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Implications of Drought and Floods on Household Food and Nutrition Security in the Arid and Semi-Arid Lands in Kenya

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Abstract

The cycles of drought and floods in Kenya have become shorter and are now 2- 3 years, which has resulted in unprecedented challenges regarding household food and nutrition security, especially in the arid and semi-arid areas. Data for this study were collected from both secondary (national statistics) and primary sources, where interviews were carried out with 1,370 randomly selected households based on NASSEP V (KNBS) using a structured questionnaire. The survey covered 27 counties, specifically 23 arid and semi-arid counties plus 4 counties that were prone to floods, and was conducted between February and March 2018. The analytical techniques used included descriptive statistics of respondents' characteristics and linear regression analysis to identify factors influencing their household food security. The results show that the arid and semi-arid lands of Kenya are vulnerable to food insecurity especially during incidence of drought and floods. The situation in the country is not getting better, which is evident by the increasing number of undernourished citizens. There is need to diversify the food groups that Kenyans consume. Three food groups constitute half of the household food basket: milk, maize, wheat, and their respective products. Households in the sampled counties are net food buyers due to their reliance on rainfed agriculture - mainly livestock production systems. Regarding factors influencing household food and nutrition security, the household head's age, gender, and education level contributed positively to the status of the household. While the presence of assets, access to credit and remittance also contribute positively to household food and nutrition security. The study recommends that production systems need to be transformed by introducing technology such as irrigation to reduce dependence on rainfall, and at the same time introduce insurance mechanisms against the impact of weather-related shocks. Finally, there is need to strengthen markets to minimize supply failures, thus reducing chronic poverty, by introducing a range of pre-emptive measures, including building transport infrastructure to integrate markets and build asset buffers at the household level to reduce their vulnerability.

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1.   Introduction

1.1   Background

The impact of droughts and floods usually has wide-reaching consequences such as reduced production, deterioration of health, loss of life, and destruction of assets and infrastructure, and environmental degradation. Many times, these impacts are grossly underestimated (Shiferaw et al., 2014; Bekele et al., 2014). The country is prone to frequent weather-related episodes of droughts and floods especially in the arid and semi-arid lands (ASALs). Since independence, there have been several drought episodes, namely: 1983/84, 1991/92, 1995/96, 1999/2000, 2004, 2005/2006, 2009, 2011 and 2016/2017. The 1999-2000 drought was one of the most severe; it affected 4.4 million people, killed an estimated 60-70 per cent of livestock in the arid and semi-arid areas of the country, and caused crop failure in most arable areas in the country (Rift Valley, Coast, Eastern and Central regions). In 2011, a similar drought happened, which affected about 3.75 million Kenyans, 598,218 refugees, and had a combined economic impact of approximately 0.7-1.0 per cent of GDP (World Bank, 2011).[1] According to the Kenya Red Cross, the drought episode in 2017 affected 23 out of the 47 counties and an estimated 2.7 million people were given food aid. The drought situation resulted in sporadic conflicts for grazing areas especially in Laikipia County where armed cattle herders invaded private ranches, wildlife reserves and private farms in search of pasture.

Usually, after a prolonged dry spell, episodes of flooding follow; for instance, after the 1995/96 drought, *El Nino*-related floods in 1997/98 struck with widespread devastating effect on infrastructure and an epidemic of Rift Valley Fever (RVF) that affected huge populations of livestock (AFDB, 2008). The Kenya Red Cross estimated that the 1997/98 *El Nino* floods resulted in 300 deaths and damages worth US$ 670 million and US$ 236 million to infrastructure and the agricultural sectors, respectively[2]. During the 2003 floods, part of the earth embankments (dykes) constructed in the 1970s to control water flows were destroyed and 25,000 people were displaced (Onywere et al., 2011). The 2002 floods caused a major landslide in Maua where 11 people died and at least 10 people among them three children were killed after landslides hit Elgeyo Marakwet County following heavy rains in 2012[3]. In 2017, Kenya experienced heavy floods in Kwale, Mombasa, Taita Taveta and Garissa counties. The Kenya Red Cross estimated that in the months of May and June 2012 alone, 26 people lost their lives, 24,803 people were displaced in 13 counties across the country and there was a huge livestock loss in some areas[4] due to floods.

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1   World Bank boosts assistance to battle drought, increase food security in Horn of Africa. September 24, 2011 (https://www.worldbank.org/en/news/press-release/2011/09/24/world-bank-boosts-assistance-battle-drought-increase-food-security-horn-africa)

2   https://www.devex.com/news/how-kenyan-communities-embrace-flood-resilience-strategies.

3   https://www.standardmedia.co.ke/article/2000073887/10-killed-in-marakwet-landslides.

4   http://reliefweb.int/report/kenya/heavy-rainfall-and-flash-floods-cause-havoc-across-kenya.

1.2   Institutional and Policy framework

Significant efforts have been put in place by both National and County Governments with regard to legislation and relevant institutions to deal with disasters and emergencies. The National Drought Management Authority (NDMA) coordinates all activities related to drought management while the National Disaster Operations Centre (NDOC) coordinates national efforts in reducing the impact of rains and widespread infrastructural and environmental destructions across the country. Despite the existing policy and legislative measures, the country's response to drought and floods has been more reactive than pro-active.

The Second Medium-Term Plan (2013-17) and the third Medium-Term Plan (2018-2023) recognize that ending emergencies related to natural disasters of drought and floods is a key enabler to economic growth. There are several flagship projects that target resilience building during droughts and floods, and they include the Hunger Safety Net Programme (HSNP), irrigation projects, and agriculture insurance where there are two projects (one in the crops sector) targeting 28 counties, and the other in the livestock sector targeting 14 ASAL counties, just to mention a few. Further, the Government has committed to ending drought emergencies in Kenya by the year 2022. The Ending Drought Emergencies (EDE) strategy builds on the National Policy for the Sustainable Development of Northern Kenya and other Arid Lands, using two approaches to reduce the impact of drought. The first approach is to strengthen the basic foundations for growth and development, such as security, infrastructure and human capital while the second is to strengthen the institutional and financing framework for drought risk management (DRM). The Ending Drought Emergencies (EDE) strategy is also in line with the African Union Agenda 2063 priority on climate resilience and natural disasters' preparedness and prevention, and on renewable energy.

1.3   Household Food and Nutrition Security

The Food and Agriculture Organization (FAO) of the United Nations defines food security as a situation "that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). Household food security is investigated often in a narrower framework (Azeem et al., 2016) that focuses on nutrition security, food consumption and expenditure pattern (Li and Yu, 2010; Carletto et al., 2013; Alexandri et al., 2015). However, usually food and nutrition security is linked with other basic factors that are necessary, such as production, water, access to land, assets, health status, malnutrition and a range of other factors that are vulnerable to weather-induced disaster, such as drought

and floods. Studying this broad concept of food and nutrition security with a lens of climate change can provide insights into the implications of weather-induced disasters on households in the affected areas.

Droughts and floods undermine farm yields, reduce household food availability and household agricultural income. When poor harvests are experienced, then livelihoods at both household and national level are threatened to varying degrees according to the extent that the family or nation depends on agriculture for its food and income. Economies and households that are more diversified are less vulnerable to these direct impacts of droughts and floods, provided that their alternative income sources are neither correlated with rainfall, nor directly or indirectly dependent on agriculture.

1.4   Problem Statement

Twenty-four (24) out of forty-seven (47) counties in Kenya are considered arid and semi-arid and constitute an estimated 36 per cent of the Kenyan population. These counties occupy 89 per cent of the country's land surface area and herd 70 per cent of the national livestock. Additionally, 90 per cent of the wild game that supports the country's tourism industry is found is these counties. Given the nature of the climatic characteristics in the arid counties, and in some of the semi-arid counties, it is estimated that 50 per cent of the red meat consumed in the country is produced in these regions.

The frequency, intensity and duration of droughts and floods has increased due to climate change, therefore increasing the need for robust drought and floods mitigation and adaptation strategies. Drought episodes occurred in seven years out of every ten years in the ASALs in Kenya, while floods occur every four and half years, implying that at any given time, there is usually either a drought or flood disaster. Recurrent droughts and floods have become more severe and frequent and are progressively eroding livelihoods in pastoral, agro-pastoral and agricultural zones. According to the Kenya National Bureau of Statistics (2018), at least one in three Kenyans (14.5 million) suffer from food insecurity and poor nutrition, with counties in ASALs being hard hit. Therefore, Kenya has a long way to achieving zero hunger by 2022 in spite of several initiatives by the government to increase and improve the food and nutrition status of her citizens.

1.5   Research Objectives

Given this background, the overall objective of this study is to assess the impact of droughts and floods on household food and nutrition security.

Specifically, the objectives are to:

1. Identify the perception of households on the impact of drought and floods.

2. Establish the status of household food security.

3. Examine the factors that influence household food security.

2.   Literature Review

2.1   Policy and Institutional Framework

Drought risk management

The National Policy for the Sustainable Development of Northern Kenya and other Arid Lands (the ASAL Policy) was passed by the Cabinet in October 2012 and its Sessional Paper approved by Parliament in December 2012. It reinforces constitutional provisions on inequality and marginalization, emphasizes the region's contribution to national development, and commits the Government to adopt flexible approaches to service delivery and governance in pastoralist areas. It also establishes an institutional framework for multi-sectoral and multi-stakeholder ASAL development (Figure 2.1).

This policy provides for the institutional arrangements for the management of drought risks in Kenya, principally the National Drought Management Authority and the National Drought and Disaster Contingency Fund.

