Climate Risk Profile
Uasin Gishu County

Highlights

- Uasin Gishu County referred to as the breadbasket of Kenya has high and reliable rainfall, relatively large farm sizes, and highly mechanized farming. Ninety percent of the total land in the county is arable. Agriculture is the mainstay of the economy contributing 80% of total rural household income and food security. Maize, wheat, beans, dairy, Irish potatoes, horticulture and local chicken are the key value chain commodities in the county.
- Changes in both growing seasons' rainfall characteristics and intense rainfall compromise productivity and food security in the county with climate projections indicating even greater challenges in the coming years.
- On-farm strategies to cope with climate risks and shocks include; conservation agriculture, early maturing crop varieties, early and dry planting, diversification, animal feed conservation, tree planting and water harvesting. The main constraints to the uptake of these strategies include limited knowledge of new technologies and high costs of investing in these technologies.
- Off-farm services to alleviate the risks associated with climate change and variability include early warning systems and advisory services for better decision-making, insurance uptake and formation of cooperative societies for easier access to farm inputs, credit, markets and information.
- High input prices, low input use, poor access to credit, declining soil fertility, poor road infrastructure and poor governance in farmer organizations are some of the salient factors that aggravate the impacts of climate change and variability.
- Inadequate financial, technical and human resources and lack of county-specific legislation are some of the most common institutional bottlenecks to climate risk management.
- Drafting and implementation of county-specific policies on climate risk management is of utmost importance and needs to be fast tracked in order to tackle the emerging issues of climate change and the associated implications on agricultural production.

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

List of acronyms

ADC	Agricultural Development Corporation
AEZ	Agro-ecological zones
AI	Artificial Insemination
ASDSP	Agricultural Sector Development Support Programme
CIC	Cooperative Insurance Company
CIP	International Potato Centre
CIDP	County Integrated Development Plan
CFA	Community Forest Associations
EADD	East African Dairy Development
EMCA	Environmental Management and Coordination Act
ERA	Economic Review of Agriculture
EWS	Early Warning System
GHG	Green House Gases
GIZ	German Development Agency
GoK	Government of Kenya
ICRAF	World Agroforestry Centre
IDA	International Development Agency
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agricultural and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Program
KAVESKenya	Agricultural Value Chain Enterprises
KCSAP	Kenya Climate Smart Agriculture Project
KDHS	Kenya Demographic Health Survey
KES	Kenya Shillings
KFS	Kenya Forestry Service
KMD	Kenya Meteorological Department
KPHC	Kenya Population and Housing Census
KPLC	Kenya Power and Lighting Company
KTBHsKenya	Top Bar Hives
LH	Lower Highlands
MoALF	Ministry of Agriculture, Livestock and Fisheries
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NCPB	National Cereals and Produce Board
NEMA	National Environmental Management Authority
NGO	Non-governmental Organization
PSP	Participatory Scenario Planning
RCP	Representative Concentration Pathways
SDCP	Smallholder Dairy Commercialization Programme
TIMPs	Technologies, Innovations and Management Practises
UH	Upper Highlands
UM	Upper Midlands
USAID	United States Agency for International Development
VCC	Value Chain Commodity

Foreword

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

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

This document presents the Climate Risk Profile for Uasin Gishu County. The county has a relatively low vulnerability index (0.419) to climate change (GoK, 2013) yet it continues to suffer extreme weather events like drought and floods. Though climate models have shown that floods are likely to occur every three years[1], recent news reports in the last three consecutive years (2013, 2014, 2015, and 2016) have shown devastating floods in different regions in the county. For instance, in 2013, floods killed eight people in Uasin Gishu[2], in 2014, and destroyed property, roads and buildings including the Uasin Gishu District Hospital[3], and more than 30 families displaced in Kimumu estate in 2016[4]. In addition, due to climate variation, there has been proliferation of crop diseases such as Maize Head Smut, Maize Ear Smut, Maize yellowing and Maize Lethal Necrosis disease and insect pests e.g. Fall Army Worm which have significantly reduced production. Drought on the other hand has resulted in crop failures[5] and reduction of the areas under crop production. For example in 2014, the area under maize production reduced from 92,500 hectares (ha) to 77,225 ha. Considering that Uasin Gishu County is the breadbasket for the country, the above consequences of climate change and variation on agriculture and livelihoods in general necessitate deliberate effort to mitigate climate risks in future.

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 Metrine et al. (2015)
2 Source: The Star, 2013
3 Source: Kenya Daily Nation, 2014
4 Source: Daily Nation, 2016
5 No available quantification of the extent of the crop failure at the time of this assessment.

Agricultural context

Economic relevance of farming

Uasin Gishu County is located in the Kenyan rift valley, which is part of the Great Rift Valley. The County covers a land area of 3,345 km^2. It borders Trans Nzoia County to the north, Elgeyo Marakwet County to the east, Baringo County to the southeast, Kericho County to the south, Nandi County to the southwest and Kakamega County to the northwest.

Agriculture is the mainstay of the county contributing to about 80% of rural household income and food security. According to the Agricultural Sector Development Support Programme (ASDSP) household baseline survey (GoK, 2014), at least 56% of households are engaged in crop and/or livestock farming. Uasin Gishu County divides into three agro-ecological zones (AEZs) namely; the upper highlands (UH), upper midlands (UM) and lower midlands (LM) zones. High and reliable rainfall experienced in the county support crop farming, livestock rearing and forestry. The major crops in the county are maize, beans, wheat, sunflower and potatoes while the livestock include dairy farming, beef cattle, poultry, sheep, goats, pigs, beekeeping, rabbit farming and fish farming. The mean annual total household income is KES 871,076. The mean annual on-farm income earned by households in Uasin Gishu County is KES 334,320 with crop income accounting for 62% compared to livestock income which accounts for 20% (GoK, 2014).

People and livelihoods

According to the Kenya Population and Housing Census (KPHC) of 2009, the total population of Uasin Gishu County stood at 894,179 in 2009 and it is projected to grow to 1,211,853 by 2017 at a growth rate of 3.8% which is higher than the national population growth rate of 2.9%. Approximately 64% of the County's population is concentrated in the rural areas whereas 36% lives in urban areas.

Poverty rates in the county are estimated at 47% compared to 43.37% at the national level. Access to water in the county is relatively high. The county has three main water towers, Kaptagat, Timborowa and Kapchemutwo forests, and four major rivers, Moiben, Sosiani, Kipkarren and Nzoia. Ninety percent of the County's population has access to water within a 2 km radius while 42% has access to potable water (GoK, 2013). Firewood is the main source of cooking fuel with 84% of households using it as the primary source of fuel (GoK, 2013). This can be attributed to the sizeable portion of the total county land under forests. The county has 29,802 ha of gazette forests out of which 56% are under indigenous forest cover while 44% is under plantations. The reliance on firewood by a large portion of the population puts undue pressure on the existing forests in the county reducing the forest cover. According to the KPHC (2009), 28% of the households in the county have access to electricity for lighting and this is rising due to the current efforts by Kenya Power and Lighting Company (KPLC) to connect households to the national grid. The literacy level in the county is 81%.

Food insecurity in the county stands at 32% of households characterized by shortage of food at household level, which is mainly prominent in the months of May to August (GoK, 2014). Prevalence of stunting is 31.2% while 11.5% of children under-five are underweight (KDHS, 2014) attributable to less diet diversification due to overdependence on crops such as maize. The county being commercially oriented in terms of crop and livestock production produces enough for local consumption and sale to other neighbouring counties and further afield. Relatively large farm sizes, good soils and favourable climatic conditions play a key role in making the county a leading producer in most of the important crops in the country such as maize.

Most households in Uasin Gishu County depend on food and cash crops, livestock, and employment for their livelihoods. The major crops grown include maize, wheat, beans, potatoes, and horticultural crops while livestock include dairy farming, beef cattle, goats, sheep, pigs, bee keeping, rabbit farming and fish farming. These are categorized into two farming systems namely; mixed farming of food crops and livestock, mixed farming of commercial crops and dairy cows Production in the county ranges from small-scale low-input farming to highly mechanized large-scale farming with high levels of input use. The dairy livestock kept are predominantly high grade. Estimates by the County Livestock Production Office indicate that there are 331,972 dairy cattle, 38,522beef cattle, 128,632 hair sheep, meat goats 84,849, dairy goats 451, pigs 12,695, rabbits 12,215, exotic chicken 143,884; local chicken 707,903; log hives 10,997; Kenya Top Bar Hives (KTBHs) 7,477; Lang-stroth 2,138; wool sheep 37,407; donkeys 5,825 and camels 6. According to the Directorate of Livestock, livestock enterprises earned farmers in Uasin Gishu County KES 7.5 billion shillings in 2016.

