marketability; reduced volumes available to be transported to millers; low income for farmers

Magnitude of impact

Moderate

Moderate

Severe

Major

Farmers' current strategies to cope with the risks

Holistic approach to dissemination of information; use of organic manure; replication of practices implemented by neighbouring farmers

Farmers near the offices are served with first-hand information; minimized weeding; Conservation Agriculture

Early harvesting; use of indigenous methods (ash/natural insecticides) to preserve produce; the produce is manually sorted and graded

Produce sold at farm gate due to low volumes; selling to local consumers or consumed at household level

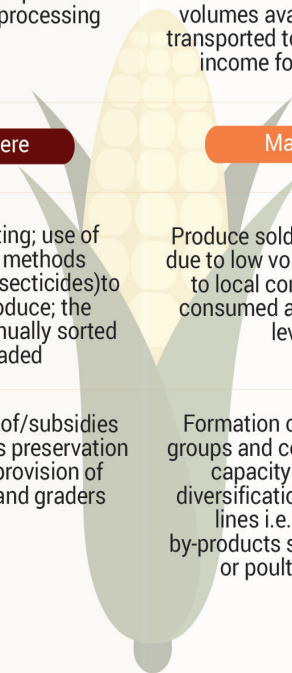
Other potential options to increase farmers' adaptive capacity

Enhanced and build on synergy from relevant departments; increase the frequency of disseminating weather forecast information

Scale up conservation agriculture; availing farm machinery to farmers; application of foliar fertilisers; capacity building of extension service providers on packaging of climate related information; establishment and expansion of irrigation schemes

Encourage use of/subsidies alternative seeds preservation compounds; provision of maize dryers and graders

Formation of marketing groups and cereal banking; capacity building; diversification of product lines i.e. to make by-products such as cattle or poultry feeds



Goat (meat)

Provision of seeds and other inputs



On-farm production



Harvesting storage and processing



Product marketing



Moderate increase in temperature

Increase in dipping frequency; slight increase in disease outbreaks especially Contagious Caprine Pleuropneumonia (CCPP); increase demand for extension services

Decreased productivity as the goats will not come on heat uniformly; reduced availability of browse for the goats

Delayed slaughtering process; ease of transport due to road accessibility

Linkages between farmers and traders is enhanced due to road accessibility, fewer goats traded; price fluctuations due to irregular supply

Magnitude of impact

Minor

Moderate

Moderate

Moderate

Farmers' current strategies to cope with the risks

Hand picking of ticks; biological control (use of chicken); burning of tick breeding grounds; herbal medicines (traditional knowledge on disease control and animal husbandry); isolation of sick animals

Exchange of bucks with neighbours; use of traditional dry season grazing zones; use of stored acacia pods as feed; kids and lambs are separated keeping them in shed; use of thatched feed enclosures; social points for dips and watering

Sales in informal markets; trekking of goats to markets; slaughter at markets; slaughter of weak stock

Marketing at public functions (bazaars, ceremonies); withholding of goats from the market until prices improve; exploring alternative livelihoods e.g. honey; borrowing from relatives for immediate needs

Other potential options to increase farmers' adaptive capacity

Encourage demarcation of land (to discourage communal grazing); County subsidizing of vaccinations and drugs/acaricides; enforcement of vaccination regimes; employment of more veterinary officers; facilitation of extension services

Promotion of local breeds; (e.g. purchase of Galla bucks); modernization and strengthening of remote improvement centres; planting of forage trees/reseeding of range lands; commercial fodder production; capacity building on proper/modern housing of goats

Encourage use of auction yards for sales; development of modern slaughterhouses/ abattoirs/slabs; enforcement of slaughter sanitary standards; meat value addition (e.g. drying)

Development of goat market information systems (including use of social media and Whatsapp); improvement of feeder road networks; formation of goat marketing cooperatives



Decrease in rainfall (1st season)

Increase in frequency of dipping and other routine practices; slight increase in cases of vaccination especially cases of CCPP; increase demand for extension services by farmers