Figure 1.1: Institutional framework for ASAL development
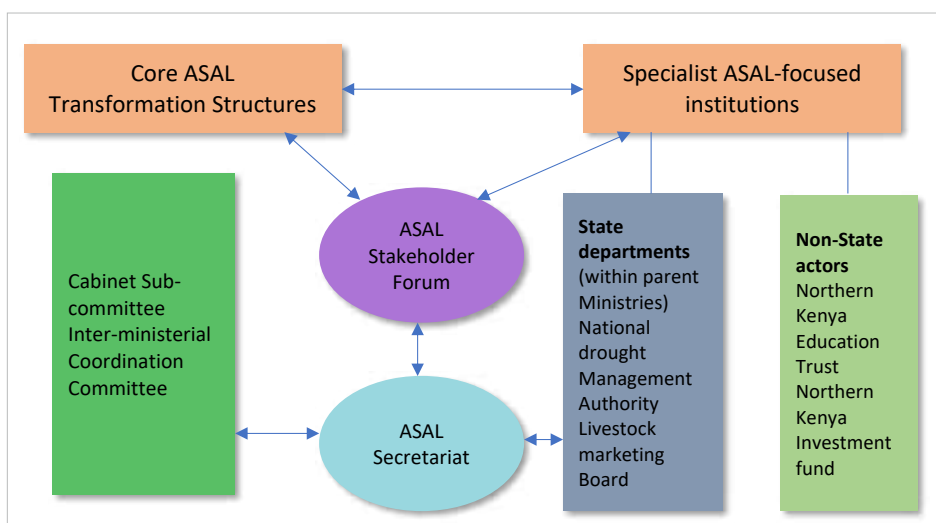
Source: Ministry of Devolution and Planning (2017)

The ASAL institutional framework has four components:

1.   Cabinet oversight, through a Cabinet Sub-Committee and Inter-Ministerial Committee.

2.   Specialist institutions in a range of areas relevant to the ASALs, including drought (the National Drought Management Authority), education (the

      National Council on Nomadic Education in Kenya), and livestock (the Livestock Marketing Board).

3. Stakeholder engagement through the ASAL Stakeholder Forum, whose inaugural meeting was held in July 2012.

4. An ASAL Secretariat to service these structures and ensure policy coherence and coordination of ASAL development.

Drought management is a multi-agency and cross-cutting issue that involves many stakeholders depending on the frequency and the severity at national, county and community levels. The structure shown in Figure 2.1 provides a framework to facilitate and coordinate efforts in the ASALs, which usually bear the large brunt when drought occurs. Several flagship projects have been proposed in the Ending Drought Emergencies (EDE) strategy, a few of which are highlighted below.

Flagship projects to transform livestock production in ASALs

- The objective is to complete and fully operationalize abattoirs in Isiolo, Wajir and Lokichoggio, with a clear management model in place for each, in partnership with the private sector; produce/preserve 3,000 hectares of fodder in Turkana, Marsabit and Garissa counties; and increase the production and marketing of drought-tolerant crops in semi-arid areas by promoting dryland crop production technologies such as conservation tillage, appropriate drought-tolerant and early maturing seeds, and fertility management.

- Establish and operationalize the Northern Kenya Investment Fund (NKIF); expand entrepreneurship and employment opportunities in the region and create jobs as a priority for the growing urban population in the ASALs, whose well-being is significantly affected by factors such as food and fuel prices. The Fund is in the final stages of design and will be a private sector facility, supported by the ASAL Secretariat, which facilitates investment with both social and economic returns; establish a national livestock insurance scheme; and introduce an acceptable livestock evaluation system that would make it easier for pastoralists to access credit; operationalize the New Livestock Marketing Board, including development of a strategic plan to give direction to livestock marketing in Kenya and strengthen the legal and policy framework. The strategic plan will emphasize the role of the private sector and be informed by lessons learned in this area by both government and non-governmental agencies.

- Reclaim and rehabilitate livestock holding grounds in Isiolo, Samburu and Kajiado and ensure that these are appropriately developed and managed in

collaboration with the private sector; develop and expand livestock markets by constructing/expanding those in 12 locations; establish and/or rehabilitate meat processing factories in Wajir, Isiolo and Turkana; strengthen disease control and surveillance systems along stock routes and trade markets; improve range rehabilitation, fodder production and conservation; take measures to support adaptation to climate change, including up-scaling of livestock insurance, operationalization of the Livestock Enterprise Fund, and subsidized livestock inputs.

Flood risk management

Flood risk management in the country is not well coordinated; there is no institution mandated with the management of flood risk as is the case of drought management. The stakeholders in the management of floods include Water Resources Authority (WRA), Kenya Meteorological Department (KMD), National Disaster Operations Centre (NDOC), National Disaster Management Unit (NDMU), Kenya Electricity Generating Company (KenGen), Kenya Red Cross Society (KRCS). Legally, flood risk management is accounted for in the National Disaster Risk Management Bill, and the Disaster Risk Financing Strategy, both of which underscore the importance of better disaster prevention, preparedness, mitigation, response and recovery, including in relation to floods (Government of Kenya, 2018; National Treasury and Planning, 2018; Weingärtner et al., 2019).

2.2   Food Security as a Basic Human Right

Food security refers to a situation when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2002). The right to food is a cross-cutting issue. It presents a perfect example of the indivisibility, interdependence and interconnectedness of economic and social rights. There are four elements of the right to food, namely: availability, accessibility, stability of supply, and utilization. The right to food is a human right recognized under international law, which protects and promotes the right of all human beings to feed themselves adequately either through production or purchase of food. The realization of the right to food is linked to the right to life, right to health, right to livelihood, right to work, right to private property, right to water and right to education (Office of the High Commissioner for Human Rights, 2010).

In the Kenyan constitution, freedom from hunger is central in the Bill of Rights discussed in Chapter Four - Cap 4 (Government of Kenya, 2010). The Bill of Rights is an integral part of Kenya's democratic state and is the framework for

social, economic and cultural policies, whose purpose is to recognize and protect human rights and fundamental freedoms to preserve the dignity of individuals and communities; and to promote social justice and realization of the potential of all human beings. Article 43-C states that every Kenya has a right to be free from hunger, and to have adequate food of acceptable quality. Given that under Article 21, the State and every State organ has the duty to observe, respect, protect, promote and fulfil the Bill of Rights, implies that the government has to ensure that food insecurity is addressed at all times. The Constitution urges the State to enact and implement legislation so that it fulfils its international obligations in respect of human rights and fundamental freedoms (Article 21(4)). According to Article 21(1) of the Constitution: "The State shall take legislative, policy and other measures, including the setting of standards, to achieve the progressive realization of the rights under Article 43."

2.3   Emerging Threats to Food Security

Food insecurity has far reaching effects on the population. This can be examined across regions (rural-urban), gender, and demographic divides. Kenya's population has been changing over time in all respects, in terms of size, structure, and distribution. The 2009 Kenya Population and Housing Census enumerated a total of 38,610,097 people, representing an increase of about 35 per cent from the 1999 census. Kenya's population has been changing over time in all respects in terms of size, structure, and distribution (population dynamics). The population structure is of great interest because people's social and economic behaviour and needs vary at different ages, with varied impacts on socio-economic development. The age structure of the population should be the key factor informing how the country should position itself to define strategies to address the needs of different social groups.

2.3.1   Rural urban disparities

In Kenya, a large segment of the population suffers from chronic food shortages. It is estimated that 40 per cent of the population lives on less than US$ 2 a day. With increasing population size, demand for food has also been increasing steadily. As of 2010, 22 per cent of Kenya's population was living in urban areas. Close to 50 per cent of rural and urban poor households are net buyers of food, who spend 50-70 per cent of their budget on food. More importantly, one third of Kenya's 40 million people live in urban areas, out of which 40 per cent reside in slums, with low and irregular sources of income. Up to 45 per cent of slum dwellers have no access to safe drinking water, while sanitation coverage is less than 40 per cent.

In addition, close to 50 per cent of overall household income is allocated to food purchases, a clear indication of heightened vulnerability due to volatility in food prices, amidst unstable labour opportunities. Therefore, rising food and nutritional insecurity in Kenya is precipitated by rapid and rising urbanization. The current population in urban centres is eight times what it was at independence. Kenya has a high dependence ratio, such that dependants far exceed the wage earners. A large proportion of urban dwellers are unable to meet food needs on a sustained basis over an extended period, adopting instead detrimental coping strategies such as increased child labour, skipping meals and foregoing non-food expenditure to bridge significant deficits. The food security status for poor households in urban areas is likely to worsen further and could deepen markedly as food and fuel prices increase significantly in coming years (USAID, 2011).

When food shortages occur, it is the poor who are most affected. With decreases in food supply, those already forced to live on the smallest of rations are confronted with a simultaneous increase in the price of food. Poverty, hunger and high fertility rates will continue to be a major hurdle to economic prosperity and, therefore, food security.

2.3.2   Gender disparities

The gender of the household head plays an important role in household food security, and this usually has an influence on income and food expenditure (Kassie et al., 2014). The structure of Kenya's population is such that women constitute 51.2 per cent while men account for 48.8 per cent. Moreover, women constitute 75 per cent of Kenya's agricultural labour force and, therefore, play a key role in facilitating food security (FAO, 2011). Cultural and traditional factors, however, undermine the ability of women to produce agricultural food products due to land ownership and access challenges.

In Kenya, women are primarily responsible for feeding their families and take on the lion share of household and agricultural work. More than 30 per cent of all Kenyan households are headed by women, and the majority of these households face chronic food insecurity (USAID, 2010). Employment and income generating opportunities for women are meagre, particularly given time constraints from their heavy household demands. At times of price crisis, women and children are most vulnerable, especially in extreme climate-related disasters. Women are up to 14 times more likely to die as a result of a disaster than men due to socially constructed gender roles that affect access to resources. In Sub-Saharan Africa, for instance, women are often acknowledged as owners of crops, but not of land. The role of women in ensuring household food security and their dependence on

natural resources to do this reinforces their vulnerability to disasters (Neumayer and Pluemper, 2007; ISDR et al., 2009).

In the pastoralist communities, women have access to productive resources such as land, water, and livestock. However, the control over these resources and their benefits is entrusted to the men. As such, women own and control the animal products (milk, ghee, hides and skins) but not the animal itself, even if it was given to them in form of a gift or inheritance (Ministry of Devolution and Planning, 2017).

2.4   Food Crises as Entitlement Failures

Sen (1984: 497) has defined entitlements as "the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces". It should be noted immediately that this is a descriptive rather than a normative concept; entitlements derive from legal rights rather than morality or human rights. The law stands between food availability and food entitlement.