Agricultural activities

Uasin Gishu County has a total land area of 334,500 ha. Arable land covers 299,500 ha representing about 90% of the total county area while forestland (both indigenous and plantations) covers 29,802 ha representing 8.9% of the total county area. The remaining portion is non-arable being hilly and rocky. Uasin Gishu County has three main distinct agro-ecological zones (AEZs) namely; lower highlands ranging from LH2 to LH4, upper midlands (UM3) and upper highlands representing UH1 and UH2 (Jaetzold et.al., 2010).

- The Lower Highlands (LH2) have an annual average precipitation of 1150 – 1220 mm, annual mean temperatures of 15.70C – 15.10C and an altitude of 2350-2450 m. Areas under LH3 have an annual precipitation of 900-1300 mm and annual mean temperatures of 18.0C-15.10C with altitude ranging between 1950-2450 m above sea level. Areas under LH4 have an annual precipitation of 900-1100 mm and annual temperatures of 18.00C-16.30C with altitude ranging between 1950-2250 m above sea level.

- Areas under Upper Midlands (UM4) have an annual precipitation of 1000-1400 mm and annual mean temperatures of 20.50C-18.00C and an altitude ranging between 1550-1950 m above sea level.

- The remaining areas of the county fall under Upper Highlands (UH2), which have an annual precipitation of 1150-1400 mm and annual mean temperatures of 150C-130C. UH3 areas have an annual precipitation of 1100-1200 mm and annual temperatures of 150C-130C. Altitude in these areas range between 2350-2750 m above sea level.

The County experiences high and reliable rainfall throughout the year. Soils in the county are red loam soils, red clay soils, brown clay soils and brown loam soils .The climatic conditions in the county make it favourable for growing various crops, livestock rearing and forestry.

The average farm size in Uasin Gishu County is 2-10 acres in the rural areas. Average farm sizes range from three hectares for small-scale to fifty hectares for large-scale farming. Large-scale farming found mostly in Moiben and Ziwa areas while small-scale farming is prevalent in the rest of the county. Most of the land tenure is privately owned (80%) with title deeds, thus allowing and encouraging long-term investment and access to credit facilities from financial institutions. The most common land tenure is ownership with formal title or allotment letter followed by ownership with no formal title e.g. inheritance (GoK, 2014).
Farmers in Uasin Gishu County use inputs such as seeds, fertilizers and labour in crop production. Most farmers use improved seed with wheat, cabbage and maize recording the highest proportion of improved seed use at about 90%, 82% and 78% of the households respectively (GoK, 2014). Inorganic fertilizer for planting is used by 33% of households, 23% of households use herbicides and 15.1% of households apply top dressing fertilizer. Adult males provide the highest share of hired labour for crop production whereas youth dominate hired labour for livestock. Female labour ranks the highest in family labour for crop production. The low use of inputs especially fertilizers and herbicides is attributable to the high costs of inputs. This perhaps explains why the county has not exploited its full potential in agricultural production. About 2% of the households in Uasin Gishu County use irrigation (GoK, 2014). This indicates the huge irrigation potential that exists in the county.

Agricultural value chain commodities

A broad diversity of agricultural commodities is grown in the county. Of these commodities, various value chains have been prioritized as being strategic for the county as indicated in the County Integrated Development Plan (CIDP) and the Agriculture Sector Development Support Programme (ASDSP) as well as by government institutions such as the Kenya Agricultural and Livestock Research Organization (KALRO). For the development of this County Climate Risk Profile, four major value chain commodities (VCC) were selected for in-depth analysis based on: prioritization in County Frameworks and Programmes; economic value (KES/bag or KES/livestock or KES/unit livestock product)[6]; resilience to current weather variability and future climate change[7]; and number of economically active people engaged in the commodity's value chain (including vulnerable groups, women, youth and the poor[8]). The VCCs selected are maize, potatoes, dairy (cattle milk) and local chicken.

6 As stated in the 2015 Economic Review of Agriculture (ERA) - Ministry of Agriculture, Livestock and Fisheries. 2015.

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

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

Livelihoods and agriculture in Uasin Gishu

Demographics

2.3% Of Kenya´s population

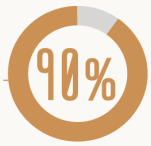
894,179 inhabitants

64% Live in rural areas

Farming

County´s farming area

299,500ha



ND of the population employed in agriculture production

ND of farmers have title deeds

80% are women

Farming activities

Food crops

ND

Cash crops

ND

Of county´s agricultural land

Livestock

Birds (local)	400,000
Dairy	375,287
Birds (exotic)	140,703

Access to basic needs

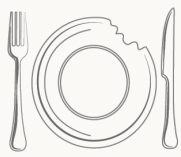
47% of the population lives in **absolute poverty**

Potable water	42%
Electricity for cooking	ND
Electricity for lighting	28%
Education (youth literacy rate)	81%

Food security

32% of the population suffers from **food poverty**

ND of household **income spent on food**



ND	People **undernourished**
31%	Children **stunted**
12%	Children **wasted**

ND: No data

Farming inputs

Water uses

Fertilizer types (% of households)

10%	Organic manure
33%	Planting fertiliser
15%	Top dress fertiliser

Pesticide types (% of households)

15%	Field pesticides
8%	Storage Pesticides
23%	Herbicide

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)

Maize

Maize is a key staple food crop grown predominantly for commercial purposes with only a small percentage used for household consumption. Uasin Gishu County is the leading producer of maize in Kenya. It grows mainly in LH3, LH2 and UH4 agro-ecological zones, which are in Kesses, Kapseret, Turbo, Soy, Moiben and Ainabkoi areas. Maize production is under mixed farming systems: mixed farming (food crops and livestock) and mixed farming (commercial crops and livestock). Especially farmers with large farms and as an intercrop with beans by farmers with relatively small farms mainly grow maize as pure stands. About 61-80% of the population are engaged in the value chain. According to the County Directorate of Agriculture, Uasin Gishu County, the area under maize in 2016 was 102,753 ha which produced 4,220,120 bags of maize valued at KES 12,660,360,000. This is a clear indicator of the economic value of maize to the county. Maize is a staple food crop and sold to provide income, thus it contributes to the food security of the county. The income from the maize sales – almost 75% of the total produce is sold – is used mainly to purchase inputs for the next growing season and to educate the children.

Farmers in Uasin Gishu County have formed cooperative societies to help them bulk the maize for sale to millers. The cooperative societies also provide services like, cheaper and affordable inputs, and facilities for drying maize to achieve the recommended moisture content. The marketing for maize include both formal and informal channels. The formal markets consist of the National Cereals Produce Board (NCPB), a key player in the sector, and several milling companies ranging from large-scale processors such as UNGA to small-scale millers. These actors offer pre-set prices to farmers for their produce. The informal channels comprise of traders, millers and posho mills. The millers and posho mills process the maize into various products such as flour and animal feeds. The millers are mostly large-scale while the posho mills are small-scale in nature.

