

Climate Risk Profile Kwale County

Highlights

- The agriculture sector plays a crucial role in guaranteeing food and nutrition security, reducing poverty, and creating employment in Kwale County where subsistence farming accounts for about 80% of the average household income. The key agricultural value chain commodities produced by the overwhelming majority of farmers are maize, cowpea, poultry and goat, which contribute to household food and livelihood security.
- In spite of the importance of agriculture, food insecurity is a critical issue in the. Roughly 70% of the households are considered food poor and 14% report not having enough food to meet their needs, leading to a high incidence of childhood stunting, general undernourishment and general acute malnutrition. Food insecurity peaks between the months of April and June, when the harvested stock is generally depleted.
- Food insecurity is tied to a combination of factors that include extreme weather and climate conditions, resource management, and access to appropriate inputs. Water is a constraining factor that limits productivity for crop and livestock production. About 30% of the households use machinery and equipment on their farms, but only 2.5% use irrigation water. High prices associated with these inputs have been identified as main barriers to adoption.
- Reliance on rain fed agriculture makes farmers in Kwale especially vulnerable to climate shocks and changes. Historical records indicate that average temperatures have increased significantly in the past twenty years and the number of heat and drought-stressed days are projected to continue increasing during the First Season (March to May), leading to shorter crop cycles. Farmers have noted that rivers and streams have dried up in recent years, forcing them to adopt alternative planting or livelihood strategies. Producers also engage in value-adding practices such as boiling and fermenting milk and salting and drying meat.
- Some of the most widely used on-farm strategies include staggered planting, water harvesting techniques, food storage, and value-added processing. Female-headed households are more likely to adopt postharvest and value added strategies to ensure food security through diversified production and market offering. Male-headed households are more likely to invest in longer term strategies to improve yields and ensure sustainable production. These may relate to differences in access to information and resources.
- In this sense, successful implementation of climate adaptation strategies will require strengthening the institutional and financial capacity of key actors. In turn, farmers must have the information to understand, and the tools to respond to climate change and risks such as onset of drought and floods. Appropriate adaptation and mitigation response will be contingent upon farmers' ability to access crucial extension services in a systematic way.
- Off-farm services such as early warning systems, extension and training, credit, storage facilities and market information are offered to farmers by public, private, non-profit and local institutional and governmental actors. However, the capacity to deliver relevant and timely information to farmers throughout the County is limited by coordination, infrastructure, and resource constraints and could be improved through the concerted efforts of various actors working on climate change adaptation. Farmers need the tools and information to understand and act upon the urgency of adapting to climate and mitigating risks.

List of acronyms

ABEC	African Bird's Eye Chili
AEZ	Agroecological Zone
ASAL-DCF	Arid and Semi-Arid Lands Drought Contingency Fund
ASDSP	Agricultural Sector Development Support Programme
CBO	Community-Based Organizations
DA	Department of Agriculture
DVS	Department of Veterinary Services
EMCA	Environmental Management and Coordination Act
FAO	Food and Agriculture Organization
GEF	Global Environmental Facility
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands
KALRO	Kenya Agricultural and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Programme
KEFRI	Kenya Forestry Research Institute
KENAFF	Kenya National Farmers Federation
KFS	Kenya Forest Service
KIFSLP	Kinango Integrated Food Security and Livelihood Project
KLPC	Kwale Local Poultry Cooperative
KMD	Kenya Meteorological Department
KRCS	Kenya Red Cross Society
KWS	Kenya Wildlife Services
LD	Livestock Department
MoALF	Ministry of Agriculture, Livestock and Fisheries
MESPT	Micro Enterprise Support Programme Trust
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NCPB	National Cereals and Produce Board
NDMA	National Drought Management Authority
NEMA	National Environmental Management Authority
NMK	National Museums of Kenya
PIKKPU	Kenya Kwale Program Unit
PRRO	Protracted Relief and Recovery Operation
SCCF	Special Climate Change Fund
SHICOFA	Shimba Hills Community Forest Association
VCC	Value Chain Commodity

Kwale

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 extremely susceptible to climate related events, and projections indicate that the impacts are likely to affect the country even more in the future. In many areas, extreme events and variability of weather are now the norm: rainfall is irregular and unpredictable; some regions experience frequent droughts during the long rainy season and others severe floods during the short rains. The arid and semi-arid areas are particularly hard hit by these climate hazards thereby putting the lives of millions of households and their social and economic activities at risk.

In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS) which recognized the importance of climate change impacts for Kenya's development. This was followed by the development of the National Climate Change Action Plan (NCCAP) in 2012. Since the focus of these initiatives has been the national level there is a need to mainstream climate change perspectives in programs and development plans at the County level as the country shifts towards County Governance and focus.

To strengthen local capacities of stakeholders to reduce the near-, medium- and long-term vulnerability to current and future climate variability, the Kenyan Government, through the Ministry of Agriculture, Livestock and Fisheries (MoALF) is implementing the Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL) project, with a grant from the Global Environmental Facility (GEF)/ Special Climate Change Fund (SCCF) through the World Bank. The present study is part of the KACCAL project and aims to inform the County Government and stakeholders on the climate change risks and opportunities for agriculture so that they are able to integrate these perspectives into their development plans and processes.

This document presents the Climate Risk Profile for Kwale County. In recent years, Kwale has made headlines in national and international news coverage for the state of disaster brought about by extreme

drought conditions and related crop failure. Low rainfall patterns in March, April, and May 2013 resulted in maize and rice harvests at just 14% and household food stocks at 22% compared to the five-year average¹. More recently, as much as half of the total County population are estimated to face hunger due to lack of rains in 2016. In the past year, when rains did come, the River Uмба burst its banks destroying more than 25,000 acres of land, displacing as many as 34,219 people, and creating major health concerns regarding water-borne illnesses for humans and livestock. In response to these disasters, the national government distributed food aid and emergency relief but also encouraged the population to adopt drought-resistant farming practices such as alternative crops, and utilizing irrigation². The magnitude and severity of these climate hazards makes the identification of impending climate risks an urgent matter; likewise, considering how practices that help citizens become more resilient in the face of imminent threats to their health, safety, and livelihoods becomes an exercise with the potential to affect hundreds of thousands of lives.

This Profile is organized into six main sections, each reflecting an essential analytical step in studying current and potential adaptation options in key local agricultural value chain commodities. The text first offers an overview of the County's main value chain commodities key to food security and livelihoods, as well as major challenges to agricultural sector development in Kwale. In the next section, the main climate hazards are identified based on the analysis of historical climate data and climate projections, including scientific assessments of climate indicators for dry spells, flooding, heat stress, among other key hazards for agriculture. Then it continues with an analysis of the vulnerabilities and risks posed by the hazards deemed to be potentially most harmful to 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 policy, institutional and governance context that can enable adoption of resilience-building strategies, and finally presents potential pathways for strengthening institutional capacity to address potential future climate risks.

1 As reported by IRC (2014).

2 As reported by Floodlist (2015).

Agricultural context

Economic relevance of farming

The agriculture sector plays a crucial role in guaranteeing food and nutrition security, reducing poverty, and creating employment in Kwale County. In the fiscal year 2011-2012, Kwale County allocated Kenya shillings (Ksh) 159 million, equivalent to 3.9% of the total Ksh 4.1 billion County budget, to the agricultural sector. The income generated by the major field crops in 2012 was Ksh 2.99 billion, of which maize was the greatest contributor (Ksh 592 million; 19.8%), followed by rice and cassava valued at 187 million and 180 million respectively. Horticulture crop production reached 322,595 metric tons (MT) valued at Ksh 5.12 billion and contributing 2.5% to the total agricultural sector production value. Mango was the leading horticultural value chain commodity valued at Ksh 1.7 billion (over 56% contribution), followed by bananas and tomatoes valued at Ksh 199 million and 25 million respectively (GoK, 2014), another important horticultural value chain is citrus. The main products from the livestock subsector are beef and dairy milk, which generated Ksh 1.8 billion and 742 million respectively in 2014. In the same period, fish production totaled 2134 MT, equivalent to Ksh 193 million (GoK, 2014).

The agricultural sector plays a significant role in household income in spite of recurring challenges associated with climate shocks such as drought and floods, and productivity shortcomings such as food shortages and insecurity. Subsistence farming accounts for 80.6% of the average³ household income and is an important source of employment for approximately 62,681⁴ people in the County (GoK, 2013). Youth-headed households⁵ provide most of the hired labour (37%) and family labour (65%) in the agricultural sector. Adult male and youth-headed households provide hired labour for livestock production activities, adult female-headed households tend to provide hired labour for crop production (GoK, 2014). About 37% of male-headed and 31% of female-headed households earn income from crop-related, on-farm activities; while 32.9% of female- and 68.6% of male-headed households earn income from livestock activities. In total, on-farm activities contribute Ksh 70,970 per annum to the average household income (see Annex 1).

Income from crop production represents the largest part (34%) of all on-farm income, followed by livestock activities (30%). Female-headed households earned less income from on-farm activities (Ksh 28,922) compared with adult male households (Ksh 95,107) and youth-headed households (Ksh 88,880). Several factors are likely to contribute to this disparity, amongst the most important being that men have more access to farm inputs and extension services; men are the primary owners of resources; and women are less involved in household decision-making.

People and livelihoods

According to the most recent Housing and Population Census, the population of Kwale County was 649,931 in 2009 and was projected to increase by 9.8% to 713,488 persons by 2012, and by 28.2% to 833,527 persons by 2017 (GoK, 2013). The County population growth rate (3.1%) is higher than the national growth rate (2.9%) which may be explained in part by the limited adoption of family planning and contraceptives by the population that is of childbearing age, related to the religious and cultural influence.