Weather shocks (droughts and floods) trigger not only harvest failures but a sequence of knock-on shocks to local economies and societies and, second, there are several points in this sequence where effective intervention could mitigate the shock and prevent a production shock from evolving into a full-blown famine. With sophisticated early-warning systems and humanitarian response capabilities, and given that most droughts and floods are slow-onset disasters (allowing lengthy lead times for external intervention), what needs to be explained in contemporary food crises is not what triggered the production shock (this is "old famine" thinking) but why there was no response.

Table 1.1: Impact of drought and floods in different categories of entitlement

Categories of entitlement	Impacts of drought and floods	Policy response
Production-based	Harvest failure	Productivity enhancing
Labour-based	Employment opportunity and real wage rates fall	Public works programme
Trade-based	Market failure	Food price subsidy Pricing policies
Transfer-based	Food aid Informal safety nets	Cash transfers Weather insurance

Source: Adapted from Sen (1984)

3. Methodology

3.1 Conceptual Framework

There are many factors that affect food and nutrition security. These factors can be expounded through four elements, namely: availability, accessibility, stability of supply, and utilization. In addition to these factors, market price for basic commodities is influenced by external trade factors, stock factors and market characteristics under which these products are traded (Benson et al., 2008).

3.1.1 Food security pillar: Availability

Factors influencing food production

The Kenyan population is largely dependent on the available productive resources for their livelihoods. The combination of these factors of production (land, labour, and capital) to achieve a given level of food product outputs, both for subsistence and commercial purposes is through provision of goods and services, the level and extent of subsidy, and the priorities in terms of business support. The quality of infrastructure of the economy, such as the road and rail system, and economic conditions also have effects on how easy or how difficult it is to trade with agricultural products as this affects both capital availability and cost, and demand. For example, high interest rates may deter investment because it costs more to borrow, while a strong currency may make exporting more difficult because it may raise the price in terms of foreign currency.

Food commodity stock

The ability of a country to cushion its citizens against food insecurity is hinged on the ability to stock enough of the basic food stuff. For instance, in Kenya, the National Cereals and Produce Board (NCPB) has the responsibility of ensuring that the country has enough cereals in stock to be released to the market during shortage. In absence of buffer stocks, then the country will not be able to smoothen supply during the shortage periods.

Food commodities external trade

Kenya is a food deficit country that has been depending largely on food imports. As global world price for most food stuff increases, this is transmitted to the domestic economy. In the same line of argument, Benson et al. (2008) argues that the reason why Uganda, which is a landlocked country did not experience volatility in its food commodities in 2008 is because of its reliance on indigenous staple

foods produced locally. This implies that Uganda experienced minimal effects from the global price crises. The export bans by Kenya's trading partners may affect domestic supply of food commodities. It is therefore important to establish policies that do not create shortages in the domestic markets. In addition, it is prudent to regulate cross border trade especially when this is informal.

3.1.2   Food security pillar: Access

Market characteristics

This examines the nature of markets for food exchange, market structure, conduct and performance. Most of the food markets are controlled by a few players, which at best constitute monopoly, duopoly, or oligopoly market structures. Very few food markets operate near perfect competition.

3.1.3   Food security pillar: Use and utilization

Food utilization

The production and consumption of food commodities is usually affected by changes in the behaviour of the society. These changes in social trends can impact the demand for products and the availability and willingness of individuals to buy various commodities in the market. They are normally under different categories that includes health consciousness, population growth rate, age distribution, social mobility, perception of safety and education infrastructure. New technologies lead to creation of new products and new processes through cost reduction, quality improvements and new innovation. These developments can benefit consumers and producers of food products by considering issues to do with automation, emerging technologies, technological change, and technology transfer.

3.1.4   Food security pillar: Stability of supply

Environmental factors

Environmental factors such as weather and climate change also influence the consumption and production of food commodities. Changes in temperature impact on many industries, including farming, tourism and insurance. With climate changes occurring due to global warming, and with greater environmental awareness, this external factor is becoming a significant issue for farms/firms to consider. The growing desire to protect the environment is having an impact on

many industries such as the travel and transportation industries, and the general move towards more environmentally friendly products and processes is affecting demand patterns and creating business opportunities. The factors included here are ecological, environmental regulations, waste disposal, energy consumption, and popular attitude towards the environment in Kenya. All these factors should conform to the legal and regulatory framework in relation to how local, national and global legislation affects production and consumption of food products. In recent years, there have been many significant legal changes that have affected production and consumption of food commodities, the main one being the promulgation of the Constitution in 2010. The introduction of age discrimination and disability discrimination legislation, and increase in minimum wage are examples of relatively recent laws that affect food production and distribution in Kenya.

3.2   Analytical Framework

3.2.1   Household food insecurity access scale

Food and nutrition security is broad, complex, and a multidimensional concept, thus an attempt is made to measure the level of household food and nutrition status, computed using the Household Food Insecurity Access Scale (HFIAS) based on 30-day recall period (Coates et al., 2007[5]). The scale accounts for perceptions regarding issues of food supply, food quantitates, food quality, reductions on food intake, the consequences of reduced food intake, and the overall level of food insecurity access at the household level. The HFIAS compliments the food poverty numbers generated by national bureaus of statistics, which are computed based on household expenditure on food items based on a 10-day recall period.

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5   Coates, J., Swindale, A. and Bilinsky, P. (2007), Household Food Insecurity Access Scale (HFIAS) for measurement of Household Food Access: Indicator Guide (v. 3). Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development, August 2007.

Figure 3.1: Universal domains of inadequate household-level food access
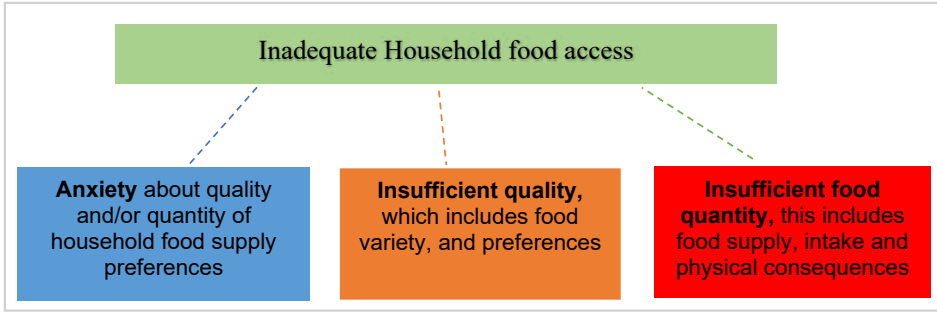
Source: Coates et al. (2007)

3.2.2   Model specification

To determine the factors that influence household food security, the multinomial logit model was used because it assumes more than two outcomes for the dependent variable, in this case the number of meals that a household consumes in a day, which was used as a proxy for food security.

The multinomial logistic regression (MLR) model is useful in analyzing categorical data, especially if the response variable is categorical. For a response variable *Y* with two measurement levels and explanatory variable *X*, let: *π(x) = p (Y=1│X=x) = 1-p (Y=0│X=x)*, the logistic regression model has a linear form for logit of this probability

Logit [π(x)] = log [(π(x))/(1-π(x))] = α + βx, where the odds = [(π(x))/(1-π(x))]

(1)

The odds = *exp (α + βx)*, and the logarithm of the odds is called logit, therefore

Logit [π(x)] = log [(π(x))/(1-π(x))] = log [exp (α+βx)] = α + βx   (2)

The logit has linear approximation relationship, and logit = logarithm of the odds. The parameter *β* is determined by the rate of increase or decrease of the S-shaped curve of *π (x)*. The sign of *β* indicates whether curve ascends *(β > 0)* or descends *(β < 0)*, and the rate of change increases as *|β|* increases.

The logistic regression can be extending to models with multiple explanatory variables. Let *k* denotes number of predictors for a binary response Y by 1 2 , … X_1, X_2, X_3 the model for log odds is:

$$logit\ [P\ (Y=1)]\ = \alpha + \beta_1 x_1 + \beta_2 x_2 \dots + \beta_k x_k$$

The parameter β_i refers to the effect of on the log odds that $Y=1$, controlling other x_j, for instance, $exp\ (\beta_i)$ is the multiplicative effect on the odds of a one unit increase in x_i, at fixed levels of other x_j (El-Habil, 2012). Therefore, if we have n independent observations with p-explanatory variables, and the qualitative response variable has k categories, to construct the logits in the multinomial case, one of the categories must be considered the base level and all the logits are constructed relative to it. In our case, the household is considered food secure if they consume three (3) meals is a day, moderate food insecure if they consume two (2) meals in a day, and insecure if they consume one (1) meal in a day.

The multinomial logit allows that the dependent variable outcomes are also not ordered (Brooks, 2008; Chinwuba et al., 2016), thus one of the outcomes used as the reference category against which the others are compared with, implying that the estimated set of coefficients is for 3 meals a day, 2 meals a day and one meal a day, corresponding to each outcome. The model assumes independence across the choices (Woolridge, 2016).

The dependent variable can be assumed to take one of the j categories or alternatives such that $j = 1, 2, \dots k$. The probability of observing outcome M given X in a probability model for Y is given as:

$$Pr\ (Y=M/X) = e^{\beta(Z)} / \Sigma\ [1+e^{\beta(Z)}] \tag{3}$$

In the multinomial logit model estimate, a set of coefficients $\beta(1), \beta(2), \beta(3)$, which corresponds to the outcomes, households are food secure if they consume three (3) meals in a day, less food secure if they consume two (2) meals in a day and insecure if they consume one (1) meal in a day.

The reference category or base was set as 3 meals a day, given as implying that $\beta^{(3)}=0$, therefore change will be measured relative to $y=3$. The equation can be written as:

$$Pr\ (y=3) = 1/(1+ e^{x\beta(2)} + e^{x\beta(1)}) \tag{4}$$

$$Pr\ (y=2) = e^{x\beta(2)} / (1+ e^{x\beta(2)} + e^{x\beta(1)}) \tag{5}$$

$$Pr\ (y=1) = e^{x\beta(1)} / (1+ e^{x\beta(2)} + e^{x\beta(1)}) \tag{6}$$

The relative probability of $y=2$ to the base outcome is $Pr(y=2) / [Pr(y=1)] = e^{x\beta(2)}$

Having estimated the multinomial logit, the marginal effects are then computed and interpreted as the change in probability for observing outcome i for the explanatory variable concerned, with reference to the outcome that is used as the base category (list of variable in Appendix 5).