Minimal breeding and irregular heat season for goats hence affecting multiplication; reduced resistance to diseases due to malnutrition; reduced drinking water availability

Ease of collection of the goats for marketing; declined number of goats to be transported; declined in number of goats slaughtered

Reduced linkage between producers and traders because of accessibility; decrease in prices of goat meat; decrease promotion activity because of high supply

Magnitude of impact

Minor

Major

Moderate

Moderate

Farmers' current strategies to cope with the risks

Use of local medicinal herbs; hand picking of ticks; burning of tick breeding grounds; use of traditional disease control and livestock husbandry methods; isolation of affected animals

Salt licking the animals; use of supplementary feeding; use of local herbs

Goat hawking; sale at homestead/farm gate; trekking of goats to the market; use of local slaughterhouses or slaughter at market

Marketing through word-of-mouth at social places and bazaars; withholding of goat meat until prices improve

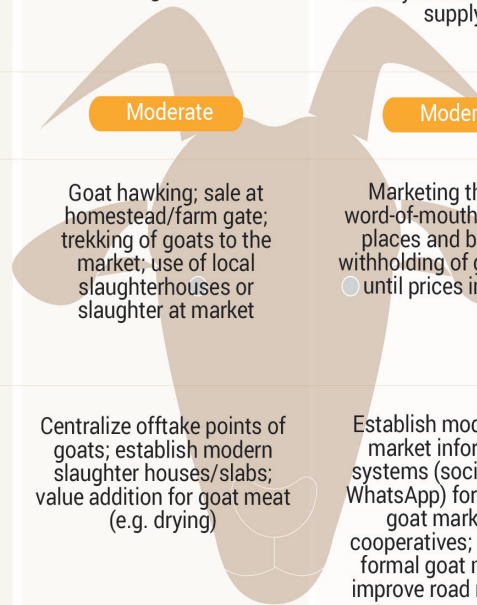
Other potential options to increase farmers' adaptive capacity

County government subsidies for vaccines and acaricides; land demarcation to control animal grazing; community disease surveillance systems; increase number of livestock extension staff (including paravets)

Capacity building on supplementary feeding and forage conservation; capacity building on correct doe-buck ratios; encourage modern housing and routine hygiene/management practice

Centralize offtake points of goats; establish modern slaughter houses/slabs; value addition for goat meat (e.g. drying)

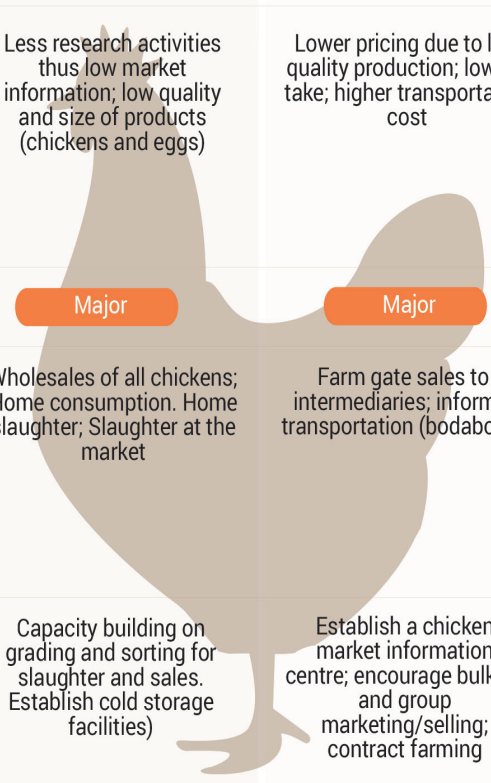
Establish modern goat market information systems (social media, WhatsApp) formation of goat marketing cooperatives; establish formal goat markets; improve road networks



Chicken (local)