Irish Potatoes

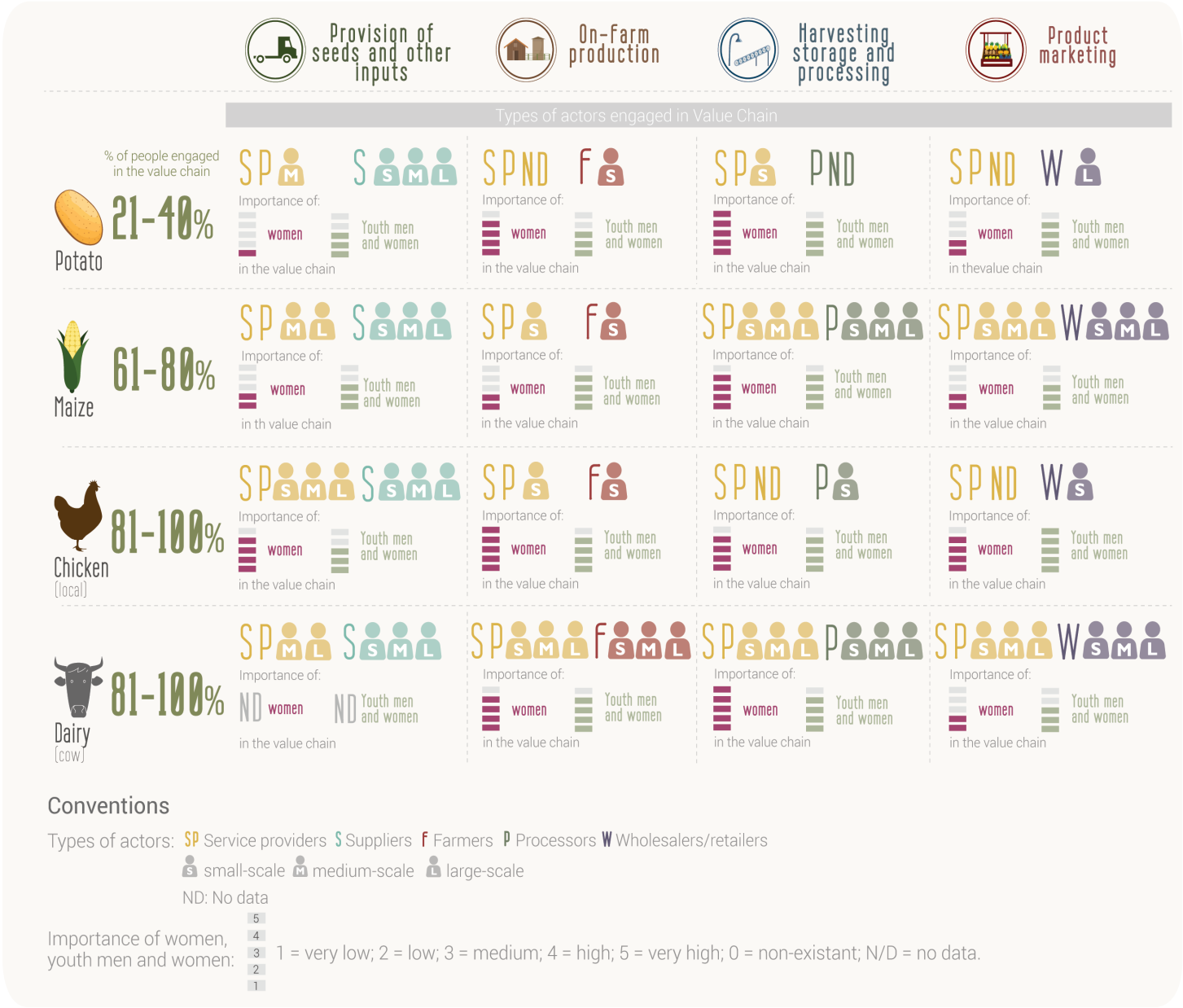
Potato is the second most important food and cash crop after maize in Kenya. Uasin Gishu County is one of the leading producers of potatoes in Kenya. Potato growing is for both commercial and household consumption purposes. Potato growers constitute between 30-60% of the total population of the county. It production is limited to a small part of the county mainly in the agro-ecological zones UH2 and UH3 which are characterized by very high altitudes. These zones have mostly mixed farming systems comprising of commercial crops and livestock. Potatoes grows in pure stands across farms with varying sizes. Most potato farmers are small scale with the major growing areas being in Ainabkoi and Kesses sub-counties. In 2016, according to the County Directorate of Agriculture, the area under potatoes in Uasin Gishu County was 1,428 ha producing 15,975 tons valued at KES 639,000,000. This underscores the importance of potato as a crop contributing significantly to household income and food security by providing an alternative food source to cereals such as maize.

Women are mainly engaged in on-farm production and harvesting. The importance of the potato value chain to the women ranges from high to very high. The youth on the other hand are largely involved in harvesting, sorting and marketing of potatoes. In terms of inputs, the potato value chain is served by medium- to large-scale service providers such as Agricultural Development Corporation (ADC), and NCPB complemented by the small-scale actors such as the local and small-scale agro vets. Small-scale processing takes place such as the production of potato crisps, sold in supermarkets.
Marketing of potato is informal and dominated by traders who are predominantly middlemen or brokers. The traders, who fall mainly in the medium- to large-scale category, determine the price of potatoes. Due to their bulky nature, farmers sell their potato produce at farm gate where the potatoes are taken to fast food outlets and markets in major urban centres.

Cattle (milk)

Uasin Gishu County is one of the leading milk producing areas in Kenya and often referred to as a dairy county. Dairy farming is practiced in all the agro-ecological zones found in the county. Due to the importance of livestock to the livelihoods of farmers, every farm family is at least involved in some form of dairy production. Between 81-100% of the people are engaged in the value chain. According to the Directorate of Livestock, in 2016 the dairy sub-sector produced 200.5 million litres of milk, which earned farmers a total of KES 6.2 billion. This large volume of milk produced contributes significantly to the household food security in the county as part of the milk consumed at household level. The average milk production from dairy cattle is 5 litres per cow per day. According to Agriculture Sector Development Support Programme (ASDSP), the average milk production for exotic cattle during the wet and dry season is 13.3 and 10.8 litres respectively while that of indigenous cattle is 6 and 5 litres per day respectively. Women are highly involved in the on-farm activities (mostly feeding and milking) in this value chain while youth are mostly involved in the transportation to collection points or urban centres and sale of the milk.

Agricultural value chain commodities in Uasin Gishu



Although dairy farming is widespread, the output is average. Most farmers are practicing extensive and semi-intensive management practices characterised by low input use. Because of this, farmers do not realize their milk production potential despite the high number of grade cows kept.

There are several collection points and cooling plants used by large-scale processors like Brookside, New KCC and other small-scale processors. The raw milk is processed into fresh milk, sour milk, long-life milk, butter, cheese, yoghurt among others. Farmers are price takers and have no voice in determining the milk price, which is set by the processors. These large-scale milk processors control a large share of the market. Some of the milk is sold as raw milk in urban centres.

Chicken (local)

Local chicken is one of the enterprises that is gaining currency in Uasin Gishu County. Both large- and small-scale farmers are engaged in local chicken production major production systems being extensive, semi-intensive or intensive. Almost every household (between 81-100% of the population) keep local chicken and the majority of farmers are women. The majority of farmers in the county practices free-ranging

management systems. Rearing of local chicken is is mainly practised by women. It requires low capital investment, low labour, a small area to operate, and it does not require very high management skills. Women are involved in all the value chain activities from on-farm production to marketing. The eggs and meat from local chickens provide a cheap and readily available source of proteins and nutrients to households playing a significant role in improving food security in the county.

Most of the chickens are sold with only about 10% reserved for household consumption. The marketing channel for local chickens is informal, dominated by local traders who purchase at farm gate or through local markets for selling to urban centres where chickens are in higher demand. Farmers rarely have influence on the price of chickens, as they are price takers. Processing of local chicken in the county is minimal.

Agricultural sector challenges

Agriculture is the economic mainstay in Uasin Gishu County, contributing greatly to food security and household income, yet it is experiencing several production, economic and social challenges. Even though the county has good soils and favourable climatic conditions, agriculture is yet to realized its full potential. Several factors have contributed to this. The high cost of inputs (such as seeds, fertilizers, pesticides, farm machinery) is one of the limiting factors since it increases the cost of production, making it difficult for farmers to make profitable returns. Increasing incidences of counterfeit inputs from unscrupulous input suppliers contribute to low productivity. In addition, population growth has led to increased land fragmentation, which also negatively influences agricultural production. Continuous cultivation of the land coupled with overuse of inorganic fertilizers in some instances has led to declining soil fertility resulting in low crop production.

Most of the commodities produced in the county sell in raw form without any form of value addition fetching low prices. Poorly organized marketing channels in the county have resulted in farmers receiving very low prices for their produce. In addition, poor governance and corruption rendering them ineffective and inefficient trouble the cooperative movements on which small-scale farmers rely for credit and inputs. Low market access caused by poor road infrastructure especially during the wet season is another important challenge to the sector. Underfunding and understaffing of extension services has resulted in inadequate service provision to farmers, which hampers their ability to make informed decisions.

Although the livestock sector shares most of the abovementioned challenges, some are specific to livestock and these include; poor livestock nutrition, animal diseases and low-quality genetics. This is often a result of inappropriate production systems and poor management by farmers. Farmers by far prefer the traditional extensive free-range production system, which depends on good rainfall patterns. However, this system is marked by climate risks, which can affect both water and fodder supply for the animals. The high cost and inadequate availability of high quality concentrates is also a challenge for livestock producers. In addition, animal feed conservation is still low in the county despite concerted efforts to upscale the technology. The use of artificial insemination (AI) to improve production traits and genetic variability is also low.