3.3   Data

The study used both secondary and primary data sources.

Secondary data was collected for food access, food availability and food utilization from the Kenya National Bureaus of Statistics (various) Economic Surveys, which provide a wide range of data at national level, including the food balance sheet. Additional data was drawn from the Basic Report on Well-being -2015/2016: Kenya Integrated Household Budget Survey (KIHBS), which covered a range of socio-economic household characteristics regarding food availability (KNBS, 2018a).

Primary data: A cross-sectional survey of households was administered in a sample of 27 counties that are prone to droughts and floods. The KIPPRA Survey covered 27 counties, specifically 23 arid and semi-arid counties and 4 counties that were prone to floods. The selection of the sampled households was based on NASSEP V developed by the Kenya National Bureau of Statistics (KNBS) and was collected in February and March 2018. A total of 1,500 households were sampled through a two-stage sampling design, where in the first stage 150 clusters were selected from the identified counties, and in the second stage, 10 households were selected from each cluster. A total of 1,370 households were interviewed using a structured questionnaire (Appendix 1).

4.   Results and Discussion

The results are presented as secondary data results, which show the amount of food available at a national level, then the second section shares results from the primary data collection.

4.1   National Level

4.1.1   Food availability

At the national level, the amount of food available is a function of national production plus stock and imports, including food aid, minus the quantity of exports, seed, feed and post-harvest loss. Based on the food balance sheet for 2017, it is evident that cereals and vegetable oils were the largest contributors to the import bill. Nonetheless, for most food categories, the country relied on its own production (Figure 4.1).

Figure 4.1: National level food balance sheet in broad categories, 2017
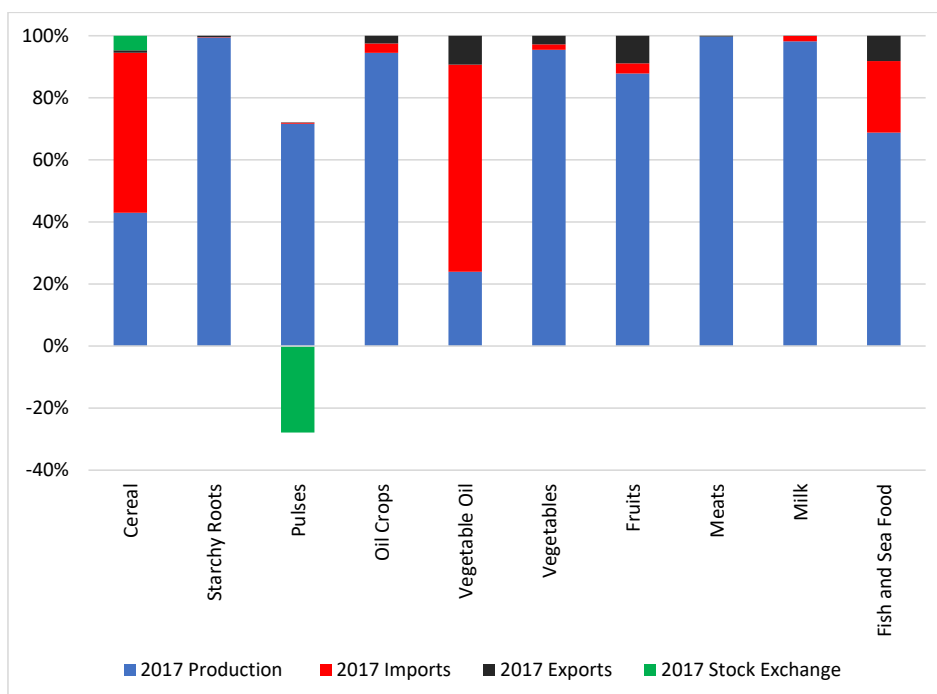
Data source: Kenya National Bureau of Statistics (2019), Economic Survey

Figure 4.1 shows the amount of food available in the year. This is then translated into calories that are consumed by the total population as shown in Figure 4.2. Kenyans mainly consume three food groups, which account for 50 per cent, namely: milk and milk products (23%), maize and products (17%), and wheat and products (10%). This is supported by data from FAOSTAT (Table 4.1), which shows that the country has adequate supply in regard to dietary energy, which is more than 100 per cent. This implies that if there is a shock occasioned by weather variability, such as drought or floods, or change in price of these products due to market forces, then the implication on the economy and by extension on households will be far-reaching. It is evident from Figure 4.1 that apart from milk, the cereals domestic supply in 2017 was from both production and imports at almost equal proportions.

Figure 4.2: National consumption per capita by different food groups in 2017
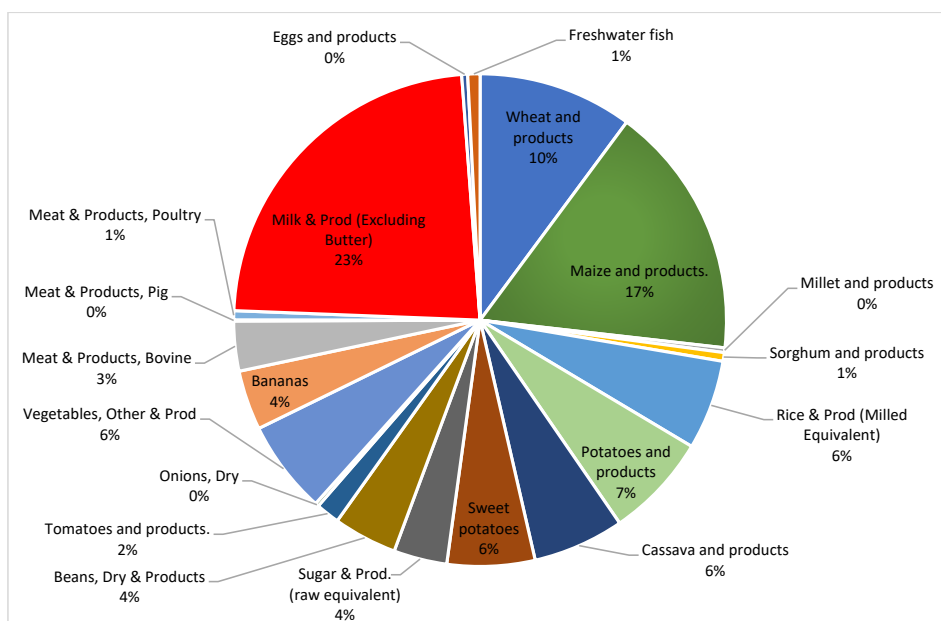
Data source Kenya National Bureau of Statistics (2019), Economic Survey

Table 4.1: Indicators for food availability in Kenya

Description	Unit	2014-2016	2015-2017
Average dietary energy supply adequacy (%) (3-year average)	%	101	101
Average value of food production (constant 2004-2006 I$/cap) (3-year average)	I$ per person		149

Data source: FAOSTAT (2019), accessed on 30th April 2019

4.1.2   Food access

Whether households have access to food depends upon factors such as household income, food prices, employment opportunity and working resources such as labour, capital and capability (Frelat et al., 2016; FAO, 2015). An adequate supply of food at the national level does not in itself guarantee household level food security. Therefore, indicators such as prevalence of undernourishment and the number of undernourished show the extent of food access. For the case of Kenya, it is evident that prevalence is increasing for all the indicators (Table 4.2), which is a worrying trend. This, therefore, implies that there needs to be deliberate initiatives that result in increased access to food, such as those that increase household's purchasing power or initiatives that focus on markets and price of food.

Table 4.2: Indicators for food access in Kenya

Description	Unit	2014-2016	2015-2017
Prevalence of undernourishment (%) (3-year average)	%	22.5	24.2
Prevalence of severe food insecurity in the total population (%) (3-year average)	%	31.8	35.6
Number of people undernourished (million) (3-year average)	millions	10.6	11.7
Number of severely food insecure people (million) (3-year average)	millions	15	17.3

Data source: FAOSTAT (2019), accessed on 30th April 2019

4.1.3   Food utilization

Utilization is basically assumed to imply that the food taken up by individuals is nutritious as a result of several factors such as distribution of food, food preparation, the diversity of the food types just to mention a few, thus determining the nutritional status of individuals (FAO, 2018; FAO, 2015). However, from Table 4.2 above, it is evident that nutritional status at national level is declining. In addition to the nutrition components, other important considerations include food storage, processing, health and sanitation (FAO, 2018) as they relate to nutrition. For this paper, we look at how the available domestic supply of food is used according to the food balance sheet of 2017. Figure 4.3 shows that an estimated 10 per cent of all food groups is lost, with oil crops and vegetable oils being the food groups that are processed. In regard to the variance with the domestic supply (Figure 4.4), Kenya experiences deficit in fish and sea food,

vegetable oil and pulses, which are food groups critical for nutrition. Considering that the prevalence of undernutrition is increasing, it means that it is not only important to have enough food but also nutrition.