	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
<p>Drought spells</p>	<p>Low attendance at trainings organized by extension officers; reduction in supply/availability of construction materials; low availability of feeds resulting in low production of eggs and consequently few chicks available for stocking</p>	<p>Poor body condition of the chickens makes response to vaccine low; low feed availability; low feeding tendency by the chicken thus low production; cleaning becomes difficult due to dust; Extension officers are assigned emergency related duties thus little time is left for extension services</p>	<p>There is low market research; there will be less feed for the activity; there is high cost of transportation due to low volumes</p>	<p>Low market prices as a result of reduced weight; low profit margin due to increased feed prices; low offtake rate due to low production level</p>
<p>Magnitude of impact</p>	Moderate	Moderate	Major	Major
<p>Farmers' current strategies to cope with the risks</p>	<p>Scheduling training times in the afternoons rather than the mornings when most farmers are searching for water; outsourcing feeds from outside the county</p>	<p>Postpone vaccination; periodic cleaning of chicken enclosures; destocking; sprinkling of water before cleaning</p>	<p>Sales to local markets; home slaughter or slaughter at market; using small transport (such as bodaboda)</p>	<p>Farm gate sales to middlemen; Home consumption</p>
<p>Other potential options to increase farmers' adaptive capacity</p>	<p>Use technology for dissemination of extension information e.g. WhatsApp; provision of subsidized feeds; establishment of more water points; promote drought-tolerant tree fodders; encourage use of incubators; establishment of a county hatchery</p>	<p>Capacity building on supplementary feed production and feed conservation; design and promote dust resistant free chicken enclosures; capacity building on good housing</p>	<p>Institutional support on market research; organize alternative transporting means; value addition alternatives; capacity building on timely off-take at good body condition/quality eggs</p>	<p>Establish/enhance market information systems; formation of poultry cooperatives; promote flock planning; encourage group marketing; contract chicken and egg farming</p>
<p>High temperature</p>	<p>Low attendance at trainings by farmers; low hatchability of chicks' thus low availability of stock; Less movement and less interaction between the farmers and extension agents</p>	<p>Poor response of chicken to vaccines; low feed intake by chicken thus low productivity; high temperature good for chicks but not for chickens</p>	<p>Less research activities thus low market information; low quality and size of products (chickens and eggs)</p>	<p>Lower pricing due to low quality production; low off take; higher transportation cost</p>
<p>Magnitude of impact</p>	Major	Major	Major	Major
<p>Farmers' current strategies to cope with the risks</p>	<p>Scheduling training in cool hours of the day and at common gathering grounds; use of shaded chicken structures with proper air circulation; outsourcing chicks from neighbouring counties</p>	<p>Observing/implementing hygienic standards; use of traditional medicine; offtake of excess chicken; availing alternative feeds e.g. left overs; sprinkling water on or in the enclosure</p>	<p>Wholesales of all chickens; Home consumption. Home slaughter; Slaughter at the market</p>	<p>Farm gate sales to intermediaries; informal transportation (bodaboda)</p>
<p>Other potential options to increase farmers' adaptive capacity</p>	<p>Develop fixed schedule of afternoon extension activities; capacity building on raised, ventilated chicken enclosure construction; encourage use of incubators</p>	<p>Capacity building on disease control; enhance access to vaccines; feed subsidies; capacity building on highly nutritious feeds to enhance high feed conversion</p>	<p>Capacity building on grading and sorting for slaughter and sales. Establish cold storage facilities)</p>	<p>Establish a chicken market information centre; encourage bulking and group marketing/selling; contract farming</p>



Policies and Programmes

The agriculture sector in Baringo County remains vulnerable to climate change and variability. For this reason, various policies and programmes exist to enhance interventions that support agriculture directly or indirectly. The legislation is either at national or county government level.

The Agricultural (Farm Forestry) Act of 2009 provides maintenance of a compulsory farm tree cover of at least 10% of any agricultural land holding; sustainable production of wood, charcoal and non-wood products; and prohibiting planting of invasive species in wetlands and riparian areas. The Act has contributed to planting more trees and conserving existing ones through the efforts of various actors including the county government, Kenya Forest Service, Kerio Valley Development Authority (KVDA), NEMA, WRMA, Corporates such as KCB Foundation and self-help groups such as Lachmet. Organisations such as World Vision are promoting the use of Farmer Managed Natural Regeneration (FMNR) to restore degraded lands, improve tree cover in the County and provide fodder sources for animals. Financial constraints and limited enforcement and monitoring of forest regulations hinders full realisation of the County's tree planting goals.