Climate change-related risks and vulnerabilities

Climate change and variability: historic and future trends

Uasin Gishu County has a relatively cool climate with mean annual temperatures across the county being predominantly below 21°C, a factor attributed to its location on a plateau that rises gently from 1500m a.s.l. to 2,700 m a.s.l .Rainfall in the county is relatively high with the northern and central parts receiving between 1000 and 1250mm of rainfall annually, the southern parts receiving 1250-1500mm annually and the western tip receiving above 1500mm. Rainfall in the county is reliable and evenly distributed throughout the year and even the driest months between November and February receive some rainfall. The climatic conditions are favorable for crop and livestock production, and the County is referred to as a breadbasket for Kenya particularly in relation to its high maize production. Annual rainfall variability does occur, and year to year variations in rainfall between the months of July and September have been found to be most crucial in determining the county's maize yields[9]. Due to the importance of maize production in Uasin Gishu for Kenya as a whole, particular attention needs to be paid to changes in the County's weather and climate. Drought is not common in the County, however when they do occur the impacts have repercussions not just for the county but for Kenya as whole, due to

9 http://meteorology.uonbi.ac.ke/sites/default/files/cbps/sps/meteorology/Biwott.pdf

Uasin Gishu being among the main maize producing counties in the country. Floods on the other hand have occurred every year since 2013 in different parts of the county, affecting crop and livestock production as well as infrastructure and sometimes resulting in loss of lives[10].

Analysis of temperature trends in the county over 25 years (1980 to 2005), showed that both first and second season temperatures have increased moderately over the years (0.5°C and 0.3°C respectively). These temperature changes have however not resulted in any significant changes in the number of heat stress days. Analysis of rainfall over a 35 year period (1980-2015) showed that average seasonal rainfall had remained relatively constant in the first season and had increased only slightly (≈25mm) in the second season. Although average annual precipitation has not changed significantly, there have been changes in rainfall intensity, with the number of days of high intensity rainfall[11] increasing from an average of 20 days in the to 25 days in the second season and from 21 days to 23 days in the first season. The maximum 5-day running precipitation average has also increased from 15mm/day to over 20mm/day in the second season. The first season has however experienced a slight increase in the average maximum number of consecutive dry days from 17 to 20.These changes have resulted in an increased flood and erosion risk in the second season. The increasing variability of rainfall has resulted in an increased drought risk in the second season. Despite some differences in the changes in rainfall patterns between the two seasons, rainfall in both seasons has become more variable with a tendency for more intense rainfall over shorter periods of time accompanied by longer dry spells in between, changes which can have a great impact on soils, crops, livestock, infrastructure[12], livelihoods, and economic development in the county.

Looking ahead to the period 2021-2065, climate projections based on two representative concentration pathways (RCPs[13]) indicate that under both scenarios there is expected to be a reduction in the length of the growing period for both the first and second seasons. In addition, there is expected to be a change in the frequency and magnitude of intense rainfall episodes in both seasons, with the maximum 5-day running precipitation average expected to rise from an historical average of 22mm/day in a season to between 28 mm/day and 30mm/day. Under both scenarios, there is also expected to be a moderate increase in dry spell length[14] and this increase is more pronounced in the second season. These projections of future climate change under the two climate scenarios, show some differences but exhibit similar trends, and point to increasing climate risks to crop and livestock production in Uasin Gishu. Even under the conservative GHG emissions scenario there are expected to be changes in climate and weather parameters and hence there is need to plan for and implement resilient agricultural practices.

Climate Perceptions by the farmers

Farmers in Uasin Gishu County perceive climate change in different ways. These include: changing dates in the onset of the rainy seasons, extreme temperatures with higher temperatures recorded during the dry season and much lower temperatures recorded during the wet season, reduced amounts of rainfall and overlap of seasons with rainfall extending into the dry periods. Hailstorms have also become more common especially in the maize growing areas. Farmers have become apprehensive of dry planting especially of maize and now they have to wait for the actual rains to start before planting. The planting dates of wheat are shifting from May to June due to changing weather patterns. Farmers are reporting increased incidence of pests and diseases. For instance, wheat farmers complain of increased incidences of wheat rust and Setaria grass commonly referred to as "*Arap Misoi*". Potato farmers have seen an increase in fungal diseases such as potato blight related to extremely low temperatures at night. Maize farmers are reporting cases of emerging weeds, which have become a menace to crop production. These include the Niger weed that is christened "*Arap Seroney*" by the locals. This weed appears to be resistant to herbicides and poses a great danger in maize growing areas since it can lead to total crop failure. The net effect of these changes has been an increase in spraying regimes, which has resulted in increased production costs. According to farmers, there is an upsurge in animal diseases such foot and mouth disease as compared to a few years ago.

10 http://www.the-star.co.ke/news/2013/04/16/eight-killed-in-nandi-uasin-gishu-flooding_c762284

11 Number of days reaching the 95th percentile of average daily precipitation

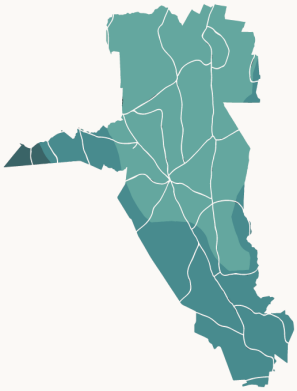
12 http://reliefweb.int/report/kenya/huge-losses-floods-cause-havoc-eldoret

13 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

13 Indicated by the maximum number of consecutive days receiving less than 1mm/day of rainfall.

Past and future impacts of climate hazards in Uasin Gishu

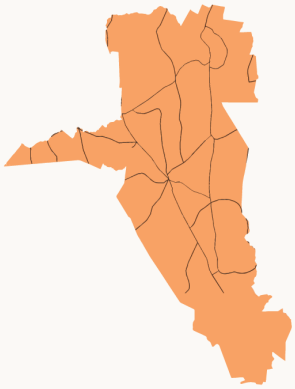
Historical annual mean precipitation (mm/year)



Legend
- Road
- 1000-1250
- 1250-1500
- 1500-1750

Data sourses
Precipitation: CHIRPS
Roads: Digital Chart of the World

Historical annual mean temperature (°C)



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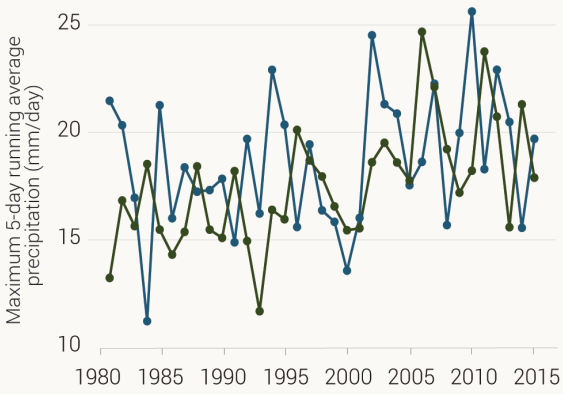
Precipitation: WordClim
Roads: Digital Chart of the World

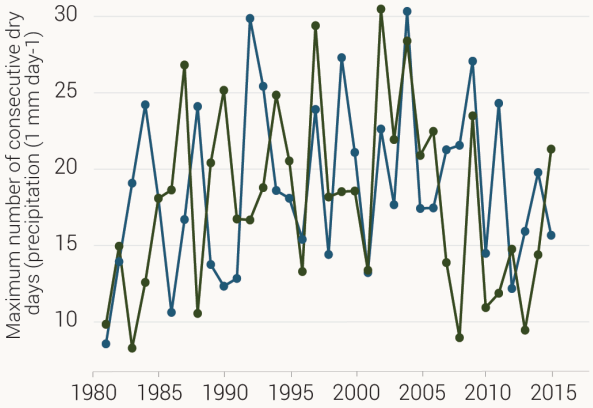
Flood hazards

Drought hazards

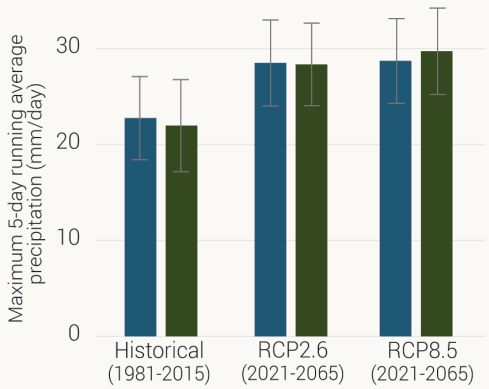
Historical extreme flood events



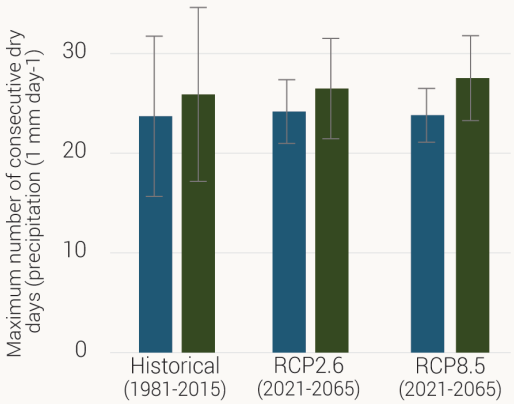
Historical drought stress events



Historical and expected extreme flood events



Historical and expected drought stress events



January - June July - December

Climate vulnerabilities across agriculture value chain commodities

Expected future climate change and variability poses serious threats to value chain commodities prioritized for analysis in this study. Hazards affecting the agricultural sector include; changes in the onset of the planting seasons (decrease in stability of season), intense rainfall and prolonged dry spells in both seasons.