Population distribution, employment, and livelihood factors in Kwale are strongly influenced by the County's topography and agro ecological conditions. Non-agricultural livelihoods are concentrated in more urban sectors, although most households (male-headed, 53%; youth-headed, 12%; female-headed, 10%), receive at least part of their income from off-farm activities regardless of their location. The average annual household income from off-farm and non-farm activities is KSh 519,588, with major differences between male-headed (KSh 887,000), youth-headed (KSh 420,845), and female-headed (KSh 250,451) households (GoK, 2014). That males earn more than three times as much as females may in part be explained by the comparably low female education and literacy levels, and males having the skills and expertise required for off-farm labour.

Wage employment is still very low within the County, contributing just 8.6% of the average household income. Wage labour is mainly concentrated in the hospitality sector, catering to tourist sites such as the

3 The mean household income in 2011-2012 was KSh 166,588.

4 Of the total county population of 649,931 people, 352,353 are considered potential available workforce (15-64 years old). Of the county's workforce, 30% are unemployed or underemployed.

5 Defined by ASDSP as a "household whose main decision maker on agricultural production, marketing and consumption is a male or female person aged between 18 and 35 years irrespective of sex or marital status. The sampled total youth headed household was 30".

natural and marine reserves (Shimba Hills National Reserve and Mwaluganje Sanctuary); historic sites (Shimoni Holes, Diani Mosques); forest, coral and sand beaches (Diani, Tiwi, Gazi, Msambweni) and wildlife habitats (bird and turtle breeding grounds). Other formal wage earners include teachers, public servants, general labourers, and those employed in the production and manufacturing sector (mining, agro industry, distilleries). About 1.9% of rural and 6.2% of urban inhabitants are considered self-employed, engaging in the informal sector ('jua kali') and other Small and Medium Enterprises (SMEs) (GoK, 2013). An additional 30% of the total labour force (mainly youth) is either unemployed or underemployed.

The remainder of the County is predominantly rural and agriculture-based with lower livelihood indicators. In total, 82.4% of the population (535,543 people) live in the rural area where subsistence farming employs 62,681 people and contributes 80.6% to the household income. Mixed farming is the primary occupation for most households (male-headed, 55.2%; female-headed, 43.8%; and youth-headed, 26.6%) (GoK, 2014).

In spite of the reliance on agriculture, food insecurity is a critical issue in the County; an estimated 14% of households do not have enough food to meet their needs and should be considered for food relief. At least 13% of the adult male-headed households, 10% of adult female-headed households, and 7% of youth-headed households do not have enough food to meet their needs (GoK, 2014). Food insecurity peaks between the months of April and June since the harvested stock has been depleted. The effects of malnutrition are observed in the high incidence of stunting (35%), underweight (2%) and acute malnutrition (6%) in the County's population (GoK, 2013). Relatedly, the rate of absolute poverty is 74.9%, with only 10.6% of the households having access to electricity and 80.2% reliant on fuelwood for cooking (GoK, 2013). The literacy levels in the County have increased over the last few years to 57%⁶ compared to the national average of 61.5%. Female literacy levels stand at 47.4%, compared to 66.6% male literacy (GoK, 2014).

Land is an underutilized resource in Kwale County. There has been a constant land tenure problem along the coastal strip and the coastal uplands. To deal with this, trust and government land within these areas has since been adjudicated and government settlement schemes established. In the drier areas of the Nyika Plateau (Kinango, Kasemeni, Samburu Ndavaya, and parts of Lunga Lunga Divisions), land is held in trust and under group ranches. Most of the group ranches are currently not functioning well, resulting in unplanned human settlements, small-scale farming, mining, and quarrying (GoK, 2013).

About 45.7% of the households own land without formal documents⁷ such as title deeds or letter of allotment, while 27.1% have land under communal ownership. Only 11.4% households have formal land ownership documents and just 22.5% of the land has title deeds (GoK, 2013). Disaggregated by gender and age, 52.6% male-headed households, 20.0% female-headed households and 41.7% youth-headed households held land without ownership documents (GoK, 2014). The Matuga and Msambweni constituencies are especially susceptible to landlessness and squatters because of a combination of lack of title deeds and high levels of poverty (low income, unemployment) that make land inaccessible in the area.

Agricultural activities

As indicated above, the great majority of Kwale County's population is dedicated to agriculture, dividing their activities between crop production, livestock rearing, and fishery reserves. Agricultural land constitutes 87,530 ha, corresponding to 10.6% of the County's total area. The County is divided into several agro-ecological zones (AEZs) in terms of agricultural potential.

- The Coastal Uplands (wet), commonly known as Shimba Hills, an area of medium to high agricultural potential, where dairy and crop production is practiced, is made up of sandstone hills that include the Shimba Hills (420m),

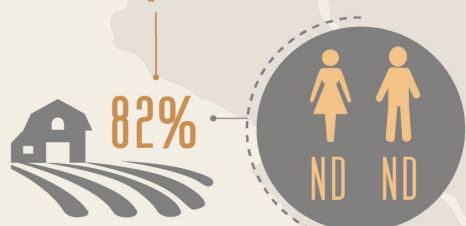
6 The introduction of free primary education by the National Government and adult classes has led to increased literacy levels in the county
7 Land ownership documents are title deeds or letters of allotment

Livelihoods and agriculture in Kwale

Demographics

2% Of Kenya's population

649,931 inhabitants



Access to basic needs

75% of the population lives in **absolute poverty**

Potable water	ND
Electricity for cooking	ND
Electricity for lighting	11%
Education (youth literacy rate)	57%

Food security

14% of the population suffers from **food poverty**



ND of household income spent on food



21% People undernourished
35% Children stunted
11% Children wasted

ND: No data

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

Farming

County's farming area

87,530ha 11%

9% of the population employed in agriculture production

23% of farmers have title deeds 10% are women

Farming activities

Food crops



Cash crops



Of county's agricultural land

Livestock



8 Group ranches
5 Company ranches

Farming inputs

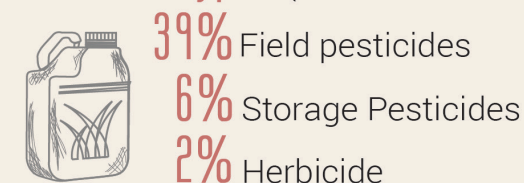
Water uses



Fertiliser types (% of households)



Pesticide types (% of households)



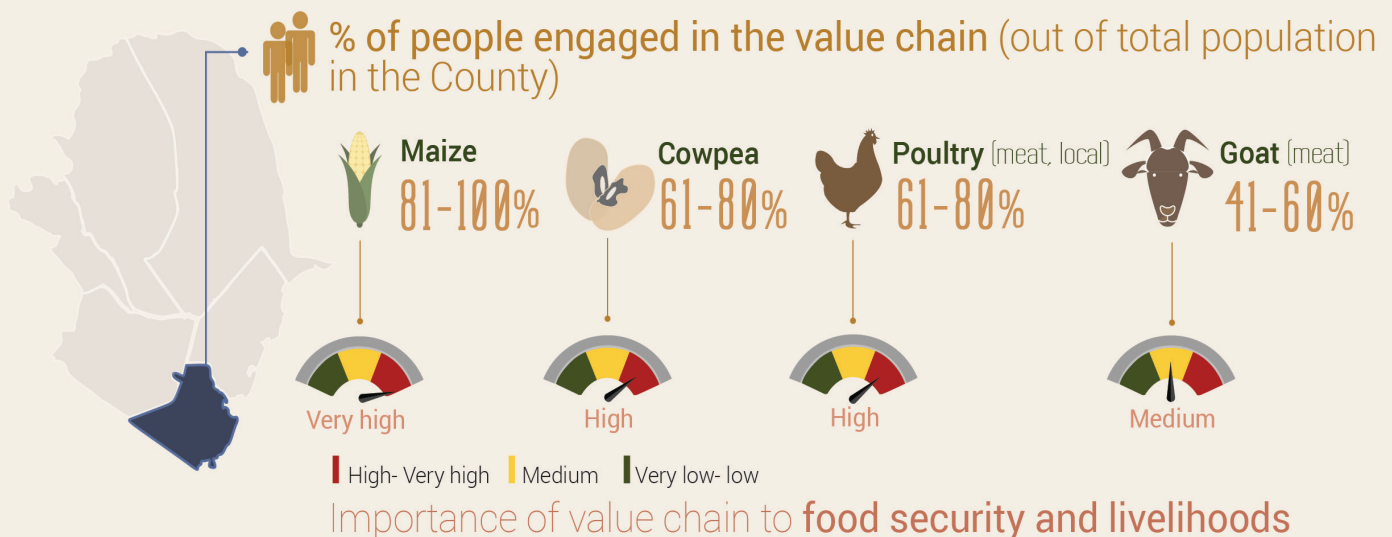
Tsimba (350m), Mrima (323m) and Dzombo (462m).

- The coastal plain, hot and humid, and where crop production and fishing activities predominate, includes areas near the shoreline up to Vanga before the Kenya-Tanzania border including Msambweni, lower Diani and Ramisi.
- The foot plateau, sub-humid, includes areas bordering the elevated Nyika Plateau such as Matuga and Kikoneni.
- The coastal and dry hinterland, where the semi-arid land is only suitable for livestock (cattle (beef), sheep and goat) and to some extents for drought-resistant cultivars (cowpea, green gram and cassava). These areas include Kinango sub-County and the upper parts of Msambweni in Lunga Lunga sub-County; Mwagulu is dry (Mweremi ward). The annual rainfall in the area is less than 800mm on the average and is extremely unreliable.