Figure 4.3: Utilization by different food groups in 2017
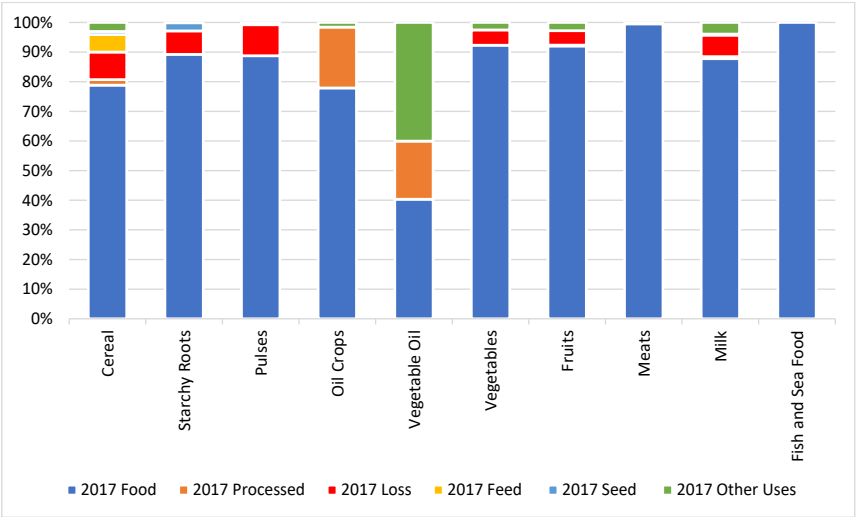
Data source: Kenya National Bureau of Statistics (2019)

Figure 4.4: Variance between domestic supply and utilization
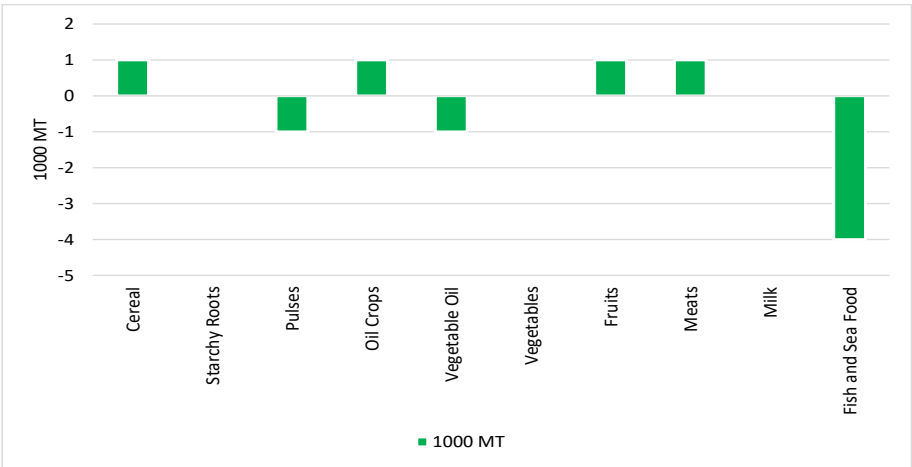
Data source: Kenya National Bureau of Statistics (2019)

It is with the background of the food security situation at a national level that the paper takes a further analysis at the households in arid and semi-arid areas in Kenya, which are vulnerable to the effects of climate change such as drought and floods.

4.2 Household Level Food Security Status for Arid and Semi-Arid Counties

4.2.1 Household characteristics

Households in the sampled counties, on average, have 5 members per household, with rural areas having an average of 6 members, while urban areas have an average of 5. The average age of the household head was 46 years with, on average, seven years of schooling; i.e. primary level of education (Table 4.3 and Appendix 1)

Table 4.3: Household characteristics

Area of Residence	Household Size	Age of Household Head	Years of schooling	Gender	
	Mean			Female	Male
Urban	5	41	9	50.5%	47.4%
Rural	6	50	6	49.5%	52.6%
Total Sample	**5**	**46**	**7**	**100%**	**100%**

Data source: KIPPRA (2018) Survey

The main economic activity for households was work for pay where 48 per cent of the males participate compared to 24 per cent of their female counterparts. Owning a family business and agricultural farm holding are the other sources of income for most of the households (Figure 4.5).

Figure 4.5: Main economic activity by gender
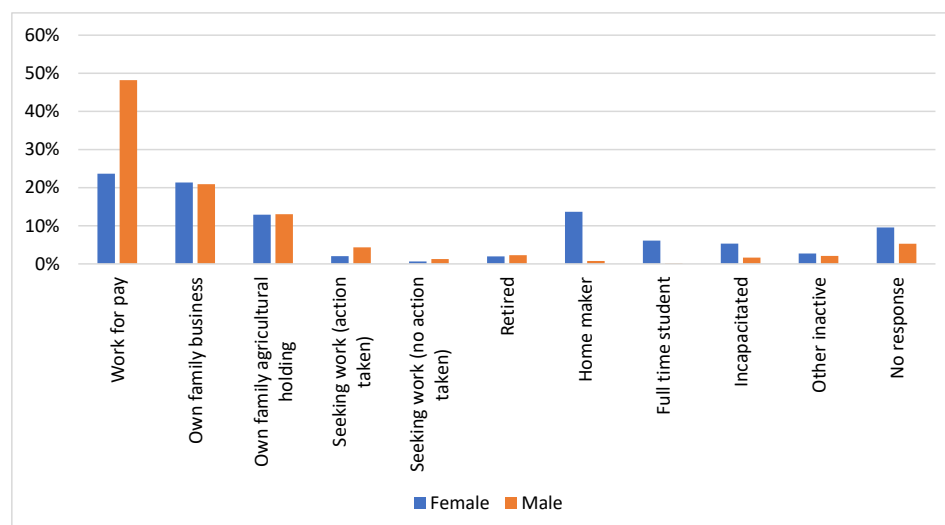
Data source: KIPPRA (2018) Survey

Figure 4.6 shows that more than 50 per cent of households earned Ksh 0-14,999 monthly, while 17 per cent did not have any earnings. When marital status is considered, it reflects the society as it is currently growing with household having different marital status, but still earning between Ksh 0-14,999 per month (Figure 4.7).

Figure 4.6: Household earning
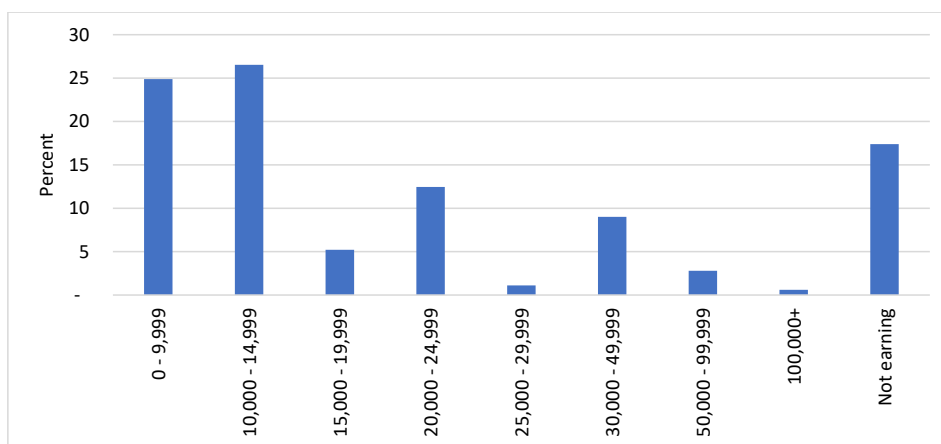
Data Source: KIPPRA (2018) Survey

Figure 4.7: Marital status and household earnings
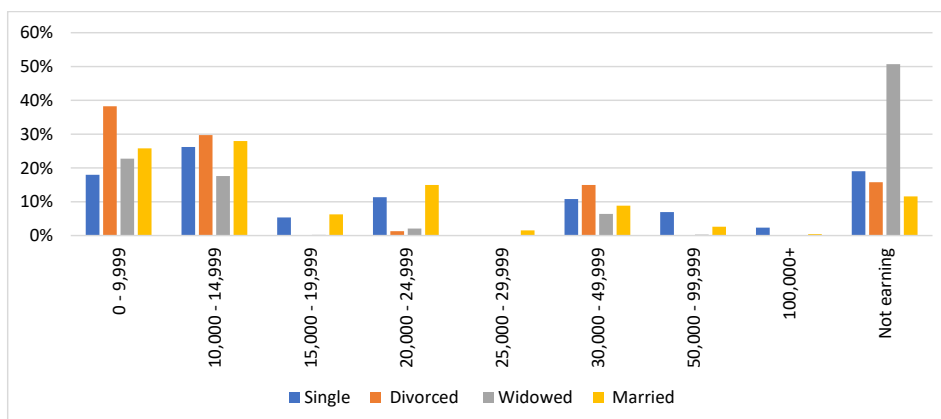
Data source: KIPPRA (2018) Survey

It is expected that the more educated you are, the higher the amount that one earns. This is the case for the sampled households, which had a huge majority of respondents having completed pre-primary and primary education (Figure 4.8).

Figure 4.8: Monthly earning and education level
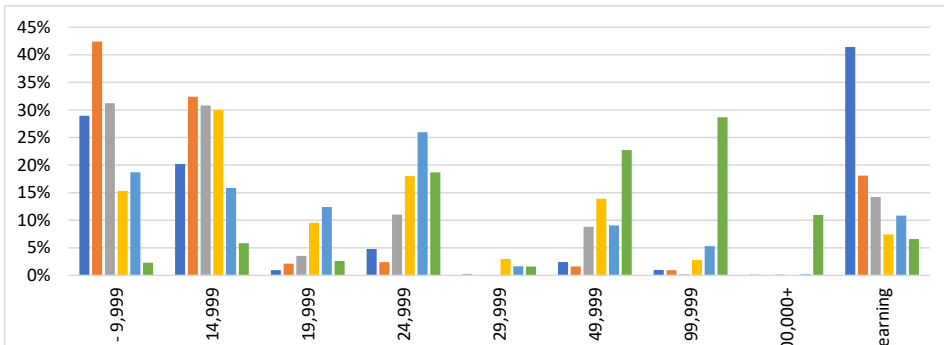
Data Source: KIPPRA (2018) Survey

4.2.2 Weather-related information: Perceptions

This section presents the perceptions of drought and floods by farmers in the sampled counties. The discussion on the perceptions of drought is concentrated in two areas; variability and impacts of drought and floods. Respondents were asked their perception on rainfall, temperature, drought and floods variability and impacts.

Results from the different counties are mixed, most counties considered the variability in rainfall as lower (Figure 4.9). However, the perceived impact on their livelihoods is perceived to be higher (Figure 4.10). This would be attributed to the changing rainfall seasonal patterns, in that there are rains that come at the mid or at the end of the season, instead of the beginning of the season. As a result, the rainwater is not adequate to support crop and livestock production this leads to crop failure and loss of livestock.