Maize

Decrease in stability of both growing seasons and slightly longer periods of drought are important hazards to maize production in Uasin Gishu County. This mainly occurs in Kesses, Kapseret, Soy, Moiben, Turbo and Ainabkoi areas of the county. Decrease in stability of seasons leads to uncertainty on when to procure inputs, prepare the land, plant, and harvest. Unexpected changes such as early rain causes shortages and consequently price hikes of agricultural inputs. Unscrupulous traders take advantage of this situation to sell counterfeit products to farmers. This has a domino effect on all other stages of the value chain such as increased production costs and reduced crop yields. Similarly, extended periods of drought also affect crop yields negatively because of a deficit for moisture required for optimal growth.

Farmers have adopted a host of measures to increase their adaptive capacities. Some opt for the use of uncertified seeds in the event that planting seeds become more expensive or scarce. Some make better use of organic manure and/or purchase subsidized fertilizers. Those who are members of cooperatives purchase agricultural inputs at lower prices because cooperatives can negotiate better prices on behalf of farmers. Early land preparation, tilling several times to break the ground, and in extreme cases reducing the acreage planted are other measures farmers use to increase their adaptive capacity. Traditional methods of weed and pest control are employed to tackle the increased incidence of pests and weeds. Some farmers opt for early harvesting and marketing at farm gate to brokers and middlemen, unfortunately, this often has a negative effect on the price farmers receive for their produce. The government through the NCPB provides drying and storage facilities and buys produce from large-scale farmers.

The most affected in the maize value chain are resource-poor farmers who have less income and low access to credit facilities, therefore hampering their preparedness. This also includes access to inputs, mechanized land preparation and access to storage facilities. Poor extension linkages, limited market information and a lack of a pricing policy make maize farmers more vulnerable to climate change and variability.

Cattle (milk)

Less intense rainfall and slightly longer periods of drought in both seasons affects the cattle for milk production. These hazards occur in almost all parts of the county while less intense rain is experienced in Moiben, Soy and Kesses sub-counties. Moiben sub-county is prone to slight increases in dry spells. These hazards lead to feed scarcity and increased production costs of dairy cattle (such as increased demand for extension services and vaccinations, and high costs of feeds). These hazards mainly affect the on-farm production stage of the value chain resulting in reduced milk production, reduced market supply and therefore higher producer and consumer prices.

Farmers are forming producer groups for easier access to extension services, training and information. The Kenya Agricultural and Livestock Research Organization (KALRO) and MoALF (Ministry of Agriculture, Livestock and Fisheries) are assisting farmers to establish more pastures and alternative fodder such as Rhodes grass to increase feeding capacity. Large-scale farmers are allocating parts of their farms to produce pasture for individual use and for sale. Some farmers are conserving feed while others are formulating feed on their farms to alleviate feed scarcity. There are organized programmes for subsidized mass vaccinations of cattle and other livestock against disease outbreaks. Finally yet importantly, information on the weather outlook by early warning systems has helped farmers to plan and make better decisions.

Farmers who lack the financial ability to invest in technologies are hard hit by climatic hazards. In addition, inadequate extension services also contribute to vulnerability of farmers. Lack of policies and advisory services hampers the implementation and enforcement of measures that tailored to increase farmers' adaptive capacity.

Irish Potatoes

Intense rainfall and decrease in stability of seasons are important hazards in Irish potatoes production. These hazards occur mainly in Ainabkoi and Kesses sub-counties where potato is grown. Decrease in season stability leads to uncertainty with farmers caught off guard on when to acquire inputs and when to plant. Untimely planting and poor germination of the potato tubers affects harvesting and yield of the potato crop. This results in loss of income for farmers because of

lower yields and higher consumer prices because of low supply.

In order to increase their adaptive capacity; farmers have employed a number of strategies. Farmers use their own farm-saved seed tubers or acquire planting material or seed from their neighbours when there is scarcity. Farming communities also share their knowledge and experience because many smallholders cannot currently access extension services. Organic manure is used when farmers are unable to procure inorganic fertilizers. Early land preparation prior to planting to create a soil structure favourable for crop growth help address the untimely planting. During harvesting, farmers contract extra work force to reduce post-harvest losses. A potato chilling plant has been set up in the county at Ainabkoi sub-county, which can store up to 50 tonnes of potatoes for over six months. This will enable farmers to store their produce during high production when prices are low and take their produce out of the store when prices are high.

Poor road infrastructure is one of the underlying factors that make farmers vulnerable to climate hazards since the roads are impassable for farmers to access markets. The high costs of hiring mechanized machinery puts resource poor farmers at a disadvantage since they have no access to credit facilities. Farmers in the lower areas withstand the worst of intense rain, which causes rotting of potato tubers as opposed to the higher areas. Potato production practices in the county are suboptimal; good crop management, which involves the appropriate and efficient use of inputs, such as good-quality seed, is seldom practised.

Chicken (local)

Moderate decreases in temperature and intense rainfall in both seasons affect the local chicken production. This occurs in the upper midlands and upper highlands agro-economic zones. These climatic hazards cause feed scarcity, low breeding rates, low growth rates, high mortality rates and high production costs. They affect mostly the input supply, on-farm and post-harvest stages of the value chain.

Chicken farmers increase their adaptive capacity by feeding chickens on leftover food. They also use traditional herbs and shrubs to cure any ailments faced by the birds. Energy saving jikos referred to locally as "*Chepkube*" guard the chickens against extreme low temperatures. Keeping local chickens is in itself an adaptation mechanism because local chickens are hardy and can survive extreme temperatures. The chickens thrive in both extensive and semi-intensive management systems. Farmers select birds with vigour for breeding purposes to improve productivity.

Adaptation to climate change and variability

On-farm adaptation practices

Farmers in Uasin Gishu County predominantly depend on rain fed agriculture. Rain fed agricultural systems are highly vulnerable to climate variability forcing farmers to adopt measures that increase their resilience. Farmers are shifting to early-maturing maize and potato varieties in order to optimize on the short crop cycle occasioned by climate change. In the same vein, farmers are embracing early dry planting with the slightest hints of impending rainfall. Other farmers are replacing maize with high value horticultural crops like passion fruit. According to GoK (2014), 29% of households in the county are changing crop types as an adaptation measure to climate change.

Climate smart practices such as minimum or zero tillage are gaining currency in the county. These practices improve the soil moisture content to enable optimum growth of crops. For instance, maize and wheat farmers use chisel ploughs and planters for minimum tillage to help retain soil moisture content and thus aid crop growth during moisture stress. Since the chisel ploughs are few and the cost is prohibitive, some farmers opt to use herbicides such as roundup to prevent soil disturbance. Some wheat and maize farmers to break the life cycles of pests found in soils use crop rotation.

Farmers are being encouraged to engage in commercial fodder growing and feed conservation to address the issue of feed shortages. About 11% of households in the county are conserving animal feed in one form or another as a climate change adaptation strategy (GoK, 2014). Hay production is an alternative feed to help dairy farmers increase their resilience during dry spells. Farmers also use crop residues that previously used to be left on the fields and burnt as animal feed. These include maize stalks, wheat straws and even sunflower stalks. With the increase in dry spells in the county, free-range grazing or extensive management, systems are becoming unsustainable. Farmers are therefore transitioning to more appropriate production systems such as the semi-intensive and intensive systems e.g. zero grazing.