The average farm size is 4.8 ha, with little disparity when disaggregated by head of household (men 4.9 ha, women 5.2 ha; and youth 4 ha) (GoK, 2014)⁸ The total area under food crops is 27,606 ha and consists of maize, cassava, beans, cowpea, green gram cultivars spread across the County. Cowpea, cassava and green gram is prominent in the hot and dry coastal hinterland, and in the semi-arid areas of Kinango. Cash crops include cashew nut (all over the County), sugarcane (mostly in Lunga Lunga sub-County and Ramisi), cotton (held on trial in Msambweni) and bixa (in Lunga Lunga, Msambweni, Matuga)) and are spread on 44,868 ha of agricultural land. Semi-commercial crops, such as coconuts and mangoes are found throughout the entire County, particularly in Msambweni and Matuga sub counties.

Livestock production is an important economic activity and cattle ranches make up 15,055 ha of the total land area. The County's 13 ranches (5 company owned, 8 owned by farmer groups) are concentrated in the Nyika Plateau and Kinango sub-County. According to the 2009 census, the livestock population included: 255,143 cattle heads⁹, 349,755 goat heads, 83,133

Agricultural value chain commodities in Kwale



⁸ Household, as referred to by the ASDSP, is a collection of persons who depend on a common store and make common production, marketing and consumption decisions (GoK, 2014).

⁹ The main cattle breeds are Zebu and Boran for beef and crosses of Ayrshire and Sahiwal for dairy.

sheep heads, and 433,827 indigenous chicken heads (GoK, 2013). Kwale has abundant fisheries reserves¹⁰ and 40 landing sites along the coastline including Shimoni, Vanga, Msambweni, Diani and Tiwi. In 2014, the total quantity of captured fish was 2,643 MT valued at Ksh 390.782 million. In addition, the total quantity of fish farmed (aquaculture) was 451 MT valued at Ksh 97.263million (GoK, 2015)

The three major farm inputs used on annual crops are seed/planting material, field pesticides and organic manure. The levels of inputs used on annual crops by different households vary between seasons and crop type with higher levels of seed planting material for cowpea, green gram and maize. Other farm inputs include storage pesticides, herbicides, and inorganic fertilisers at planting and for top dressing. About 30% of the households use machinery and equipment on their farms, but only 2.5% use irrigation. The three most common inputs in livestock production are vaccines (31.9%), de-wormers (28.9%) and acaricides (25.5%). High prices is the main constraint to the use of both crop and livestock inputs (GoK, 2014).

The County's generally low productivity and yields are associated with low input use, particularly by adult female and youth-headed households. High prices are the main constraint to the use of crop inputs.

Agricultural value chain commodities

Agricultural production in Kwale County is characterized by subsistence farming and small-scale production of commercial crops and livestock. Various value chains have been prioritized for development interventions by different government organizations and programs such as the Agricultural Sector Development Support Programme (ASDSP), the Kenya Agricultural and Livestock Research Organization (KALRO) and University of Nairobi survey, and the Kenya Agricultural Productivity Program (KAPP). For the development of this County Climate Risk Profile, four major value chain commodities (VCCs) were selected for in-depth analysis based on their contribution to food security, productivity characteristics and importance to the economy. These VCCs, validated by local stakeholders, have been selected from a list compiled from the above-mentioned documents using the following

prioritization indicators: harvested area (hectares), production (90 kg bags), variation in production (in the past five years), value of production (KES/bag), dietary energy consumption (Kcal/capita/day), protein content (gr of protein/100 gr of product), iron content (mg of iron /100 gr of product), zinc content (mg of zinc/100 gr of product), and Vitamin A content (IU Vitamin A/100 gr of product).

The selected value chains for Kwale are maize, cowpea, goat (meat), and poultry (local). Maize and cowpea were selected mainly for their contribution to food security, as they are main staple foods in the County; goat meat was prioritized for economic purposes, as it is mainly used as a family investment for when there are emergencies and urgent need for money such as payment of medical bills and school fees; and local poultry was selected for economic reasons too, as there is high demand in the market. The rest of this section focuses on the four value chains commodities and subsequent sections discuss how they are affected by climatic conditions.

Maize

Maize is a major contributor to both food security and livelihoods in Kwale County. The majority of the farmers in the County (81-100%) engage in the production of this staple grain. In 2012, incomes from maize production represented 19.8% (Ksh 592 million) of the total income from field crops generated in the County¹¹.

Although maize requires abundant annual rainfall (1,200-2,500 mm) and rich, well-drained, light-loam soil, farmers in Kwale cultivate it in both seasons¹², in relatively poor soils¹³. This explains the relatively low maize yields throughout the County, which are roughly 10% lower than in high potential maize zones in Kenya. While male, female, and youth-headed households grow maize on relatively small areas of land, male-headed households tend to use more inputs and register higher yields (see Annex 2).

Farm inputs are bought from seed companies and farm input dealers located in major towns such as Ukunda and Kwale and in some market centres¹⁴; (GoK, 2013). The National Cereals and Produce Board (NCPB) in

¹⁰ The main types of fish are rabbit fish, scavengers, jack fish, and king fish.

¹¹ The income from the major field crops in 2012 for the County was Ksh 2,995 million shillings.

¹² Rainfall in Kwale is low and unreliable (from 600-1,200 mm). Maize cultivation in the First season occurs during the long rain of March-May (that in some cases extends to July), commonly known to the farmers as mvua ya mwaka or masika and in the Second season during the short rains of October-December, also known to the farmers as mvua za vuli.

¹³ Kwale's soils vary, from loamy to sandy with basement rocks.

¹⁴ There are around 68 market centres in the County

Kwale provides fertilisers at subsidized prices. The County government provides seeds and extension services, and has 41 tractors available for ploughing services (for free) across the 20 wards. However, the most common practice by the farmers is ox ploughing. A project under the Food and Agriculture Organization of the United Nations (FAO) provides additional subsoilers. About 30% of maize-growing households use machinery and equipment on their farms, most of which is owned by the households (49.2%) or hired (36.5%) and used for ploughing (63.5%) and harrowing (9.5%) (GoK, 2014).

Farmers' cooperatives (Dzombo, Vanga and Shimba Hills) are engaged in post-harvest and marketing activities such as storing maize surplus¹⁵, pricing, and selling with the help of the Kenya National Farmers' Federation (KENAFF). Construction of cereal banks by the County and national government is planned in Dzombo, Kikoneni and Vanga. Cooperatives offer farmers several benefits that potentially improve their position in the value chain including more bargaining power through bulk volumes; discounted inputs; and better access to technology transfer, extension services, and credit facilities.

Cowpea

Cowpea is a staple food and a major contributor to food security and livelihoods in Kwale County. In 2012, incomes from cowpea production represented just under 1% (Ksh 23 million) of the total income from field crops generated in the County¹⁶ (GoK, 2015).

Cowpea is commonly cultivated by small-scale, resource-constrained farmers because it thrives with minimal or no fertiliser and it is not labour-intensive. Moreover, cowpea is crucial for food security due to its resilience; it is a heat-loving and a drought-tolerant crop that weathers periods of scarce rainfall, although it grows best with consistent and well-distributed irrigation. Cowpea is grown in all the four AEZs, however it is cultivated more in the hot and dry coastal hinterland in the semi-arid areas of Kinango. The leaves are used as vegetables while the peas are sold at the markets across the County such as the wholesale and fresh produce market at Kombani and Ukunda Market, as they fetch good prices.

As part of its conservation agriculture initiative, the Kwale County government in collaboration with FAO supports the cultivation of cowpea as a cover crop and intercropped with cassava or green gram, or used in crop rotation with groundnuts, green gram, and cassava, by offering seeds/planting material. The County government also provides tractors for free at ward level. The initiative also aims to facilitate the commercialization of the crop, offering training and demonstration blocks (including free seeds)¹⁷ to subsistence farmers.

Farmers use ash and tin cans to store cowpea. Processing involves pod separation through winnowing seeds. The main cowpea recipes include fritters (bhajia), mashed (kimanga) and miseto.

Goat (meat)

One of Kwale County's most important livestock activities is goat rearing (local breeds and galla goats¹⁸), practiced in all four AEZs of the County¹⁹. Recent statistics show there are 350,874 animals in the County (GoK, 2015), with every household owning, on average, 15-20 goats. Goats represent important household investments, enabling family members to pay medical bills and children's school fees.

Productivity in recent years has been hampered by environmental degradation and climate shocks, particularly droughts and floods, to which most farmers have limited capacity to respond (GoK, 2014). At the same time, goat rearing is characterized by low levels of adoption of inputs and vaccination, the most common including: vaccines (31.9%), de-wormers (28.9%) and acaricides (25.5%) (GoK, 2014). Veterinary services are offered through both public and private service providers, but the costs associated with vector control are often prohibitively high for farmers. Following the privatization of insemination and vector management services, farmers have resorted to using low quality service providers and poor or no alternatives for cattle dips.

Most of the farmers in Kwale County have built housing units for their goats to protect them from

¹⁵ Main storage facilities are traditional on-farm granaries, but collective and unionized storage options exist.

¹⁶ The income from the major field crops in 2012 for the county was Ksh 2.99 billion.

¹⁷ Currently, there are 240 demonstration blocks in the County.

¹⁸ The galla goat, adapted to harsher climatic conditions, is mainly reared in the hot and dry areas of Kinango. The breed was introduced by national and County governments in an effort to enable farmers to cope with the hot and dry climatic conditions of the area and improve their livelihoods.

¹⁹ Especially in the hot and dry coastal hinterland in the semi-arid areas of Kinango and Lunga Lunga sub County, and the hot and sub humid areas of Msambweni and Matuga.

theft, predators, and diseases (such as pneumonia during harsh weather conditions), and to enable manure collection (a cheap and reliable input for crop production). Samaritan Purse, in collaboration with the Kwale County Government, has been in the forefront in assisting farmers with modernized goat houses.