Figure 4.9: Perceptions on rainfall variability by county
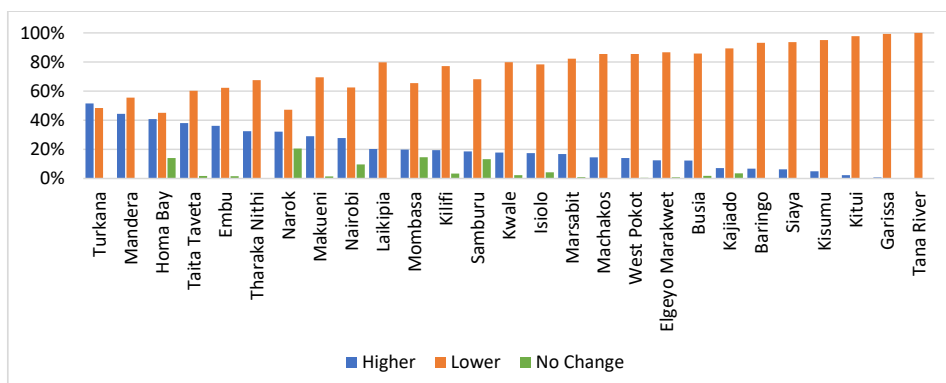
Data Source: KIPPRA (2018) Survey

Figure 4.10: Perceptions on the impact of rainfall variability by county
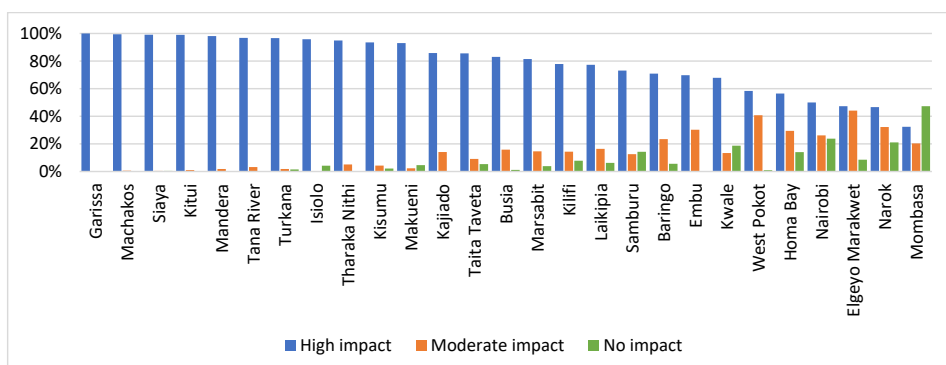
Data Source: KIPPRA (2018) Survey

Temperature variability is perceived to be high across all counties, and thus the impact is also high (Figure 4.11 and 4.12). The country is vulnerable to climate change with projections suggesting that its temperature will rise up to 2.5ºC between year 2000 and 2050, while rainfall will become more intense and less predictable, with 1-2ºC as the most likely range. For 2100, a warming ranging between 1.3ºC and 3.9ºC is likely, with some models suggesting an increase of 4ºC by 2100 (KIPPRA, 2019; Climate Service Centre Germany, 2016; Odera et al., 2013).

Figure 4.11: Perceptions of temperature variability by county
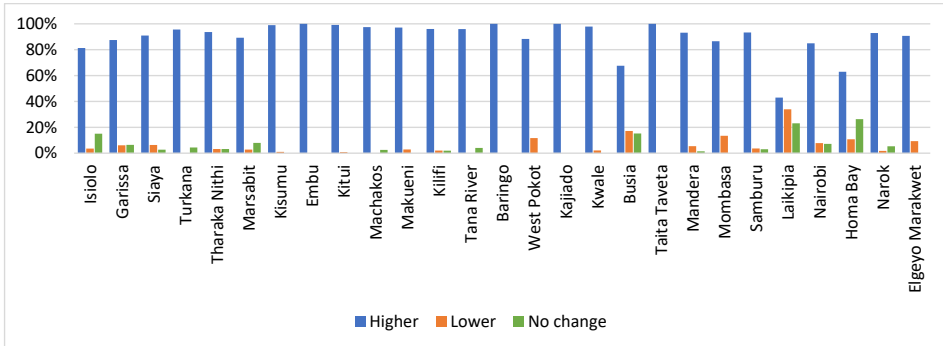
Data source: KIPPRA (2018) Survey

Figure 4.12: Impact of the temperature variability by county
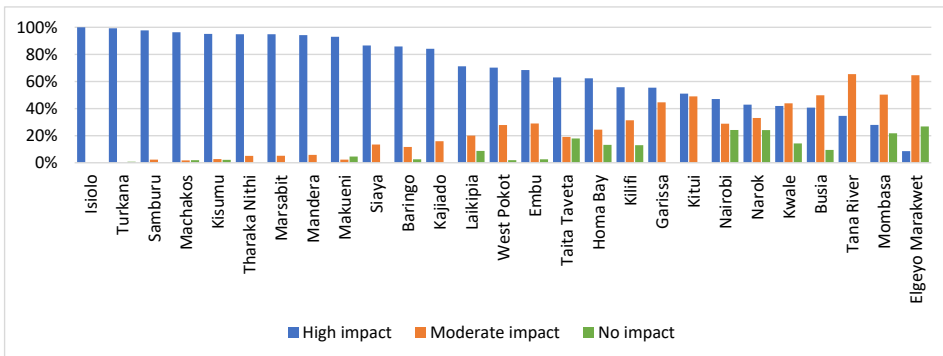
Data source: KIPPRA (2018) Survey

Nationwide droughts will occur more frequently, but they will mainly affect farmers and pastoralists in the east and north of the country.

Figure 4.13: Perceptions of drought variability by county
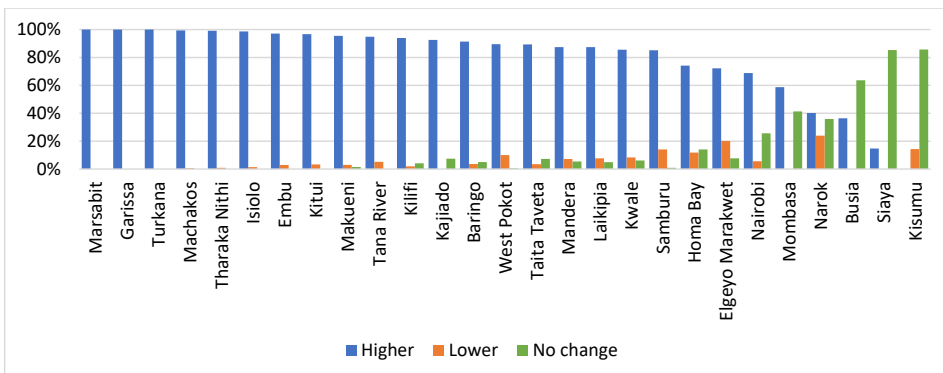
Data source: KIPPRA (2018) Survey

Figure 4.14: Perceptions of drought impact on household livelihood by county
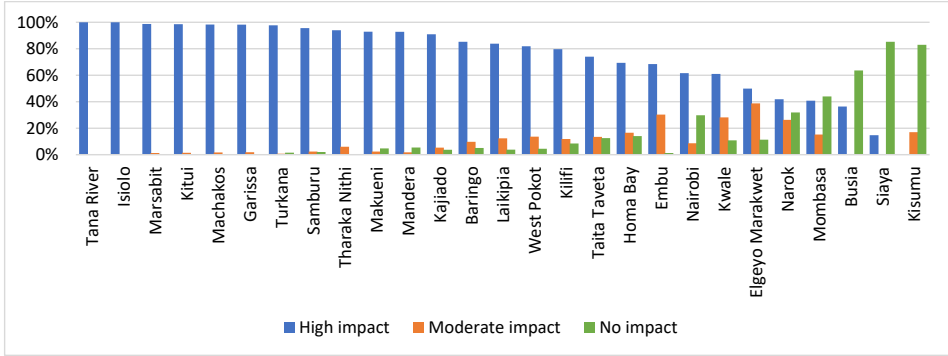
Data source: KIPPRA (2018) Survey

Figure 4.15: Perceptions of floods variability by county
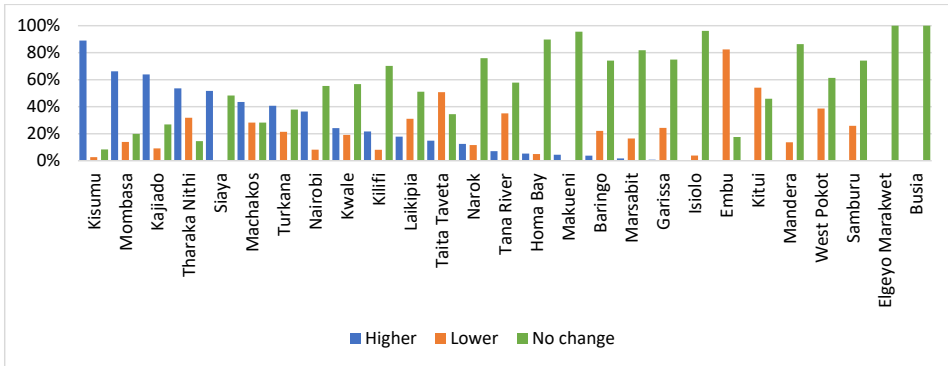
Data source: KIPPRA (2018) Survey

Figure 4.16: Perceptions of the impact of floods by county
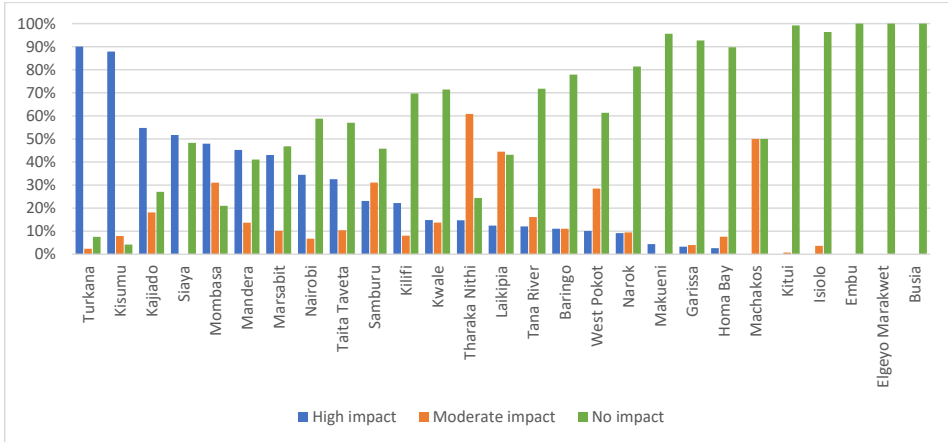
Data source: KIPPRA (2018) Survey

Impacts on livestock

Livestock production is the predominant source of livelihood in the arid and semi-arid areas in the country. There is evidence that there are a lot of losses suffered as a result of drought and floods, the magnitude differs from county to county. Figure 4.17 and Figure 4.18 shows some estimated numbers of loses of cattle and goats. In ASALs, the livestock sector accounts for 90 per cent of employment and more than 95 per cent of family incomes (Government of Kenya, 2012), thus the shocks of drought and floods usually have a huge impact on households in these areas.