Water harvesting is another technology farmers are employing to improve their adaptive capacity. This includes the construction of water pans to harvest and conserve water for use during dry spells. Irrigation exist along rivers such as River Sosiani and River Moiben where high value horticultural crops are grown. In

Uasin Gishu County, 25% of households are involved in harvesting water to improve their adaptive capacity to climate change (GoK, 2014).

Tree planting among farmers is being encouraged and promoted to help alleviate the effects of climate change on agricultural production. About 47% of households in the county are embracing tree planting as an adaptation strategy to climate change (GoK, 2014). Farmers are establishing woodlots, planting trees on their farms with the aim of providing wood fuel, timber for construction, and conserving the environment. This initiative is supported by the Kenya Forest Service (KFS) through the provision of seedlings. Forests act as carbon sinks and help reduce the amount of greenhouse gases in the atmosphere and hence mitigating climate change. However, unavailability of seedlings due to high demand is a major challenge in smallholder tree planting efforts. On the other hand, farmers are being encouraged to use alternative and efficient improved cooking stoves that use very little firewood to reduce tree cutting. However areas near forests that have abundant firewood have recorded low uptake of these improved cooking stoves. Continued dependence on wood fuel from trees has led to deforestation. Encroachment of wetlands for farming purposes are also negating the efforts of tree planting and contributing to weather changes.

Off-farm adaptation practices

Off-farm services either support on-farm adaptation practices or improve preparedness for and resilience to climate shocks. These services include finance, infrastructure (especially irrigation), climate and agricultural services including early warning systems. The providers of these services are mainly government and private institutions including non-government, faith- and community-based agencies.

The Kenya Meteorological Department (KMD) is a government department mandated to provide information on the weather outlook through timely and accurate weather forecasts. The department provides early warning systems through the Participatory Scenario Planning (PSP) forum. The department provides advisories related to the rainfall season and addresses information needs such as rainfall patterns and the type of crops and crop varieties that are well suited for rainfall that will be available. This helps farmers to plan better, make informed decisions and improve their preparedness to avoid weather-related impacts and losses. Early Warning Systems (EWS) are mainly related to the production and post-harvest stages of the value chains. The main bottleneck in the provision of timely and accurate forecasts is the insufficient number of weather stations in the county. Currently, only two functional weather stations exist and this is far from an ideal situation.

Farmers in Uasin Gishu County have formed cooperative societies to help them increase their adaptive capacity to climate change. Some of the value chains with vibrant cooperative societies include; maize, potato and dairy value chains. They provide services such as inputs at subsidized rates due to economies of scales. In addition, they provide the much needed credit facilities to farmers (both in cash and in kind) as well as access to markets for their commodities. However, poor governance and corruption is the bane of the cooperative movement rendering most of them ineffective in addressing the plight of farmers. The cooperative movement is linked to all the stages of the value chains from input supply, production, postharvest and marketing of agricultural produce.

Crop and Livestock insurance is a strategy embraced by farmers to hedge them against climatic hazards. Insurance products are linked to production and are intended to assist farmers recoup their losses because of hazards. Service providers such as the Cooperative Insurance Company (CIC) provide these products. Another promoted insurance product is *Kilimo Salama*, which is loosely translated as "Safe Agriculture". This is an insurance designed for maize and wheat farmers to insure their crop against drought and excess rain. Despite concerted efforts to encourage the uptake of insurance products, the results have not been very encouraging due to what farmers perceive to be stringent conditions set by service providers and lack of trust of the service providers. Only a paltry 1% of the households have bought insurance for their agricultural production systems (GoK, 2014)

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

Irish Potatoes

	Provision of seeds and other inputs	On-farm production	Harvesting storage and processing	Product marketing
Changes in seasons (onset and duration)	Delay in fertiliser application. Inadequate availability of seed potato particularly from accredited seed suppliers (sometimes costly or not locally available). Low quality of suckers due to longer storage	Low germination/emergence rates. Land preparation is costly and labour intensive when rains come early and fields are wet. Lack of synchronisation of farm activities	Poor quality of produce. Delayed harvesting. Increased labour (sorting and grading)	Irregular market access and loss of marketing opportunities. Market flooding at times resulting in low prices
Magnitude of impact	Moderate	Moderate	Minor	Major
Farmers' current strategies to cope with the risks	Carry-over of seed potatoes. Use of herbicides to prolong the life of seed potato	Early land preparation using hoes. Increased labour to prepare and plant in a short period. Replanting. Sharing of weather information between farmers	Delayed or early harvesting to coincide with season and market demand. Use of more farm labour to harvest in a short period	Delay harvest to coincide with market demand
Other potential options to increase farmers' adaptive capacity	Development of (certified) input systems. Training on seed potato management	Use of mechanised equipment to facilitate quick land preparation. Improved extension advisory system to allow for within season changes in weather	Use of mechanised equipment to facilitate quick harvesting. Improved storage facilities to guard against the weather	Strengthen marketing associations and cooperatives to add value. Improve transportation to facilitate quick market access
Intense rains	Impassable roads can make inputs unavailable. Water damage to fertiliser, seed potato and other inputs if not stored properly (rotting)	Difficulty of land preparation due to water logged fields. High incidence of pests and diseases (e.g. leaf blight). Leaching and loss of fertiliser and other inputs. Excess weeds	Difficulty in harvesting from water logged fields. Rotting of produce. High perishability during storage and packaging due to excess humidity	Quality deterioration and high perishability during transport to market during wet conditions. High transportation costs due to low accessibility (e.g. flooded roads)
Magnitude of impact	Major	Major	Major	Major
Farmers' current strategies to cope with the risks	Carry-over of planting materials (seed potato)	Early land preparation and planting. Application of foliar feed. Use of infield drainage systems. Engaging more farm labour	Timing harvesting to coincide with reduction of rains	Selling through middlemen. Delay harvesting to allow for sales when there is market better access
Other potential options to increase farmers' adaptive capacity	Development of (certified) input systems. Training on seed potato management. Improved storage facilities for seed n potato	Use of soil conservation structures. Development of modern drainage systems. Use of mechanised equipment for land preparation. Use of herbicides	Mechanized harvesting, cleaning and sorting. Construction of improved flood proof storage facilities for ware potatoes	Improvement of rural road and marketing networks. Improvement of market information

Chicken (local)

	Provision of inputs	On-Farm production	Harvesting storage and processing	Product marketing
Decrease in temperatures	Poor health of chicks and increased mortality	Low hatching rates, high mortality rates and slow growth. Increased feed consumption resulting increased costs. Increased heating costs. Increased costs of health management. Increased susceptibility to pests and diseases	Reduced quality and size of eggs and chickens	Supply not able to meet demand. Low prices due to quality (size and weight) of eggs and chickens. Some low quality eggs may not sell at all
Magnitude of impact	Moderate	Moderate	Major	Major
Farmers' current strategies to cope with the risks	Acquisition of chicks from neighbours, informal hatcheries and hawkers (middle men)	General livestock health promotion. Use of homemade enclosures to protect chickens from outside weather. Allowing free range feeding/ scavenging. Use of indigenous herbs for disease control	Home consumption of small eggs	Selling poultry and poultry products locally; individual to individual sales. Sales to middle men
Other potential options to increase farmers' adaptive capacity	Training on improved homemade poultry feeds and supplementation. Breed development and selection (in relation to resilience to temperature)	Loans for improved hatcheries and chicken enclosures. Training on modern low-cost enclosure heating methods (biogas, solar). Training on local incubation and chick production	Establishment of modern chicken and egg collection, storage, processing and grading facilities	Development of cooperatives for collective marketing
Intense rains	High chick disease prevalence. High mortality rate of chicks. Feed spoilage due to high moisture	High investments needed in drainage and ventilation of enclosures. High labor required for frequent cleaning of enclosures. Higher feed requirements to maintain body weight and body temperature. Increased cost for health management and medication due to higher incidence of diseases	Higher perishability of chicken and chicken products. Fewer birds and eggs harvested. Low quality and low weight of birds and eggs	Supply not able to meet demand. Impassable roads make marketing difficult. Low prices for low weight and low quality birds. Low profits due to high mortality and high costs of production, health management and marketing
Magnitude of impact	Major	Major	Major	Major
Farmers' current strategies to cope with the risks	Sun drying of feeds to avoid losses	Irregular deworming and vaccination. Use of raised housing. Allowing free ranging	Prompt sales of chickens and eggs (destocking). Avoiding brooding so eggs can be sold	Sales of low performing chickens
Other potential options to increase farmers' adaptive capacity	Improved feed storage and conservation methods and facilities. Training on quality feed production and processing. Capacity building on breed selection	Use of recommended disease management (vaccination, deworming) schedule. Regular sanitation of chicken enclosures. Use of modern hatchery designs that protect from water intrusion	Capacity building of farmers on poultry value addition. Improved facilities for processing and storage of chicken and eggs	Capacity building on marketing and sales. Improve roads networks for better market access