At the distribution stage of the supply chain, there is limited formal integration between farmers, the state, and private actors. However, Micro Enterprise Support Programme Trust (MESPT) and the KENAFF are key players in assisting the farmers in marketing the goat meat. Processing takes place in slaughtering houses found in Mwabungu, Msambweni, Pungu, Kwale, Mariakani, Kasemeni and Lunga Lunga. The meat goat is sold by butchers who collect the meat from the slaughterhouses to sell on local market centres across the County. The Livestock Department (LD) and Samaritan Purse provide extension services and animal husbandry advisory services on goat meat management in the County.

The current trading price of a three-year old goat is Ksh 3,301 (April 2016), indicative of a 37% increase from March 2016 (Ksh 2,402). Great price fluctuation is not uncommon, and in general the price of goats has increased in the past years: goat prices were 34% higher in the first half of 2016 compared to the average prices from 2011 to 2015 of Ksh 2,469 (NDMA, 2016). This price increase can be explained in part by the lack of regulation in ruminant browsing and feeding, and the recharge from the long rains of the main water sources such as pans and dams, shallow wells, and boreholes especially in the semi-arid areas of Kinango, Kasemeni, Samburu Ndavaya, and some parts of the Lunga Lunga sub-County where water pans had dried up. This consequently led to healthy goat and thus high trading prices.

Men make most of the production decisions on all types of livestock production and trading, as women tend to dominate crop production. This impacts livelihood incomes when the price of goats rises and produce stays stable or decreases.

Poultry (indigenous)

Of the 433,827 indigenous poultry recorded in the 2009 census, the great majority (61-80%)²⁰ are raised by small-scale subsistence farmers. In almost every

household, indigenous chickens freely roam around homesteads and scavenge for food with very little supplementary feeding and minimal additional inputs (sorghum). Because of the informal nature of the production process, information related to inputs and production volumes and quantities is limited. KARLO is involved in the supply of parent/breeding stock in the County, as well as in Mtwapa, Likoni, Kinondo, Samburu and Naivasha. Banks offer farmers loans, table banking and devolving funds (common especially among women and youth) to sustain this value chain.

The poultry supply chain is coordinated by cooperatives such as the Kwale Local Poultry Cooperative (KLPC), tasked with linking buyers to sellers, marketing and market assurance. Other supply chain actors involved in processing and distribution include the private poultry slaughter slab, and Kenya Bixa Limited. LD provides farmer trainings on local poultry management in Tsimba, Ramisi, Vanga and McKinnon Road wards (NDMA, 2016).

Agricultural sector challenges

The Kwale County has the potential to feed itself and export surplus to neighbouring counties. However, the County faces perennial food shortages and food insecurity due to low productivity. Only 30% of the population in urban and rural areas are food secure. Inadequate access to farm inputs, such as improved genetic material for plants and animals, fertilisers, pest- and vector-control solutions, and machinery, contributes to poor production quality and volume. Due to the limited availability and prohibitive cost of high quality plant and livestock breeds and husbandry services, crop and livestock farmers have resorted to using low quality seeds and non-certified planting material. Added to these, pests and diseases represent a threat to agricultural production in the County²¹. Most farmers plant crop varieties that are not disease-resistant and rarely use pesticides or vector control, as the prices are prohibitive and they have limited access to research and information.

Unsustainable natural resource management compromises productivity. The County has huge irrigation potential, yet there are only a few, small irrigation schemes. Only 2.5% of the households use irrigation. As a result, water shortage greatly

20 According to workshop participants¹⁶ The income from the major field crops in 2012 for the county was Ksh 2.99 billion.
21 Pests related to the maize value chain includes the larger grain borer (commonly known to the local communities as osama), weevils, and armyworms. The fruit fly affects the mangoes and the African Bird's Eyed Chilies (ABECs). Most common diseases for indigenous poultry include the Newcastle disease, fowl typhoid and fowl pox. Pneumonia and malnutrition are common diseases among goats.

affects productivity of rainfed crops and livestock. Environmental degradation is boosted by the use of unsustainable agronomic practices, such as overstocking of livestock, improper use of farm inputs (fertilisers) and disposal of farm waste²², and overfishing²³, among others. Such practices are linked with farmers' limited skills, training, and access adequate agricultural extension (the ratio between extension officers and farmers is 1:1,886).

Most cereal harvest - especially maize, sorghum and millet - is lost, as 90% of farmers within the County use traditional storage methods. The County lacks industries to process and preserve agricultural produce.

Finally, there are only 68 market centres in the entire County and most of the goods traded in these markets are food products and livestock (mostly non-processed and without value addition). The general lack of market information and skills amongst farmers and the business community has hampered the expansion of markets for diversified products from the County. Weak and inadequate farmers' cooperative societies and associations coupled with poor roads in the County is a major hindrance to marketing. Poor organization of farmer groups has exposed them to exploitation by middlemen during harvest and postharvest. This low development of the market system has a cyclical effect on cash crops such as cashew-nuts, coconuts and bixa: low quality production leads to low prices, which determines lower production.

Climate change and agriculture risks and vulnerabilities

Climate change and variability: historic and future trends

Kwale County has a moderately hot and dry climate throughout the year. The average temperature is greater than 23°C throughout the majority of the County, with areas along the coast generally above 25°C annually. There is a strong east to west gradient of decreasing precipitation with eastern (coastal) parts of the County receiving greater than 1000 mm of precipitation per year, while a majority of the County central to west around 500-750 mm. Some small areas along the western side receiving less than 500 mm precipitation per year. As such, heat stress, dry spells, and drought are hazards that strongly contribute to agricultural risk in the County, especially in the central and western parts of the County. However flooding due to intense rains has also occurred historically and as such is a risk to the County, especially in the central to eastern parts (including the coast) of the County.

Experts and farmers alike acknowledge that there has been significant changes and variations in climatic conditions over the past years, affecting agricultural production and livelihoods in the County. Historical records indicate that between 1980-2005, Kwale County has experienced a large increase (2°C) in mean temperature and an accompanying reduced crop cycle in First Season and a mild increase (0.5°C) in mean temperature in Second Season (see Figure1). At the same time, the records indicate that there has been a significant increase (between 5%-15%) in heat stressed days, with an associated increase in the frequency of drought and reduction in precipitation in the First Season--2009 and 2011 were the two driest years in the first since 1980.

Historically, dry spells, moisture stress, and intense precipitation have occurred during both growing seasons of the year. Moisture stress and dry spells were observed to occur with approximately the same frequency during both growing seasons, with approximately 65 consecutive days of moisture stress in each season. However, there has been an increasing trend in moisture stress in the first wet season (January-June) since 1981, which has not occurred as strongly during the second wet season. Historic

22 On family farms the accumulation of plastic paper bags disrupts the soil ecosystem and lowers productivity causing a major solid waste management problem.

23 Pests related to the maize value chain includes the larger grain borer (commonly known to the local communities as osama), weevils, and armyworms. The fruit fly affects the mangoes and the African Bird's Eyed Chilies (ABECs). Most common diseases for indigenous poultry include the Newcastle disease, fowl typhoid and fowl pox. Pneumonia and malnutrition are common diseases among goats. External pressure from the growth of industry and tourism leads to high demand of the fisheries thus leading to overexploitation/overfishing.

records show the first wet season more consistently experienced single days with higher precipitation, with more than 30mm falling in a single day during 8 years 1981-2015. However, the second wet season (July – December) experienced greater variability in extreme precipitation with most years below 20 mm precipitation in any single day, and only three years with a day above 30mm. But the second season had the two highest single days on record since 1981, with over 40 mm of precipitation falling on a single day in 2006, and over 50 mm falling on a single day in 1996.

Climate has already been observed to change slightly in the County. Since 1981, the first wet season has experienced a very high (2.0 °C) increase in mean temperature and associated reduction in crop cycle, a significant increase in heat stress days, and a strong trend for decreasing precipitation (on the order of 40-50% reduction). The combination of increased temperatures and decreased precipitation make for an increase in drought risk in this first wet season. The second wet season experienced a mild (~0.5 °C) increase in temperature, and no change in precipitation.

Looking to the future in the years of 2021-2065, both extreme precipitation and prolonged moisture stress are projected to occur, but the changes are different during different seasons. Within 30 years (by the early 2040's) temperature is projected to increase by 0.3°C, with the first wet season projected to experience even greater changes. And by this time, precipitation is projected to decrease by 9 % in the first wet season, and 5 % in the second wet season. Consecutive days of moisture stress is projected to increase in both seasons, from around 65 days per season to over 75 days of moisture stress. At the same time, increased extreme precipitation is projected to occur slightly during the second season, with the highest single day of precipitation increasing on the order of 10-20%. The first wet season is projected to experience a slight decrease in the single day greatest precipitation on the order of 10%. These projections of future climate change under the two climate scenarios—RCP 2.6 and RCP 8.5²⁴ — show some difference, with the climate change patterns described above being slightly greater with higher greenhouse gas concentration

Climate from the farmers' perspective: historic and future trends

Farmers attest to the on-going and intensifying changes to climate and weather patterns in the County over time. The three main long-term environmental changes noticed by farmers are drying up of wells and rivers²⁵, deforestation, and soil degradation (GoK, 2014), especially in the hot and dry coastal hinterland, and the semi-arid areas of Kinango sub-County.

Temperature and rainfall are both noted as being more sporadic and extreme. According to farmers, there are “extremely high temperatures during the hot season”, “streams that were once providing water for rice production have now dried up due to the long dry spells”. According to them, “women now have to travel as far as 5 km to look for water and firewood for domestic use” (farmers’ reports). In particular, the intense rains from 2012 led to floods, lowering productivity and destroying property, particularly in Vanga in Lunga Lunga sub-County. Farmers attest to the significant shift on the onset date of both the long rain and the short rain, From March to the end of April and from October to late November respectively.

From the farmers’ testimonials, several indigenous tree varieties such as mugama, mipingo, midugu, and mikarangombe are now at the verge of extinction due to extensive deforestation for timber and charcoal burning. As farmers have come to rely increasingly on charcoal burning as a coping strategy in the event of drought, this has led to reduced tree-cover and considerably lower productivity for mangoes, as compared to the recent past.