The Forest Act of 2005 established the Kenya Forest Service (KFS) whose mandate is to develop, manage, and conserve forest resources in Kenya. In Baringo County, KFS continues to protect forests through licensing for timber and charcoal burning. KFS also promotes tree planting in collaboration with other stakeholders. The county has also passed the Forest Conservation and Management Bill that aims to localise the Forest Act, including encouraging the conservation of forests as well as ensuring that communities benefit from forest resources through Community Forest Associations (CFAs). CFA members have rights that include collection of medicinal herbs, harvesting honey, firewood and grass, and grazing. In addition, the Baringo County Sustainable Charcoal Bill seeks to ensure that charcoal production is sustainable through formation of Charcoal Producer Associations as well as issuance of charcoal transportation permits by KFS. As part of the bill, restoration plans are required for charcoal producers. The bills have contributed to reducing erosion and landslides as well as improving the environment for other activities such as beekeeping. In 2015, the County launched a programme to plant 1 million trees annually, to help reach a 10% forest cover target. The tree planting initiative has allowed for diversified incomes (through fruit and honey production) as well as helping to restore degraded and deforested areas. Paw paws, mangos and macadamia are among the promoted trees. The result of

the tree conservation efforts include a county forest cover of 29.9%, which is higher than the national target of 10%. A means of strengthening the programme could be through capacity building of local seedling producers.

The Environmental Management and Coordination Act of 2009 established the National Environmental Management Authority (NEMA). NEMA guides and oversees projects on enforcement of the legislation on environment. In Baringo NEMA promotes measures to conserve soil and water, focusing on enforcing and sensitising people on regulations such as those related to streambank cultivation²⁶. However, local level implementation of the Act by NEMA faces challenges such as inadequate staff and resources. Complimentary organisations such as the Water Resources Management Authority (WRMA) supports NEMA's efforts to protect water catchment areas²⁷. WRMA supports the establishment of Water Resource Users Associations (WRUAs) to enhance planning for water resource use and allocation in the county.

The Agriculture, Fisheries and Food Authority (AFFA) Act of 2013 resulted in the setting up of the AFFA whose mandate includes the promotion of best practices and regulation of the production, processing and marketing of agricultural and aquatic products. Its activities have an effect on agricultural marketing in Baringo, for example regulating the standard and quality of produce sold in formal markets both within and outside the county.

The Agricultural Sector Development Support Programme (ASDSP) is a national government programme that aims developing agriculture across Kenya including in Baringo County and has a focus on improving resilience to climate hazards. It also aims at making agriculture commercial to create employment and improve livelihoods. The interventions target value chains including dairy, meat, goat, and honey. The interventions include promotion of climate-smart technologies such as biogas; dissemination of Early Warning System (EWS) in collaboration with KMD and the community; and capacity building of farmer-based organisations. However, local level implementation of the programme is limited in resources and sometimes the funding delayed, affecting the planning and implementation of activities.

The Drought Resilience and Sustainable Livelihoods Programme in the Horn of Africa (DRSLP), a project supported by the African Development Bank (AfDB), aims to enhance drought resilience and improving sustainable livelihood of the communities in the arid and semi-arid lands of Kenya. Target areas for the project include Baringo North sub-County, specifically Barwessa and Bartabwa Wards, where natural resource management activities

26 Farmers are also encouraged to plough 30 m away from rivers to protect the soil from being swept downstream into the rivers.

27 The major water catchment areas are Lembus/Koibatek (northern Mau catchment) to the south, Tugen Hills, Mochongoi and Ng'elecha to the east, Amaya and Tiati.

(water supply development and management and irrigation infrastructure development); and livestock infrastructure improvement (infrastructure for market access, improved rangeland management and improve livestock health) are being conducted.