Maize

	Provision of seeds and other inputs	On-Farm production	Harvesting storage and processing	Product marketing
Changes in seasons (onset and duration)	Unpredictable supply and availability of seed, fertiliser and other inputs due to uncertainty in season start. Scramble for inputs when rains arrive	High costs of land preparation. Late planting. Uncertainty of fertiliser and pesticide application. Poor weed control due to unpredictable rains. Uneven stands	Unpredictability in timing of harvest period. Losses of crops in the field due to late harvest or spoilage of grain due to rains occurring during the harvesting period. Post-harvest losses if cobs are not stored where they can dry properly	Low prices due to low quality of produce. Quick sales of produce to avoid losses, leading to lower prices
Magnitude of impact	Major	Moderate	Major	Moderate
Farmers' current strategies to cope with the risks	Joint sourcing of seed through farmer social networks. Use organic manure as a substitute for mineral fertilizer	Reduce land area under maize. Diversification to other crops. Green manuring to support soil fertility and guard against seasonal variations. Early land preparation. Use of preemergence herbicides	Use of on farm storage facilities	Sales to middle men. Individual sales
Other potential options to increase farmers' adaptive capacity	Establish contract seed production mechanism. Establish local seed production facilities	Dry planting. Crop rotations, intercropping and mulching. Provision of subsidized tractor services by the county government. Compost production to enhance soil fertility, reduce hardpans and improve water-holding capacity	Establishment of aggregation centres at local level. Introduction of warehouse receipting systems	Collective marketing through cooperatives. Contract farming. Scaling out of marketing platforms (EAGC, RATIN, EAX, CGA)
Droughts	Lack of availability of seeds. Hardpans make land preparation difficult and increase runoff when rains do arrive	Low germination rate and poor stand establishment. Wilting of crops. Susceptibility of crop to pests and diseases	Low yields. Poor quality and low weight of harvest	Low production can lead to higher local prices (advantage for farmers but disadvantage for buyers). Shortages in local markets and in households
Magnitude of impact	Moderate	Severe	Moderate	Moderate
Farmers' current strategies to cope with the risks	Obtain planting materials from government	Early planting	Early harvesting. Low quality produce consumption at the household level. Delayed harvesting	Quick sales of produce once it has been harvested. On farm storage. Sales through middle men. Use of marketing agencies (NCPB) to guide pricing
Other potential options to increase farmers' adaptive capacity	Establish fertiliser production plants. Bulking/seed plots of improved varieties (drought resistant and early maturing)	Use of modern land preparation equipment (subsoilers, rippers, direct seeders). Use of conservation agriculture techniques – mulching, cover crops, Improved agrometeorological information	Adopt use of moisture meters to guide harvest time. Construction of high quality storage facilities by government	Adoption of warehouse receipt system. Farmers to register with SMS marketing platforms each EAX, RATIN

Cattle (milk)

	Provision of seeds and other inputs 	On-Farm production 	Harvesting storage and processing 	Product marketing 
Less rainfall	Feed and fodder scarcity. Reduced quantity and quality of pasture. Increased cost of veterinary inputs (vaccines and drugs)	Low milk production. Low fertility and reproduction rates. Low weight gain. Occurrence of mastitis resulting in no milk being produced	Reduced milk quantity and quality	Supply not able to meet demand. Higher milk prices (good for farmer but not for consumer)
Magnitude of impact	Major	Major	Major	Major
Farmers' current strategies to cope with the risks	Sharing weather and input information from farmer to farmer. On farm feed production. Silage production	General livestock health promotion. Use of homemade enclosures to protect chickens from outside weather	Destocking. Training on milk handling and storage	Sell to processors who in turn produce products with longer shelf life (e.g. milk powder and long life milk)
Other potential options to increase farmers' adaptive capacity	Training of farmers on pasture management and fodder production. Conduct contract feed and fodder production. Feed conservation during wet season	Improved livestock health services and organised vaccination programmes. Avail other options to anima draught power. Purchase of feed mixers for on farm feed production. Training on quarantine of sick animals	Farmers to be trained on milk production hygiene and proper disease management. Introduction of meat and milk processing equipment (including long life milk production and milk powder)	Collective marketing through cooperatives (dairy farmer groups)
Droughts	Feed and fodder scarcity. Reduced quantity and quality of pasture. Increased cost of veterinary inputs (vaccines and drugs)	Emaciation and sometimes death of animals. Low milk production. Increased susceptibility to pests and diseases resulting in increased animal health management costs. Lack of energy for draught power - affects labor of farm activities that require draught power	Acute shortage of milk and milk products. Lower availability and quality of meat and milk products. Increased demand for packaging and storage resulting in increased costs or unavailability to meet demand	Low prices due to destocking by farmers. Reduced availability of meat and milk products on local markets (high demand/low supply)
Magnitude of impact	Major	Severe	Severe	Major
Farmers' current strategies to cope with the risks	On farm feed production. Sharing of early warning information from farmer to farmer	Vaccination of animals by government. Establishment of alternative fodders (oats, vetch, and desmodium)	Destocking. Consumption of milk at household level	Individual sales at local market or to vendors
Other potential options to increase farmers' adaptive capacity	Promotion of drought resistant forage and fodder. Promote local fodder and forage seed production. Purchase of feed mixes for on farm feed production. Invest in small livestock (goats). Improved information on feed and fodder availability. Feed conservation during wet season	Promote water harvesting for livestock. Invest in alternatives to draught power (machinery and equipment for ploughing). Improved livestock health management	Capacity build farmers on appropriate destocking methods (i.e. selection of animals for destocking). Use of mechanised processing equipment focusing on improving product shelf life (e.g. meat drying, production of milk powder). Establishment of modern milk collection centres. Training on milk handling and storage	Organise group marketing though cooperatives

Policies and Programmes

Uasin Gishu County like most of the Kenyan counties lacks elaborate contextual policies and legislations that directly address climate change. However, the county largely relies on, and borrows from these national level policies as foundations for programme design in achieving some of the objectives therein of incorporating climate change into the development agenda and building resilience. Some of the national policies fully or partially implemented in the county are as in the following discussion.

The Agricultural Policy of 2010 aims at increasing agricultural productivity, income growth and food security especially among smallholder farmers. This can be achieved through emphasis on irrigation to stabilize agricultural productivity, commercialization and intensification of production among small-scale farmers. Droughts and decrease in stability of both seasons have increased in frequency causing massive crop failures. The agricultural policy helps farmers improve their productivity using modern agronomic practises and technologies.

Smallholder dairy production accounts for 70% of the total milk production in the country but the potential of this sector in the county is yet to be realized .The main objective of the National Livestock Policy of 2008 is to increase the production of livestock products. The policy therefore seeks to address the challenges in the livestock sub-sector in the context of livestock breeding, nutrition and feeding, disease control, value addition and marketing and research and extension. This includes and is not limited to the use of improved fodder, use of artificial insemination using semen of superior breeds, vaccination programs and converting milk to other products of high value. The main challenge facing this policy is the innate practise of overstocking where keeping large herds of animals is considered as a symbol of wealth and status.

The EMCA act of 1999 provided for the establishment of the National Environment Management Authority (NEMA), which supervises and coordinates all matters relating to the environment and implements policies relating to the environment. In addition, NEMA creates awareness of the importance of environmental issues in the county. The environment intertwines with the survival and socio-economic wellbeing of the population who depend directly and indirectly on the environmental goods and services. Climate change poses great challenges since it has adverse effects in form of floods, landslides and prolonged drought, which are difficult to manage. Therefore, the objective of the policy is to provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources. The policy provides a legal and institutional framework for good governance, effective coordination and management of environmental and natural resources.

The Kenya Forest Services Act of 2015 ensures that measures put in place significantly increase the area under forest cover with the aim of achieving the national target of 10%. To achieve this objective, the government is promoting farm forestry and community participation in forest management and conservation. The Kenya Forest Service (KFS) is the lead actor by establishing the Community Forest Associations (CFA) and providing seedlings for farmers to plant and establish woodlots. Another strategy employed by the KFS is the Green Schools Programme that encourages tree growing in schools to inculcate the culture of tree growing among the school going population. In the same vein of improving the tree cover, KFS together with the German Development Agency (GIZ) are promoting the use of improved cooking stoves. These technologies use little firewood and reduce emissions.