Climate vulnerabilities across agriculture value chain commodities

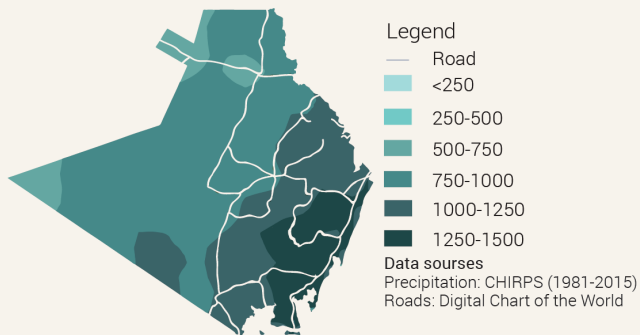
Climate change is already having an impact on agricultural production systems and food security, through an increased frequency of extreme weather events and unpredictability of weather patterns. There is evidence of increased heat stress with an associated increase in the frequency of drought and reduction

²⁴ The two RCPs, RCP2.6 and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6 and +8.5 W/m², respectively). The pathways are used for climate modelling and research. They describe two possible climate futures, considered possible depending on how much greenhouse gases are emitted in the years to come. RCP 2.6 assumes that global annual GHG emissions (measured in CO₂-equivalents) peak between 2010 and 2020, with emissions declining substantially thereafter. In RCP 8.5, emissions continue to rise throughout the 21st century.

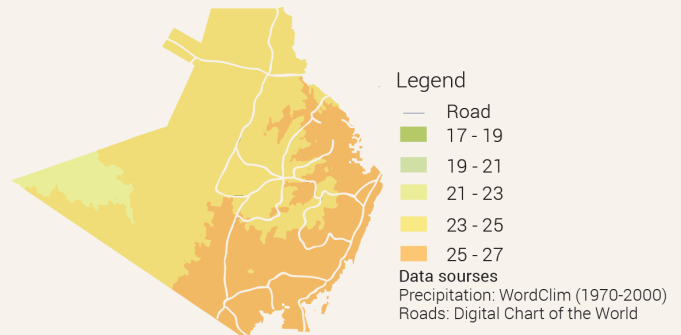
²⁵ For instance, the areas in Puma in Kinango sub-County.

Past and future impacts of climate hazards in Kwale

Historical annual mean precipitation (mm/year)



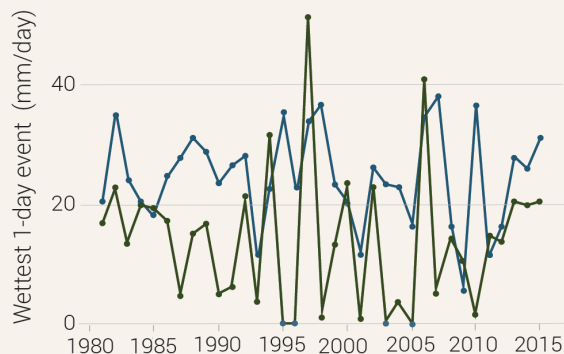
Historical annual mean temperature (°C)



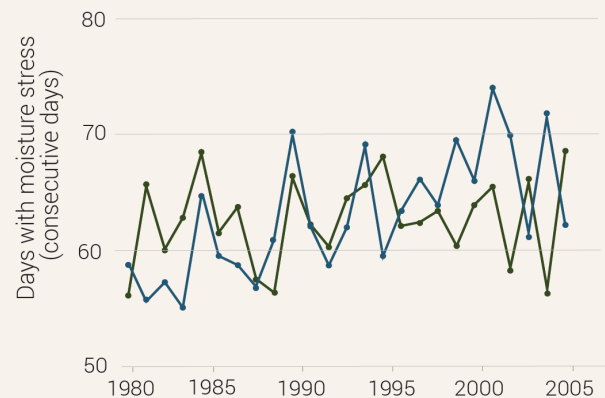
Drought hazards



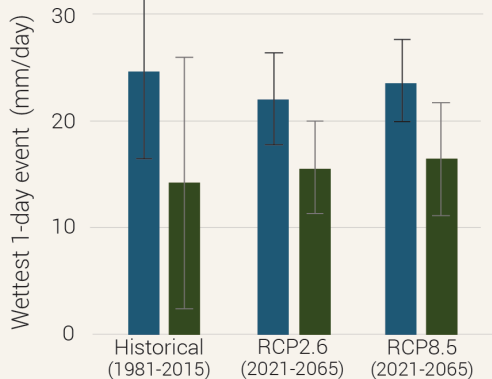
Historical extreme flood events



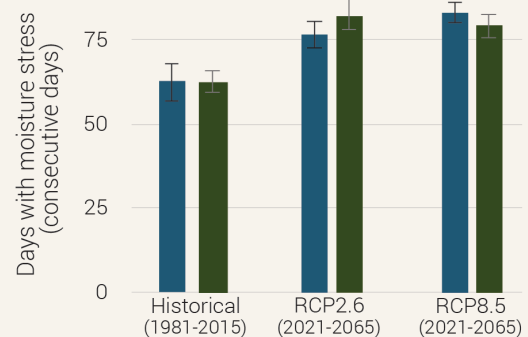
Historical drought stress events



Historical and expected extreme flood events



Historical and expected drought stress events



■ January - June ■ July - December

in precipitation in the First Season in the County. In Kwale, where crops are rain-fed, long dry spells and irregular rainfall exacerbate the problem of low yields and leave rural households even more susceptible to food insecurity. Particular climate hazards affect Kwale's key value chains in different ways, as discussed at length below.

Maize

Maize production in Kwale is almost entirely dependent on rainfall, and is thus highly susceptible to climate shocks. Drought is a major limiting factor for maize growth and productivity, as is heat stress. Maize requires high rainfall of 1,200 to 2,500 mm, whereas the County's annual rainfall averages 800 mm. Only limited areas near the coast receive sufficient rainfall. Rains are very poor in the hot and dry coastal hinterland, which includes the semi-arid areas of Kinango and Lunga Lunga sub-County.

Maize is also vulnerable to pests and diseases such as stalk borers, stem borers and armyworms that proliferate in dry times, requiring treatment with pesticides or chemicals that most of the farmers in Kwale cannot afford. In times of drought, limited production and curtailed storage facilities lead to spikes in demand and high prices for buyers. Storage pests such as large grain borer (weevils), commonly known to the farmers as osama, proliferate during the drought. In spite of this, farmers are culturally attracted to maize and unlikely to shift to heat- and drought-resistant sorghum, which is considered poultry feed.

Flooding, likewise, has adverse effects on maize production, leading to soil erosion, water logging, leaching of soil nutrients, and ultimately crop loss. Floods also destroy the road network, making farmers' access to farm inputs and output markets difficult.

Cowpea

Cowpea is known as a heat-loving and drought-tolerant crop. However, when soil moisture is insufficient early in the planting cycle, the crop becomes vulnerable, germination rates are low, causing low productivity. During drought periods, the soil becomes compact and requires more tilling, increasing the costs of inputs and labour. Compared to more vulnerable farmers that have no access to labour, wealthy farmers have the adaptive capacity to cope with these challenges, by hiring the required labour or procuring the needed water.

Flooding affects cowpea severely, as the plant cannot survive in waterlogged soils or flood conditions. The soil is susceptible to erosion and leaching of soil nutrients. This often leads to short-and long- term losses in productivity, affecting household income, livelihoods and poverty across the County.

Goat (meat)

Goat (meat) is seriously affected by both floods and droughts. The Nyika Plateau (Ndavaya, Kinango, Kasemeni, and Samburu), which covers about two thirds of the County and is popular for livestock production, receives less than 700 mm of rainfall annually (GoK, 2013). In this arid, drought-affected region, inadequate water reserves and dry pastures have a direct negative effect on goats' food supply and health, but also on other value chains. For instance, starvation and death of local goats during the droughts in 2009 and 2011 reduced the availability of organic manure, a crucial input supply for crop production. The economically-endowed farmers, with knowledge in fodder conservation and sufficient fodder stocks from previous harvests, are less exposed to drought risks and may actually benefit from higher, demand-driven prices for goats.

During floods, impassable roads create bottlenecks to delivery of inputs like vaccines and prophylactic materials. Vaccination is a prerequisite for the survival and the maintenance of goats, since traditional herbs are ineffective against worms and other pests. At the same time, floods also increase goats' susceptibility to death, as a consequence of pneumonia or drowning. Floods lead to the destruction of housing units for goats, leading to high mortality rates of the animals.

Poultry (local chicken)

Local poultry are adversely affected by drought, as they are vulnerable to inadequate food and water (feed shortage), and to increased incidence of diseases such as Newcastle disease. This leads to a decline in production and/or to stock loss. The effects of drought are not experienced equally by all farmers; wealthier farmers have the capacity to procure water or engage in water-harvesting techniques and purchase and/or store supplementary feed. Conversely, the increased costs of production adversely impact the poor and likely result in low volumes of trade with increased prices.

At the other end of the spectrum, floods affect road networks, threatening inputs availability and prices. Moreover, water damage to housing and to storage facilities compromise poultry health and survival, as there is increased incidence of diseases such as fowl typhoid. Regarding marketing activities, reduced supply and increased demand lead to high prices for local poultry.

Adaptation to climate change and variability

On-farm adaptation options

To cope with climate change and variability, many farmers in Kwale County have adopted various strategies to increase their resilience to risks (droughts and floods). These include water harvesting techniques (water tanks and water pans) that increase the farmers' capacity to have water during dry spell, intercropping for flood management (one row of rice, two of maize), staggered planting, and value-addition processing (grading in vegetables and root tubers, milling in grains, fermentation of milk, flavouring of mutton), as identified through focus group discussions and workshops with community members and farmers. These strategies, specific to each key agricultural value chain, are presented in more detail in Infographic 4.