Figure 4.17: Impact of drought and floods on livestock - cattle
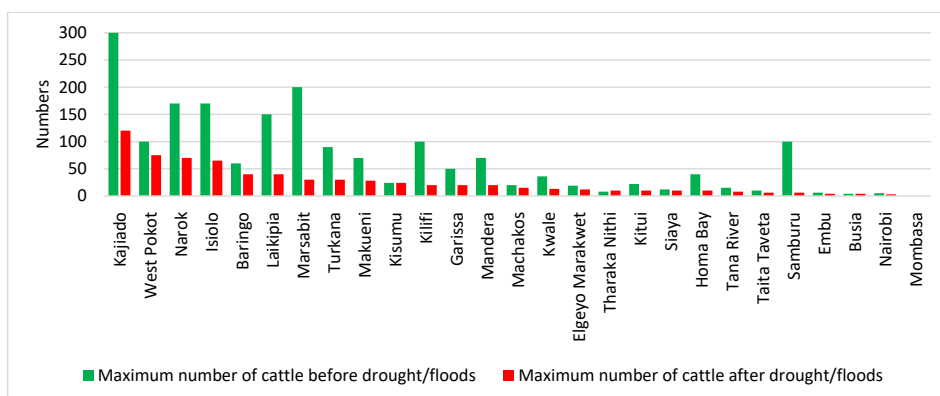
Data source: KIPPRA (2018) Survey

Figure 4.18: Impact of drought and floods on livestock-goats
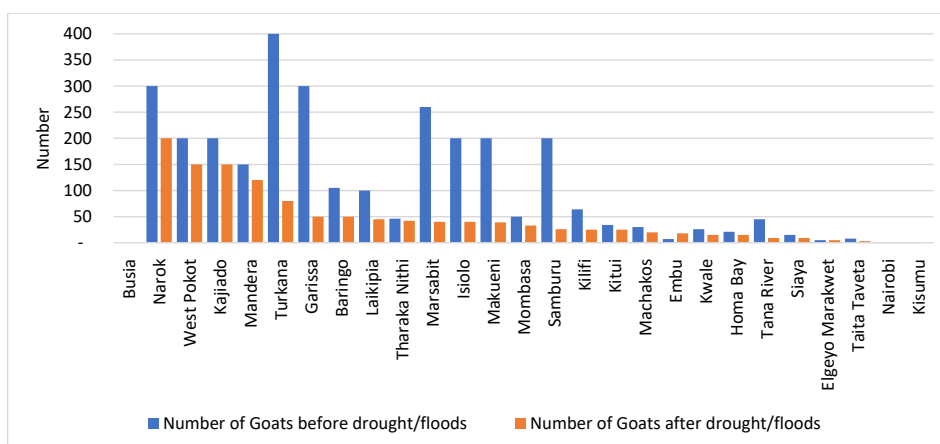
Data source: KIPPRA (2018) Survey

4.2.3 Household food supply

The amount of food available at the household is measured by counting how many times households run out of food. Figure 4.19 indicates that on average more than 30 per cent of the households in Turkana, Garissa, Homa Bay, Tana River, West Pokot, Kitui, Makueni, Taita Taveta and Narok run out of food more than 10 times during the 30-day recall period, which is equivalent to one in every three days. This was measured by asking the households how often during the recall period did they run out of food[6].

Figure 4.19: Food insecurity access-related conditions
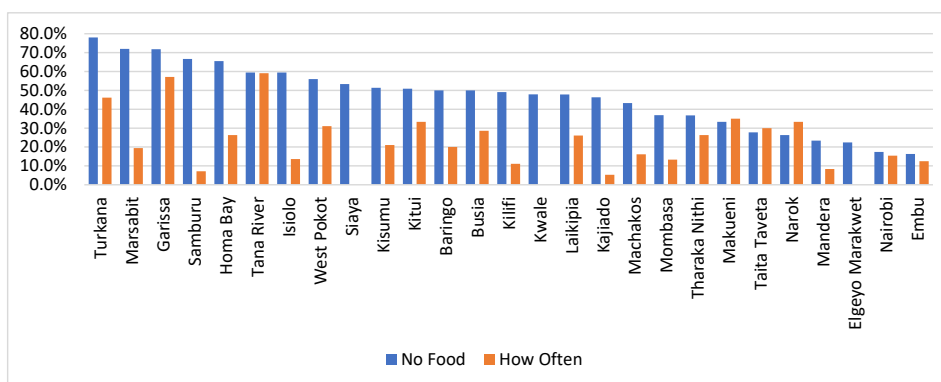
Data source: KIPPRA (2018) Survey

Figure 4.20: Food insecurity access-related domains
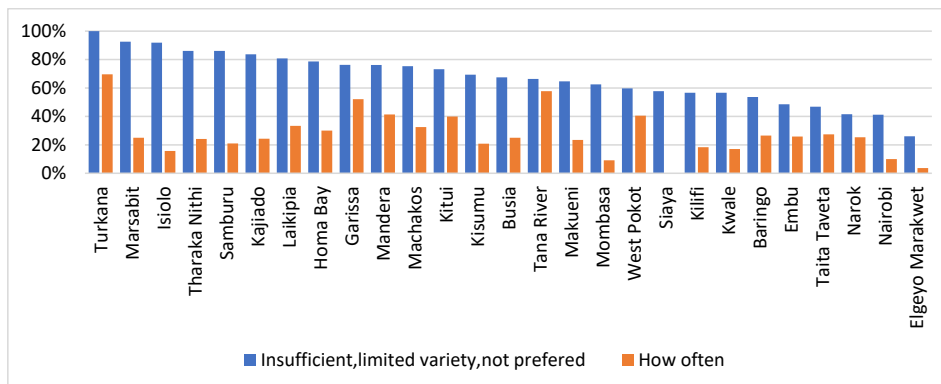
Data source: KIPPRA (2018) Survey

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6 How often did the household run out of food: 1= Rarely (once or twice in the past four weeks); 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks).

4.2.4 Household food preferences

Forty (40) per cent of households in Turkana, Garissa, Mandera, Kitui, Tana River, and West Pokot counties did not have sufficient qualities of food, had a limited variety of food, and ate food that they did not prefer during the period under review as shown in Figure 4.20. This means that during the period under review, households ate what was available. This food did not meet their nutritional requirements, or individual taste and preference. In addition, it did not provide the average required daily per adult equivalent calorie of 2,251 Kcal[3].

4.2.5 Household Food Insecurity Access Scale (HFIAS) score

The HFIAS score is a continuous measure of the degree of food insecurity (access) at household level depending on the period under review. The higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced. Figure 4.21 shows that households in the counties that score less than 5 (which is the median) have more access to food compared to the counties that scored more than 5. This score gives an indication on how the households perceptions during the interview period and therefore is biased. However, the common thread among the counties that have relative less food insecurity access is that they practice agro-pastoralism and there are regions in these counties that are middle to high altitude areas that produce huge amounts food for instance in West Pokot, Elgeyo Marakwet, Taita Taveta and Makueni.

Figure 4.21: Household Food Insecurity Access Scale (HFIAS) score
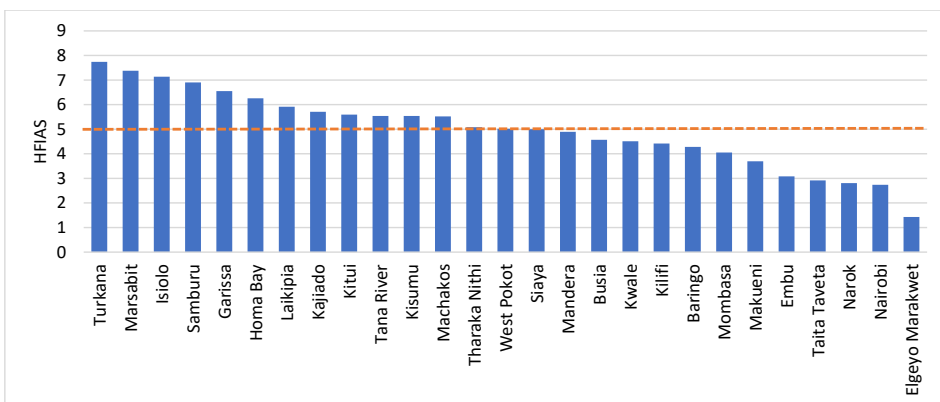
Data source: KIPPRA (2018) Survey

4.2.6   Food insecurity access prevalence

A household that experiences little or no hunger or just rarely experiences worry about not having enough food sometimes, but it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating) is considered food secure. One third of the households in Mandera, Taita Taveta, Machakos, Makueni, Samburu, Kilifi, Isiolo, Nairobi, Kwale, Mombasa, Elgeyo Marakwet and Siaya are food secure. One third of the households in Turkana, Tana River, Garissa, West Pokot, Kitui, Mandera, Narok and Laikipia are severely food insecure because they are cutting back on meal size or number of meals, often running out of food, going to bed hungry, or going a whole day and night without eating as shown in Figure 4.22. Additional information is required on the spatial distribution of the areas where households were sampled. This information will be useful planning and initiate programmes that would facilitate the resilience regarding food and nutrition security.