The Water Act takes cognisance of the contribution of the water resources to economic productivity and improvement of livelihoods. As such the National Water Policy of 2012 aims to promote optimal, sustainable and equitable development of water resources for livelihood of Kenyans. This is done through protecting, rehabilitating and restoring forests and water catchment areas which provide a continuous supply of water even to neighbouring Counties. This is of paramount importance since the county has three water towers. Water harvesting and storage can also help in realizing the objective of the water act. This is particularly relevant to Uasin Gishu County since it experiences heavy rains that can be harvested and harnessed for future use.

The aim of the National Irrigation Policy of 2012 is to expand the areas under irrigation by opening new lands for irrigation, physical expansion and rehabilitating the existing areas. Uasin Gishu County is endowed with three water towers and has four major rivers traversing the breadth and width of the county. These water resources can be harnessed to increase and stabilize agricultural productivity and enable diversification of agricultural enterprises and hence improve food security. However, high costs of irrigation infrastructure and equipment are hampering the implementation of irrigation schemes.

In addition to the policies, a number of programmes have been implemented in the county to operationalize the various policies and legislations. The Smallholder Dairy Commercialization Programme (SDCP) has enabled the Livestock Directorate to reach many farmers. The programme has assisted farmers with hay boxes, chaff cutters, nitrogen tanks for artificial insemination, artificial insemination kits, seeds for bulking plots and milk coolers

in the county. Household income among the programme beneficiaries has increased from KES 150 to KES 450 per day on average. The most vulnerable and poor farmers have received about 168 goats. The programme has assisted farmers form cooperative societies with a membership of 1,180 farmers. The societies play an important role in bulking and marketing of milk because they provide a direct link to the main processors.

The ASDSP is also a key player in supporting the development of value chains. ASDSP that started in 2011 has been working alongside other partners in implementing the Kenya Agricultural Value Chain Enterprises (KAVES) project in Uasin Gishu County. The aim of the project is increasing the productivity of the Irish potato, passion fruit, maize and dairy value chains thereby increasing incomes of smallholder farmers and improving food security and nutrition. Indigenous or local chicken is also promoted to assist vulnerable groups such as women to earn extra income.

Other programmes by the county government include; "Inua Mama na Kuku" program that supplies chicks to women groups to improve poultry enterprises; training on care and maintenance of chickens, subsidizing artificial insemination services and construction of standard milk coolers' housing structures for 46 cooperative societies who will benefit from the contribution through fully equipped milk chilling facilities. This programme was launched in 2015 and after transforming women livelihoods through its successful implementation, the second phase is already underway to increase the number of beneficiaries. The Inua Mama na Kuku program had benefited about 450 women groups through the purchase of 450,000 birds and the county government intends to upscale the number to 1 million birds

The East African Dairy Development (EADD) program is a regional development program led by Heifer International in partnership with ILRI (International Livestock Research Institute), TechnoServe, the World Agroforestry Centre (ICRAF) and the African Breeders Service Total Cattle Management. Since its inception in 2008, the goal of this project is to help families living on small 1-5 acre farms lift themselves out of poverty through more profitable production and marketing of milk. EADD has provided extensive training on dairy husbandry, business practises and operation, and marketing of dairy products. During the first phase of the program, 42,700 farmers benefited from the program and the second phase is already underway.

The International Potato Centre (CIP) is implementing a project funded by United States Agency for International Development (USAID) under Feed the Future Kenya initiative. The program seeks to harness technologies and innovations within the research system to sustainably reduce poverty and hunger in Kenya. CIP is implementing the following activities: establishment of demonstration plots; capacity-building for seed and ware multiplication with emphasis on improving access to quality seed; promoting investment in potato facilities and structures such as seed storage structures and irrigation; promotion of new technologies such as high yielding disease resistant varieties, good agricultural practises and rapid seed multiplication such as rooted cuttings. CIP has been involved in the development of disease, heat and drought resistant potato varieties. A good example is "Unica" which is a lowland and heat resistant variety that is being promoted in the North Rift region and other potato growing areas.

Governance, institutional resources, and capacity

The ASDSP which commenced its operation in Uasin Gishu County in the 2013, plays a significant role in climate risk management by bringing together the various actors through the Participatory Scenario Planning (PSP). The actors congregate when the meteorological department gives the assessment of the weather outlook and the early warning systems for the long and short rains. Based on this assessment relevant interventions are formulated based on the capacity and financial resources available and implemented. The development partners through NGOs undertake most of these interventions. Faith-based organizations are heavily involved in the implementation due to their strong presence in the largely religious population of the county and therefore their ability to influence a large number of people. Despite the PSP working towards climate risk management, there is a lack of specific policies at the county level to address climate risk management and a tendency to domesticating of national policies.

Climate risk management and adaptation strategies are addressed by collaboration between state and non-state actors either directly or indirectly. The state actors include the ministries such as; Agriculture, Livestock and Fisheries department, irrigation department, the KMD, KFS, and government parastatals such as NEMA. The non-state actors include NGOs such as CIP. Many more NGOs have their offices in Uasin Gishu County but their activities are based in the neighbouring counties. The faith-based organizations include the Anglican Church Services. Government departments provide mainly technical support and policy direction while the non-state actors are involved in research, funding and implementation of climate risk management adaptations. NEMA coordinates and supervises over all matters relating to the environment and implementation of all policies relating to the environment in the county. They ensure that there is integration of environmental considerations into

development policies, plans and programs. KMD provides meteorological and climatological services to agriculture, forestry and water resources for better utilization of natural resources. They provide early warning systems that inform decision-making with regard to climate risk management. KFS conserves, protects and manages all public forests. They assist the county government to develop and manage forest resources, assist in building capacity in forestry and forest management. Furthermore, they manage water catchment areas in the county in collaboration with other stakeholders.

There is a lot of collaboration going on among the various stakeholders aforementioned but sometimes this lacks a framework for collaboration and therefore lack of accountability. Low funding and human capacity are the bane of climate risk management among the state actors affecting planning and implementation and therefore should be addressed. Training and capacity building opportunities for actors on climate risk management are a rarity rather than being the norm in the ever-changing climate scenarios and adaptation strategies.

Synthesis and Outlook

Uasin Gishu County is agriculturally rich; endowed with fertile agricultural lands and high rainfall spread evenly through the year. Agriculture is the main economic activity at both commercial and subsistence level. The sector is characterized by large-scale farming of high value crops, food crops and livestock and a vibrant dairy enterprise. Despite recording success in agricultural production, a host of challenges that hinder the attainment of its full potential plagues the sector. This include high costs of inputs, low input use, declining soil fertility, poor infrastructure and poor governance in farmer organizations. These have been exacerbated by the negative impacts of climate change and variation that have led to intense rainfall, changes in the onset of the growing seasons, extended dry spell periods and emergence of new pests and diseases. With these climatic hazards bound to occur frequently in future, the capacity of KMD should be enhanced through the acquisition of more automatic weather stations for accurate and reliable forecasts to help farmers in planning and making informed decisions.

Farmers in Uasin Gishu County should harness their efforts to increase use of organic manure to address the challenge of declining soil fertility. Protection of water catchment areas is of paramount importance since the county has water towers which play an important role in water availability. For farmers to get better returns from their produce and be motivated, training of value addition should be enhanced so that they can improve their products. Even though alternative crops have been introduced to diversify enterprises to prevent farmers' reliance on specific enterprises that are vulnerable climate change and variability, these efforts should be scaled up. Deliberate efforts should be made to improve the road network and infrastructure in agricultural rich areas to enable farmers to access markets for their produce and better prices.

Institutional capacity to tackle the increasing climate change and variability in the county should be enhanced to make climate risk management proactive. Policies relevant to climate risk management should be enacted and anchored in county development plans to provide an enabling framework for the various stakeholders to engage, coordinate and provide the requisite synergy required to assist farmers cope with climate change and variability. Policies will ensure budgetary allocation for both financial and human resources to strengthen the efforts required in tackling climate change issues. Capacity building for climate risk management actors and specialists should be enhanced to enable them to provide up to date information and skills in the choice and implementation of adaptations strategies. Information sharing between the various actors should be encouraged to improve the efficiency and effectiveness in implementing adaptation strategies. This calls for more engagement forums between the various stakeholders involved in climate risk management.

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