Female-headed households are more likely to adopt post-harvest and value-added strategies to ensure food security through diversified production and market offering. Male-headed households are more likely to invest in longer term strategies to improve yields and ensure sustainable production. These differences may relate to differences in access to information and resources. Annex 5 identifies patterns of adoption disaggregated by head of household, as well as the common input requirements and challenges to implementation.

The main sources of information for farming practices, including coping and adaptation strategies, are traditional, indigenous knowledge, and the radio (GoK, 2014). Traditional knowledge is considered an important source of information in over 93% of the households. Information transmitted through radio programs is used by the great majority of households (62-76%) (GoK, 2014). Information may also be transmitted through less common sources such as

Off-farm services

television, faith-based organizations, and partners.

Off-farm services, such as early warning systems, insurance schemes, extension and training, credit, storage facilities, and market information are offered to farmers to increase their climate adaptive capacity. Such services are offered by a variety of actors, from government (such as the meteorological, veterinary, agriculture, fisheries and livestock departments) to organizations like KENAFF and FAO. Participatory scenario planning meetings are organized every season, bringing together key stakeholders under the guidance of professional experts who assist in collectively finding ways to interpret the information (both local and scientific knowledge) into a form that is locally relevant and useful. For instance, the Kenyan Meteorological Department (KMD) provides predictions for the expected rainfall; the Department of Agriculture (DA) has information about specific crops' water requirements or the ideal type of the seed for the season; the Department of Livestock (DL) gives marketing advice; the Department of Veterinary Services (DVS) offers advice on interventions for managing expected diseases and pests. Uniting all this expert information, a dissemination plan is compiled and transformed into a version that can be broadcast on the radio (Radio Kaya) in the local language and field barazas.

In addition, these departments might follow up their recommendations by providing the following services, amongst others: agricultural extension, weather and climate information, early warning systems, market information.

Early warning systems enable farmers to know when and where to plant, and when to move with the livestock, based on information on expected drought and floods occurrence which can affect crop and livestock production. The KMD is responsible for the County's early warning systems. Seasonal forecasts are generated by it integrating scientific and traditional knowledge. This information is then shared and distributed through pamphlets/brochures and broadcasted on local radio in local language. The majority of the population has access to radios, making it an effective means of transmitting information. The pamphlets and brochures present information in a simplified and straightforward manner, but their

Although this strategy of information sharing has been effective in many ways, there are many gaps that need to be addressed to improve farmer preparedness and response. First, the departments of the various ministries in the County lack proper coordination; there is duplication of roles in addressing climate challenges and building resilience to climate change. Second, many of the entities or institutions that collect environmental/climate data work independently and in isolation, often failing to share data or collaborate in a way that would support and enable the creation of better, more relevant information. Third, zoning data in the County and region is weak or missing. This data is important in delineation of rainfall patterns considering that rainfall in Kwale County is not uniform. This is consequently important for climate change analysis. For example, data in many parts of Kwale has not been updated sufficiently in the last 60 years; in Pachuma gate, the data available is from 42 years ago. There is a great need to build a database to support further research and modelling and to enable data-driven decision making in the future.







KENAFF is also involved in the training and sensitization of, and lobbying for, farmers on agricultural-related activities. KENAFF faces serious challenges in fulfilling its mandate and meeting the County's large demand

Information regarding markets and marketing channels is weak and not available throughout the County. The various cooperatives that focus on production and marketing for the different value chains often assume responsibility for providing market information to their members, as well as linking them to buyers. KENAFF assumes responsibility for providing market information. Likewise, cooperatives may offer farmers more bargaining power by aggregating or bulking their produce, establishing prices, and marketing. However, the incidence of very strong and fully operational cooperatives is relatively low. In terms of post-harvest storage, Kwale town is the official site for the County's off-farm storage in the NCPB warehouse. However, this warehouse is now used for storing fertilisers and food relief and not food surplus.







16 Kenya County Climate Risks Profiles Series

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

Maize

	Provision of seeds and other inputs 	On-Farm production 	Harvesting, storage and processing 	Product marketing 
 Floods	Seed spoilage; limited input access (transport challenges); less labour demand; high transport prices; reduced sales by input suppliers	Delayed land preparation; increase in weed and pest incidence; reduced labor requirement (weeding); plant lodging; low germination and stand counts;	Poor harvest (poor quality and low quantity); Under-utilization of storage structures; increased incidence of grain spoilage (rot/moisture/aflatoxin)	Less market activity (less engagement with cooperative societies); high prices (market scarcity)
Magnitude of impact	Severe	Severe-Major	Severe	Major
Farmers' current strategies to cope with the risks	Building of terraces; use of improved maize varieties (pH tolerating); use of inorganic/organic manure; access to traditional maize varieties	Intercropping (with rice); contour farming in slopes; water harvesting; delayed; staggered planting; crop rotations; enterprise diversification (horticulure); relay planting; use of farm drainage systems (trenches/ditches); weeding	Storage at community cereal banks; storage at household facilities (granaries)	Direct sale to maize millers; sale on local markets; transport to markets using human/animal/bikes
Other potential options to increase farmers' adaptive capacity	Research and development of moisture and disease-tolerant maize varieties; water-harvesting techniques; access to credit from finance institutions	Early land preparation; use of herbicides/insecticides (pest/disease control); access to crop insurance	Improved structures for harvesting, drying, packaging at community level; county support in migration to higher grounds	Building of more maize processing plants; formation of farmer associations
 Droughts	Low input demand (labour, fertilizers, seeds); access to traditional drought tolerant varieties	Staggered planting; low germination and stand counts; reduced labour requirements (land preparation/weeding); reduced application of inputs (fertilizers/chemicals); increased in field pests	Low grain yields (low quantity and poor quality); increased in storage pests; increase post harvest losses (damage by rodents)	High prices (scarcity and high demand); reduced market linkages and marketing opportunities
Magnitude of impact	Severe-Major	Severe	Severe	Severe
Farmers' current strategies to cope with the risks	Use of organic manure; access to drought tolerant and short duration maize varieties such as PH1, Duma 43, CL1, 2 and 3; utilization of chemicals (pesticides/herbicides); manual and mechanized labor	Use of conservation agriculture practices; agroforestry; crop rotations; cover crops; SLM practices (compositing/intercropping/relay cropping); access to agricultural information (extension services); enterprise diversification (to sorghum); employment	Grain sun drying; bagging; use of local storage resources (sacks/tins); storage in local granaries; shade storage (below trees) after harvests;	Grain hording to prevent market exploitation; grain sale to millers
Other potential options to increase farmers' adaptive capacity	Management of water catchment areas; research and development on drought tolerant varieties	Widespread promotion of agriculture information (at local levels); improved budgetary allocation to support extension services; access to advisories from early warning systems	Cereal banking in high potential maize areas (uplands); introduction of modern and small scale storage facilities (hand held driers)	Structured farmer groups and cooperatives; farmer linkages to giant marketers (KENAFF); regulated pricing through government grain pricing; linkage to external markets

Cowpea

	 Provision of seeds and other inputs	 On-farm production	 Harvesting storage and processing	 Product marketing
 Floods	Limited access to inputs (damaged infrastructure) and to traditional seed varieties	Reduced land preparation; low germination; poor stand counts; increased labour requirements; poor soil conditions; increased production costs (intensive pesticide use); non-use of soil fertility improving inputs during crop cycle	Low quantity and poor quality of harvested produce; reduction in stored produce; damaged storage structures	Low produce supply to markets; loss of market linkages and marketing activities; High prices (scarcity)
Magnitude of impact	Moderate	Moderate	Moderate	Moderate
Farmers' current strategies to cope with the risks	Use of improved planting seed; use of traditional varieties; use of household prepared manure	Reliance on forecasts for planting times; Intercropping (with rice); agroforestry; relay cropping staggered planting; building terraces (run-off control); contour farming; use of organic manures; use of chemicals for pest/disease control	Early harvesting and processing; use of indigenous storage (tins,cans) and strategies (ash preservation); storage at cereal banks; storage at household granaries	Value addition to locally consumable products; promotion of value addition and marketing by aid agencies
Other potential options to increase farmers' adaptive capacity	Access to moisture- and disease-tolerant varieties; dissemination of advisories from weather forecasts; drainage canals; promotion harvesting structures; access to credit from finance institutions	Promotion of conservation agriculture (zero tillage); Research on diversified intercropping species; Relay planting strategies; IPM technologies for pest and disease control	Widespread use of driers; storage silos; government-supported migration to uplands (avoiding floods); improved road networks	Market surveys; formation of farmer associations/cooperatives; capacity building for value addition; exploration of external markets
 Droughts	Low input demand; use of traditional drought-resistant varieties; water and fertilizer (manure/mineral) scarcity	Low seed germination; challenges in agronomic activities; reduced acreage; low efficiency of applied chemicals (pesticides); reduced productivity	Low quantity of harvested produce; Under-utilization of storage structures	High prices (scarcity); reduced market linkages and marketing opportunities
Magnitude of impact	Severe-Major	Moderate	Moderate	Major
Farmers' current strategies to cope with the risks	Access to drought and pH-tolerant seed varieties; use of local varieties; use of early maturing varieties; use of inorganic and organic fertilizer inputs; group labor	Minimum (zero) tillage; mulching and cover crops; agroforestry; crop rotations; access to agricultural information (extension services); Tree planting; Soil and water management practices(terracing, Zai pits); drip irrigation; Intercropping	Storage preservation practices (drying); training on post harvest handling and management; household consumption; preservation through boiling and refrigeration	Farmer-based negotiated market prices at farm gate and local markets; value addition for reduced perishability;
Other potential options to increase farmers' adaptive capacity	Continued research on drought and pH-tolerant varieties; use of subsoilers for deep ploughing	Use of conservation agriculture equipment (subsoilers/rippers); more water conservation (in catchments); promote widespread agroforestry practices; promote SLM practices (compositing)	Construction of community based silos; more exposure through training and capacity building (field demos/visits)	Community based collection centres; contract farming; linking farmers to markets (external); exposure to strategies for value addition; establish organized structures and farmer groups