The Rural Livelihoods Adaptation to Climate Change programme (RLACC) which is a sub-component to DRSLP provides climate proofing to DRSLP structures and enhancing adaptation capacities of farmers to climate change.

The Regional Pastoral Resilience and Sustainable Livelihoods Programme (RPRSLP) operate in the whole county to build resilience of farmers to the impacts of climate.

Governance, institutional resources, and capacity

Several organisations in Baringo County are involved in activities that directly or indirectly relate to mitigation of climate change risks. These organizations include government (both national and county), non-governmental organisations (NGOs), community-based organisations (CBOs), faith-based organisations (FBOs), farmer organisations and private entities.

National government institutions operating at the county level on climate related issues include the National Drought Management Authority (NDMA), National Environmental Management Authority (NEMA), Kenya Forest Services (KFS), Agricultural Sector Development Support Programme (ASDSP), and the Kenya Meteorological Department (KMD). The county government departments include Department of Agriculture, Livestock and Fisheries (DoALF), Department of Veterinary Services (DVS), Department of water and Irrigation and Department of Environment among others. Parastatals include Water Resource Management Authority (WRMA), KVDA, Kenya Agricultural & Livestock Research Organization (KALRO), Agricultural Finance Corporation (AFC), National Irrigation Board (NIB), and National Cereals and Produce Board (NCPB). Universities include Egerton University and Moi University. These organisations and departments provide support that ranges from infrastructure, extension, capacity building, input provision, marketing, regulation, research and policy support.

County government plays the role of coordinating the various organisations at the county level. NDMA is the only local level organisation that directly deals with climate hazards and risks. Among its mandates, NDMA collaborates with KMD to provide early warning information to the farmers and other stakeholders. KMD is also involved

in Participatory Scenario Planning (PSP), which helps in forecasting and dissemination of climate information. NEMA regulates projects that may have an environmental impact while ASDSP provides capacity building and policy support on good agricultural practices for selected value chains. KALRO is involved in research and development of drought-tolerant crops. KFS facilitates implementation of government policy on reforestation, promoting agro-forestry, and providing technical advice on conservation matters. KVDA supports livelihood through improvement of livestock, pasture, and tree planting. AFC provides credit to farmers. NIB supports development of irrigation schemes. Egerton University is involved in research especially in rangelands. DoALF provides extension services, inputs such as seeds, vaccination of livestock, and promotes pasture and range management.

Financial institutions include Savings and Credit Cooperatives (SACCOs), micro-finance institutions, banks, and insurance companies. They provide credit to farmers, mostly for purchase of inputs, while some companies provide insurance services to assist farmers recover after shocks such as drought. These institutions include Boresha SACCO Society, Kenya Women Finance Trust (KWFT), Equity Bank, Kenya Commercial Bank (KCB), and Jubilee Insurance among others. Mobile banking services including Safaricom (Mpesa) are also available in most areas, especially in trading centres. Institutions should be sensitised more on investing in long-term resilience and asset building, which would be more beneficial to farmers compared to the short-term assistance these financial institutions currently provide.

The private sector, NGOs, CBOs, and FBOs train farmers in project identification, project design, implementation and management. They also provide material and financial support to farmers, and assist in environmental conservation. The private sector acts as a source of agricultural inputs through agrovet shops and provide marketing channels for farmers. The agrovet shops also provide extension services as the farmers especially on seed varieties and chemicals consult them. Cooperatives are a key structure in Baringo as they help in collective procurement of farm inputs, train members on new technologies and innovations, and are a key channel for savings, credit access, resilience related investments and marketing of agricultural produce.

For the organisations involved in climate change-related activities, there is some degree of coordination through the County Steering Group, however this is still a major aspect for improvement so as to enhance the effectiveness of the actions of different organisations and possibly to ensure a focus specifically on coordination of climate change adaptation and resilience related programming. While farmers are normally involved in planning and

implementation of activities, they should be involved more in monitoring, evaluation of the activities, particularly through community based monitoring activities and improved feedback mechanisms for resilience, and climate related projects. Collaboration, between NGOs and between government and NGOs improved through joint planning and resource mobilisation.

Among the organisations interviewed, funding is the key constraining factor to improving resilience and reducing vulnerability in Baringo County. As financial and human resources are limited, there is need to concentrate resilience interventions in key areas where greatest impact can be achieved. An example of this mode of operation is the DRSLP programme that is concentrated in Baringo North sub-County, Barwessa and Bartabwa Wards in order to achieve maximum impact in these locations, rather than spreading activities thinly over a larger area. In response to weather hazards, the timeliness of funding is also crucial, as another challenge highlighted was the sometimes-late disbursement of funds.

Knowledge on climate change by staff in these organisations is in many cases low, and there is need to train the organisations and their staff on resilience and climate change adaptation so they can better serve the communities in which they work. Integration of climate change and resilience issues into County extension and training programmes would be useful.

Synthesis and Outlook

Despite agriculture being the main economic activity in Baringo County, weather variability and climate change continue to challenge the sector through droughts, floods, intense rains, erratic rainfall, and high temperatures. Drought and erratic rains cause low productivity in crop and livestock production, crop failure and livestock deaths as well as increasing time spent in the field and distance travelled to find water and pasture for livestock. Intense rains and floods cause destruction of crops as well as mudslides, while high temperatures affect productivity of both livestock and crops. Changes in weather and climate increases pests and diseases. These challenges will continue for decades to come, unless significant investments improve the resilience and enhance the adaptive capacity of individuals, households and communities in the county.

To mitigate against these climatic hazards, farmers supported by different organisations adopt various coping strategies. These include relying on social networks for agricultural inputs, using indigenous knowledge for weather forecasting, use of integrated

pest and disease management, use of various conservation agriculture principles, use of in-field soil and water conservation measures, small scale water harvesting, and use of traditional crop varieties and livestock breeds. However, communities remain highly vulnerable to climate hazards and there is need for greater investment in long-term resilience building and climate change adaptation partly because financial and technical capacity to scale up interventions are insufficient.

For livestock production, promising options for resilience building include capacity on feed production and conservation; promotion of incubators in poultry farming; dissemination of and sensitisation on improved breeds; enhancing artificial insemination programmes; improving extension information dissemination through use of cell phones (Whatsapp groups) and radio. Enhancing veterinary services provision including training of local animal health surveillance and service providers; improvement of livestock watering infrastructure; establishment of improved abattoirs; establishment of improved (cold) storage and marketing infrastructure such as auction yards; and promoting meat and milk value addition.

For crops, some adaptation strategies include integration of indigenous technical knowledge and scientific weather forecast; scaling up conservation agriculture and agroforestry, promoting crop diversification especially to drought-tolerant crop varieties (sorghum, millet, green grams and cow peas). Adopting community cereal banking; increasing the network of storage facilities such as silos; investing in value addition equipment; and expanding water harvesting and irrigation infrastructure.

Although the county government through the County Steering Group is at the forefront of promote adaptation strategies in the county, there is need for an improved and dedicated coordination mechanism specifically for resilience and climate adaptation work. In addition, while local level implementation of environmental and forest policies exists, this is not so apparent when it comes to climate change and resilience related policies. National government agencies such as NEMA, ASDSP, NDMA, KMD and KFS among others need to collaboratively develop a comprehensive resilience and climate change adaptation strategy for the County that takes consideration of access to improved and timely weather and climate information, infrastructural development, social protection for the most vulnerable, value addition in agriculture and marketing of agricultural produce.

Addressing the underlying factors that reduce household vulnerability to climate change and weather related hazards should also be a priority. These include investment in education, youth employment, and gender equity as well as infrastructural investments in domestic and productive water, clean energy, and market infrastructure. Capacity building farmers on

agricultural production and marketing, including on meeting national market related guidelines as set by the AFFA would also be crucial in ensuring that farmers can access formal markets and receive better prices for their produce. Exploring alternative livelihoods such as beekeeping and agricultural equipment manufacture and repair could also present promising options.

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