Poultry (meat, local)



Floods

High labour requirements (damaged stores); limited access to veterinary services (poor transport/communication networks); high costs of inputs (increased demand);

Increased incidence of pest and diseases (fowl typhoid); destruction of farm structures; increased flock mortality (drowning/disease incidence); reduced labour (loss of jobs)

Reduced inspection (for egg/meat quality); limited access to farms/stores (damaged road networks) reduced slaughtering activities (increased flock mortality)

limited access to markets; high sale prices; reduced market and marketing opportunities (reduced market linkages)

Magnitude of impact

Severe-Moderate

Severe-Moderate

Severe-Moderate

Major-Moderate

Farmers' current strategies to cope with the risks

Construction of improved poultry housing; stocking of vet drugs and vaccines; diversification to other feed reserves (sorghum)

Run-off control management through terracing; treating and culling of sick flock; advisories from veterinary services; alternative feeding (sunflower and sorghum grains)

Use of alternative means of transport (bodaboda); poultry slaughter at household level; packaging with plastic bags for farm gate sales and storage

Selling to brokers at low exploited prices; low marketing and market opportunities;

Other potential options to increase farmers' adaptive capacity

Construction of permanent improved housing; increased storage of vaccines/drugs; increased contact with extension and veterinary services

Water harvesting through pans/reservoirs; promotion and enforcement of vaccination and disease control; community based drainage structures (tunnels/dams)

Improved transport networks; Building of slaughterhouses; Specialized storage and transport equipment (refrigerators/coolerboxes)

Contract farming; Organized cooperatives (facilitate marketing/pricing); linking farmers to direct markets; source for external markets



Droughts

Increased labor requirements; water scarcity; low demand for inputs (loss of income to access drugs/chemicals)

Increased disease incidence (new castle); increased production costs (chemicals/drugs); increased flock mortality

Reduced production (low quality and weight of carcasse); increased inspection costs (high demand)

Low trade volumes; high market prices; loss of market opportunities (reduced linkages)

Magnitude of impact

Severe-Major

Major

Major

Major

Farmers' current strategies to cope with the risks

Water harvesting (tanks) to reduce costs; feeds diversification (sorghum, sunflower, lunga lunga); building of appropriate poultry housing units

Pest and disease management and control destocking of excess/weak/diseased flock; flock free range foraging

Slaughtering at household level; transport of poultry products (public means); use of manual labor for eggs collection; divert products to household consumption

Individual farmer market negotiations; public transport for products movements to markets

Other potential options to increase farmers' adaptive capacity

Scaled water-harvesting techniques (pan/reservoirs); promotion of widespread feed diversification (sunflower)

Construction of improved modernized poultry housing; programmed and planned mass vaccinations by government; planned seasonal production cycles

Slaughter house establishment at county levels; formation of farmers groups and cooperatives; improved poultry products storage to reduce perishability)

Contract farming; organized cooperatives (facilitate marketing/pricing); linking farmers to direct markets



Goat (meat)



On-Farm
production



Harvesting
and storage

Product
marketing



Floods

Inaccessibility to drugs and vaccines; increased mortality of breeding goats; low pasture availability; destruction of farm structures (goat shed); increased labour requirements

Destruction of pastures/feeds; increased disease incidence; poor growth rates; increased animal mortality; increased production costs (high cost of feeds, supplements, drugs); reduced breeding rates; high demand for veterinary services

Reduced processing activity (slaughterhouses); Low quality and poor weight of goat carcass; increased perishability (meat contamination)

Inaccessibility to markets (reduced transport services); loss of producer-buyer linkages; loss of marketing opportunities; reduced market supply of meat and hides

Magnitude of
impact

Moderate

Moderate

Major-Moderate

Major-Moderate

Farmers' current
strategies to cope
with the risks

Building modernized goat houses; use of vaccines; provision of family labor; use of locally available breeding bucks

Building run-off (pasture fields); restocking; provision of feed/fodder/feed supplements; access to extension and veterinary services (vaccination)

Selling of meat/milk products at farm gate; use of alternative transport (from fields to stores/markets); slaughtering at household

Selling to individual buyers; exchange of goat for non-food items (barter trade); mass sale to animal merchants/brokers

Other potential
options to
increase farmers'
adaptive capacity

Destocking (poor breeding animals); access to disease resistant breeding bucks; Access to credit facilities (purchase drugs/breeding stock)

Stall feed rearing; SLM practices (water harvesting, terracing, tree planting); culling and disposal of diseased goats; fodder conservation; increased extension support (budgetary allocation); enterprise diversification (crop farming); access to advisories from early warning systems; access to animal based insurance

Support for animal offtake programs; promote storage facilities (for meat preservation)

Market surveys; Organized cooperatives and groups; linkage of producers to external markets; county support for marketing opportunities



Droughts

Shortage of feeds and water; Unaffordability of drugs (pesticides); lack of access of improved breeds; increased labour requirements (housing and feed purchase)

Increased goat mortality (malnutrition); increased incidence of pest and diseases; low growth rates; poor feeding regimes; lack of feed supplements

Reduced number of goats available for slaughter; increased perishability (farm slaughtered and slaughterhouse carcasses); reduced carcass weight, poor quality of meat and milk products

loss of producer-buyer linkages; reduced market activities; reduced market supply of meat and hides support for marketing opportunities

Magnitude of
impact

Moderate

Moderate

Major

Major

Farmers' current
strategies to cope
with the risks

Access to improved goat breed (Gala goats); Reliance on extension advisory services; provision of feed supplements; water harvesting for herd management

Farmer vaccination; construction of community dipping points; enterprise diversification; extension advisories on animal husbandry practices

Community based slaughter houses; Sale at farm gate to brokers/neighbors; divert to household use (festivities/household consumption)

Association with marketing groups for group marketing; sale to local and external brokers; sale to local slaughterhouses

Other potential
options to
increase farmers'
adaptive capacity

Artificial insemination for improved breeds; improved housing units; support for provision of feed supplements; credit access to purchase breeding stock

Enforced quarantine and vaccination during disease outbreaks; support to subsidize veterinary services; increased training on fodder conservation

Improved road networks; construction of storage (cold rooms)

Formation of goat meat value chain cooperatives; promote/scaleout construction of community based cold rooms; linking farmers to markets; access to marketing information

Policies and Programmes

Policies are key considerations for agriculture decision-making, since they affect actions and outcomes related to the resource use. The policies that the County institutions are adopting and implementing are national statutes and international conventions. Some of the policies in the County include, but are not limited to:

- The Environmental Management and Coordination Act (EMCA) of 1999, amended in 2015, advises each ministry to consider climate change mitigation measures in the budget. It stipulates the need for environmental department or designated officer in each County.
- The Forest Act of 2005 contains many provisions to correct previous shortcomings, including a strong emphasis on partnerships, engagement of local communities, and promotion of private investment. In the new Act, forest community associations, such as Shimba Hills Community Forest Association (SHICOFA), are recognized as partners in forest management. Forests in Kwale are an important source of livelihood, environmental services, cultural importance (Kaya forests) and economic growth. The Act
- The Kenya Veterinary Policy provides an enabling environment for safeguarding animal life, health and welfare, as well as animal propagation and production for food security and economic development. The Kwale County aims to implement this policy to boost contribution of the livestock to food security and to ensure that animal products consumed or marketed meet the highest safety and nutritional standards. Through the LD, the County is engaged in inspecting slaughtered livestock to ensure quality standards, overseeing that diseases, disease-causing and disease-carrying agents are not transmitted between animals and humans.

In addition to these general policies, several programs aimed at addressing topics related to climate vulnerability have been put in place through the

collaboration of local, international, public and private actors. Local programs operating in the Kinango sub-County include the Kinango Integrated Food Security and Livelihood Project (KIFSLP) and the Protracted Relief and Recovery Operation (PRRO). The Vigurungani community is the main beneficiary of the KIFSLP project funded by the Safaricom M-Pesa Foundation and the County Government of Kwale. The project involves farming on a 107 acre plot (43 ha) using drip irrigation technology. The farm is subdivided into quarter-acre parcels that are allocated to vulnerable households in the area. The water used for the irrigation project is sourced from the Nyalani Dam, a 700 million litre reservoir rehabilitated by the Kenya Red Cross Society (KRCS). The KRCS is also involved in the PRRO project, which provides training and capacity building in the latest farming technologies to enhance food security and improve the livelihood conditions of the beneficiaries.

The National Drought Management Authority (NDMA) has partnered with the Kwale County Government and the community in Chengoni, Kinango sub-County to improve preparedness for drought through an Integrated Food security Project. The project was launched in April 2016 and aims to address perennial water shortages and boost food security within the broader Samburu-Chengoni Ward, where severe drought necessitates water trucking during dry spells. The project is implemented with financial support of the European Union- funded Arid and Semi-Arid Lands Drought Contingency Fund (ASAL-DCF) project, Kilifi County Government and Chengoni community. The project aims to excavate a 20,000 m3 water pan that is expected to benefit about 15,315 people in the villages around Chengoni, Silaloni, and Maji ya Chumvi, and thousands of livestock during dry months. The County Government is committed to funding the installation of drip irrigation infrastructure on an initial two-acre test plot and to train the community on irrigated agriculture and agronomic practices. The project also includes the planting of 3,000 tree seedlings and training on environmental conservation. It is expected that the quantity and duration of available water for human and animal consumption will increase, improving hygiene and sanitation, diversifying food and livelihood resources, improving livestock production and enhancing environmental conservation.

In the private sector, the Base Titanium Company has introduced a number of programs aimed at guiding the environmental management of operations associated with the Kwale Mine and the Likoni Ship Loading Facility, the associated minerals transportation, and water resource use. These programs target:

- Biodiversity conservation of forest patches that form part of the 'Coastal Forests of Eastern Africa Biodiversity Hotspot' located close to the Kwale Mine. This zone comprises small fragmented forest remnants rich in biodiversity, based on information collected in collaboration with the National Museums of Kenya (NMK), the Kenya Wildlife Services (KWS) and the Kenya Forest Services (KFS).
- Establishment of a biodiversity corridor to bridge several remnant patches of indigenous forest within the mining lease to the Gongoni Forest. Over 10,000 trees propagated in the nursery, including more than 1,500 of species, have been planted in the designated corridor;
- Restoration of ephemeral wetland through planting of indigenous sedges and other aquatic vegetation. The wetland now provides an ideal habitat for both floral and faunal species of significant conservation importance. Recent amphibian and reptile monitoring found that colonies of the endangered Shimba Hills Reed Frog (*Hyperolius rubrovermiculatus*) and the Forest Leaf-folding Frog (*Afrixalus sylvaticus*) have quickly re-established themselves;
- Indigenous trees nursery under the Community Programmes initiative.
- Waste recycling through the employment of trained carpenters drawn from the local communities who are engaged in turning the mountain of packing timber into well-crafted pieces that are used on the mine or in the surrounding communities.
- Other project/programs related to agriculture, natural resources for agriculture and climate change are shown in Annex 6.

Governance and institutional resources

Institutions are key considerations for agriculture decision-making since they shape actions and outcomes related to resource use. In agriculture, institutions' role can be related to the design of policies and investment frameworks, knowledge development and sharing, technological development or the delivery of financial and non-financial incentives for agricultural investments (FAO, 2010). In Kwale, there are several institutions actively involved in climate-related issues, ranging from government and non-government to the private sector. Some of the key institutions are discussed below.

KALRO is a government organization operating at the County level and responsible for transmitting knowledge and technological development to relevant stakeholders, primarily farmers and government departments (agriculture, livestock, etc.). KALRO works with various partners such as the MESPT, MoALF and ASDSP. With its partners, the institution trains farmers and departmental ministry staff on crops and livestock research outputs and the adoption and up-scaling of conservation agriculture. In Kwale, KALRO focuses its research on medium altitude crop varieties of maize, bean, cassava and fruit trees. KALRO also conducts on-farm trials, demonstrations, farmers 'field days', and on-farm interventions that promote passion fruit production. However, their capacity to undertake their roles is curtailed by the understaffing and insufficient funding to carry out the planned interventions.

The KMD generates seasonal forecasts through data analysis and workshops held with key stakeholders, including indigenous weather forecasters and relevant departments. Through Participatory Scenario Planning (PSP) the experts develop a dissemination plan that may include components such as information sharing through the ASDSP environmental resilient officers, NDMA-coordinated barazas and radio. Many of the entities or institutions that collect environmental/climate data work independently and in isolation, often failing to share data or to collaborate in a way that would support and enable the creation of better, more relevant information. The lack of adequate equipment such as rain gauges in the County, understaffing and insufficient funding challenges KMD's capacity to implement activities.

The KFS is a semi-autonomous government parastatal, implementing activities related to climate change, forestry, farm and dry land forestry, forest conservation, and environment. It works with the Kenya Forestry Research Institute (KEFRI) and other key stakeholders to finance and monitor programmes in biodiversity conservation. Even though the staff is well-trained and has the capacity to carry out planned initiatives, KFS' tree planting initiatives face a lot of community resistance, as it is not self-driven, challenging efforts to increase the forest cover in the County.

The NDMA is a public body responsible for the overall coordination of all matters related to drought management. NDMA spearheads the contingency planning process of the climate risk management in the County, where it facilitates the steering committee's interaction with key stakeholders that discuss climate risk management and adaptation options and plan specific interventions. NDMA gives early warning to the farmers, mobilizes barazas where farmers meet and share expectations and remedial options publishes monthly bulletins for the community (and posts them on their website), and monitors interventions through field visits.

Similarly, the National Environmental Management Authority (NEMA) works closely with key stakeholders to raise awareness through barazas and meetings, educating the population on the importance of tree planting through their County environmental action plans. However, the major gaps in administering the NEMA interventions include inadequate funds and limited human capacity to carry out interventions.

Plan International is an international NGO operating in Kwale as the Kenya Kwale Program Unit (PIKKPU), working towards building the capacity of community members in community-based disaster risk management. Along with strategic partners (KRCS; Ministries of Education, Health, Agriculture; Office of the President-Peace and Security), their training courses cover relevant topics such as youth capacity building, improved agribusiness practices, transitioning from rain-fed to drip irrigation, kitchen gardening, and agricultural extension services. PIKKPU also works with community members to educate children about climate change and disaster risk reduction. Community trainers work in 15 community-based organizations (CBOs), holding frequent planning, monitoring, and reflection meetings with different local actors. However,

PIKKPU's interventions are limited to a small number of areas in the County.

KRCS is a humanitarian organisation established under Cap 256 of the Laws of Kenya as the National Red Cross Society in Kenya. The Society is auxiliary to public authorities in the humanitarian field with an objective to prevent and alleviate human suffering throughout the territory of Kenya. In Kwale, it operates across the County.

KENAFF is a non-political, non-profit, member-based umbrella organization of all farmers in Kenya, representing the interests of approximately two million families through focused lobbying and advocacy, and targeted capacity building. In Kwale, KENAFF supports stakeholders' cohesiveness in distributing and adopting agricultural innovations for improved livelihoods. KENAFF's mandate includes: training farmers and community members on soil management, tree planting, and avoiding deforestation; publishing quarterly magazines in agriculture and forestry-related issues; and monitoring impact through farm visits and follow-up. In Kwale, KENAFF is not likely to administer all these due to lack of adequate funding and insufficient human capacity.

With cooperatives, farmers can pool production from their individual farms in order to meet market demand, reduce risk, access better financing, acquire and share farm machinery and other assets, negotiate better prices, and jointly market their produce. Cooperatives in the County vary in size and influence, from the large KLPC (3,740 members, mostly women and youth) to smaller groups such as the Women's Farmers Group Tumaini Godzo (8 members) that supply the Kwale Hospital with fresh vegetables. Farmers' cooperatives in Dzombo, Vanga and Shimba Hills are engaged in post-harvest and marketing activities such as storing maize surplus. However, the incidence of very strong and fully operational cooperatives is relatively low as the cooperatives are not well organized and structured to carry out their mandate.

Private sector actors such as Base Titanium have introduced a number of programs aimed at guiding the environmental management of operations associated with the Kwale Mine and through their corporate Social Responsibility.

Agro-veterinary companies engage in the distribution and sale of agro-chemicals and other farm inputs and often train farmers on the safe usage of pesticides, fertilisers and other input supplies.

Financial institutions such as banks (Equity Bank, Cooperative Bank, Kenya Commercial Bank, National Banks) provide loans to farmers to purchase the inputs needed for the production and storage of produce. The extent to which such formal financial institutions are accessible and used by farmers is yet to be clear.

Coordination among these previously-mentioned organizations exists to some extent, mostly in the consultation of local stakeholders on topics related to climate change and farming practice training. However, a clear coordination structure does not exist, leading to the duplication of roles, impeding a smooth and efficient collaboration of institutions. There is also a lack of feasible operational planning and little or no deliberate action towards planning for climate change: in most cases, climatic adaptation planning is reactive rather than proactive. Farmers' cooperative societies and associations are often weak or disorganized and receive little external support, leaving farmers susceptible to exploitation by middlemen, especially during harvest.

Synthesis and Outlook

Climate hazards such as droughts and floods have detrimental impacts on livelihood systems in Kwale County. Such impacts include but are not limited to deaths of livestock, decreases in productivity, and destruction of farm produce and structures. In response to these, farmers have come up with adaptation options to tackle these impacts, mostly by

using indigenous, traditional knowledge (such as the use of ash and tins for cowpea preservation) into their daily agricultural activities. As climate impacts become more complex and affect the entire value chain (production, harvest, processing, marketing), there is the need to integrate traditional knowledge with scientific information in order to create better forecast and solutions and prepare farmers to uncertainty.

The majority of farmers in Kwale County rely extensively on rain-fed agriculture, which is highly unreliable, especially in the semi-arid areas of Kinango sub-County. Opportunities to mitigate these risks include water/harvesting for crop and livestock production, and development of irrigation schemes so as to increase yields during the dry seasons. To complement these efforts and to increase farmers' capacity to adopt integrated value chain-oriented solutions to climate risks, further investments are required, targeting input delivery (including availability and affordability of inputs such as seeds, fertilisers, since low input use is directly linked with low productivity), access to formal markets (upgrade of the road and market infrastructure), as well as credits and subsidies to finance risk management strategies.

There are various institutions and policies that work towards improving farmers' livelihoods and resilience to climate change and variability. Even where efforts to reduce duplication of efforts exist, by setting up stakeholder-driven events and interventions, the knowledge base of experts is mostly limited to production and input supply. The services should approach adaptation from a marketing and supply chain perspective, considering that farmers' ability to adapt to climate threats in the short and long term will often require resource investment that seeks returns to incomes and improved livelihood just as much as environmental sustainability.

For further information and access to the annexes, visit <https://cgspace.cgiar.org/handle/10568/80452>

Annex 1: On-farm incomes in Kwale

Annex 2: Crop and livestock production in Kwale

Annex 3: Climate analysis

Annex 4: Environmental changes noticed by proportion of household heads

Annex 5: On-farm adaptation options in Kwale

Annex 5: Policies and Programs

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