Figure 4.22: Food insecurity access prevalence
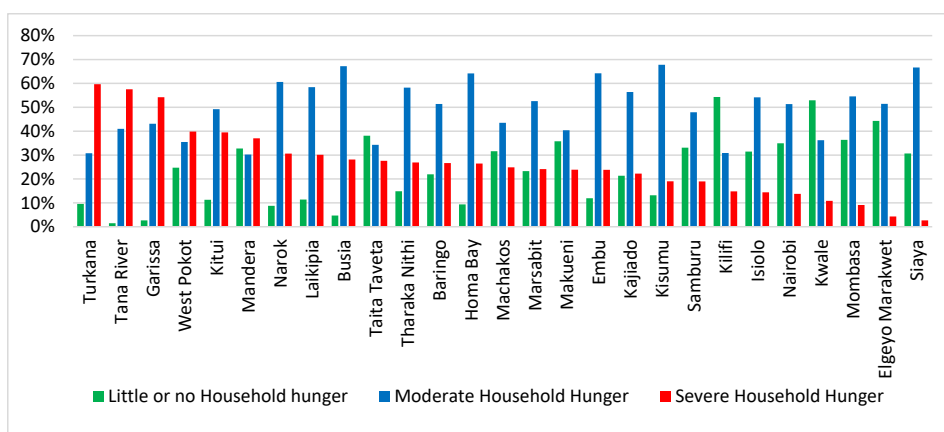
Data source: KIPPRA (2018) Survey

4.2.7   Distribution of household food consumption by source

According to the Kenya Integrated Household Baseline Survey (2015/2016), households in the selected counties are net buyers of food due to their reliance on rainfed agriculture and reliance on mainly livestock production system except for the cities of Mombasa, Nairobi and Kisumu. Garissa County reported stocks of 47 per cent, which are attributed to the geographical orientation of the county; that is, most of the households' stock their food when they receive it because

of distribution and transportation challenges. Despite the presence of stocks at household level, the nutritional outcomes for county showed food poverty of 45.2 per cent, with nutritional deprivation rate of 37.0 per cent for children under-5 years. This implies that if we improved the household level stocks, regardless of the source (Figure 4.23), it improves the amount of food available. However, this does not necessarily translate to reduction in food poverty or improved nutritional outcomes unless deliberate measures are taken.

Figure 4.23: Distribution of household food consumption by source
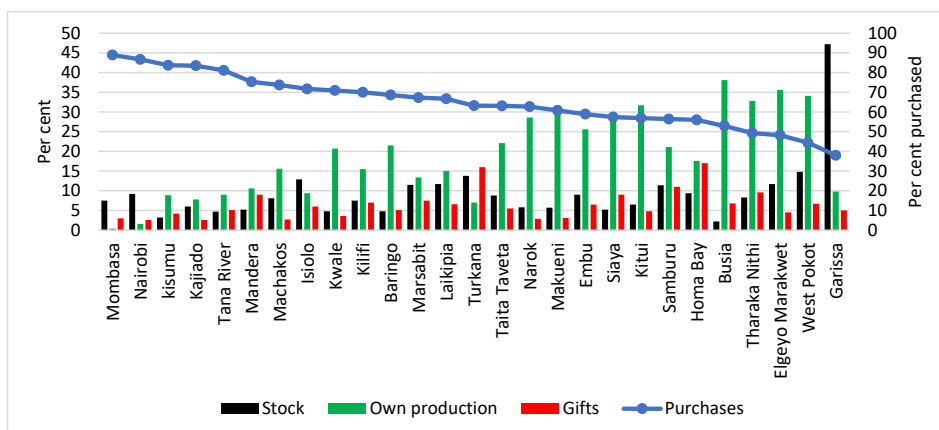
Data source: KIHBS, 2015/16

4.2.8   Factors that influence household food security

The factors that influence household food security were disaggregated by county. We cannot over-emphasize that food and nutrition security is a broad concept, that including supply-side factors, demand-side factors, market-related factors, and many more. This has not been exhaustively addressed by the objectives of this paper; what we attempt to do to give indicators that point to possible factors that affect households in arid and semi-arid areas of this country who are among the vulnerable groups to the variability of climate change, mainly due to their livelihood systems. As shown above, most of these households are food insecure.

Table 4.4: Multi-logit regression marginal effects results for determinants of food security

	When food secure = 2 meals a day	When food secure= 1 meal a day
Base outcome: Food secure = 3 meals a day		
	dy/dx	dy/dx
County		
Mombasa	0.21* (-0.116)	
Tana River	0.49*** (-0.105)	-0.30** (-0.115)
Taita Taveta	0.32*** (-0.094)	-0.26** (-0.103)
Kitui	0.42*** (-0.091)	-0.32*** (-0.101)
Isiolo		0.21* (-0.095)
Tharaka Nithi		-0.19* (-0.101)
Makueni	0.22* (-0.086)	-0.21** (-0.1)
Garissa	0.28 (-0.096)	-0.24** (-0.114)
Mandera	0.30** (-0.108)	
Siaya	-0.15** (-0.049)	
Kisumu	0.32* (-0.166)	
Turkana	0.49*** (-0.124)	-0.52*** (-0.093)
Elgeyo Marakwet	-0.13* (-0.053)	
Education		
Primary	-0.13** (-0.041)	
Secondary	-0.09* (-0.045)	0.09* (-0.051)
TVET	-0.23*** (-0.048)	0.16* (-0.072)
University	-0.21*** (-0.067)	0.23* (-0.092)
Economic Activity		
Own family agricultural holding	0.11* (-0.043)	
Retired	0.20* (-0.107)	
Full time student	0.25* (-0.138)	

Rainfall variability		
Lower	0.11*** (-0.031)	-0.13*** (-0.039)
Rainfall impact		
No impact	0.21** (-0.089)	
Temperature impact		
Moderate impact	0.13** (-0.043)	-0.08* (-0.047)
Drought impact		
Moderate impact	-0.15*** (-0.043)	
No impact	-0.17* (-0.068)	
Remittance		
Remittance from within Kenya before drought	-0.33* (-0.191)	0.41** (-0.208)
Remittance from abroad during the drought	0.34* (-0.197)	

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

Data Source: KIPPRA (2018)

The estimation (Table 4.4) shows that if a household lives in the counties of Mombasa, Tana River, Taita Taveta, Kitui, Isiolo, Tharaka Nithi, Makueni, Garissa, Mandera, Kisumu and Turkana, they have a high probability of eating 2 meals a day implying that they will have moderate food insecurity. The probability ranges from 20 per cent in Mombasa County to 50 per cent in Turkana County.

Education is important at all the levels, the sign of the coefficient is negative, implying that if heads of household have education, they have a higher probability to be food insecure. This has an implication on the economic activity that the households participate in. Households that have a household head that is a farmer have a 11 per cent chance, retired members have a 20 per cent, while full time students have a 25 per cent chance that they will be moderately food insecure.

The perception on the variability and impacts of rainfall, and temperature give an indication to the weather conditions that influence the household food security status. The perception on the impact of drought has a negative sign, implying that it does not influence the number of meals the household will have in a day.

We cannot over-emphasize the role of remittances, which are an important source of income for many households in developing countries, including Kenya. Empirical evidence suggests that migrant remittances alleviate poverty in low and developing economies through positive impact on economic growth and household incomes (Jebran et al., 2016 and Tsarai, 2018).

5. Conclusion and Recommendations

5.1 Conclusion

The arid and semi-arid lands of Kenya are vulnerable to food insecurity, especially during incidence of drought and floods. The level of household food insecurity varies from county to county. However, the situation in Kenya is not getting better. This is evident by the increasing number of undernourished citizens.

There is need to diversify the food groups that Kenyans consume, because half of the food consumed comes from only three groups, namely milk and products, maize and products, and wheat and products. During the periods of drought or floods, most households did not have enough amounts of food or eat their preferred foods, implying that their nutritional status was threaten. In addition, Kenya has deficit in fish and sea food, vegetable oil and pulses, which are critical for nutrition.

Households in the sampled counties are net buyers of food due to their reliance on rainfed agriculture, and reliance on mainly livestock production system. This makes them vulnerable to weather-related disasters. Therefore, it is critical to change the production systems in these regions to embrace technology, such as irrigation, drought tolerant crops, feedlots, silage making, etc.

Regarding factors influencing household food and nutrition security, the county, and education level of the household heads contributes positively to the status of the household. Also, remittances contribute positively to household food and nutrition security.

5.2 Recommendations

1. Transform production systems by introducing technology such as irrigation to reduce dependence on rainfall. To support this system, introduce insurance mechanisms against the impacts of weather-related shocks.

2. Strengthen markets to minimize supply failures and reduce chronic poverty. This requires a range of pre-emptive measures, including building transport infrastructure to integrate markets, and building asset buffers at the household level to reduce their vulnerability.

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Appendix

Appendix 1: Counties covered by the KIPPRA survey and response rates

County	Number Household Clusters	Number Household Targeted	Successful Interviews	Survey Response Rate
1. Baringo	5	50	50	100
2. Elgeyo Marakwet	5	50	49	98
3. West Pokot	5	50	50	100
4. Kajiado	5	50	43	86
5. Machakos	7	70	69	98.6
6. Isiolo	4	40	40	100
7. Marsabit	5	50	49	98
8. Samburu	4	40	40	100
9. Embu	5	50	50	100
10. Tharaka Nithi	5	50	50	100
11. Laikipia	5	50	47	94
12. Kitui	6	60	59	98.3
13. Garissa	5	50	50	100
14. Tana River	4	40	40	100
15. Kilifi	7	70	68	97.1
16. Kwale	5	50	49	98
17. Mandera	5	50	48	96
18. Turkana	5	50	50	100
19. Narok	6	60	60	100
20. Makueni	6	60	60	100
21. Taita Taveta	5	50	50	100
22. Homa Bay	6	60	59	98.3
23. Mombasa	4	40	40	100
24. Busia	6	60	59	98.3
25. Siaya	6	60	55	91.7
26. Kisumu	6	60	57	95
27. Nairobi	8	80	69	86.3

Data source: KIPPRA (2018) Survey

Appendix 2: Household characteristics

County Name	N	Total number of household members	Number of people earning income in the household	Marital status of the household head	Sex	Age (Years)	Education level completed	How many years of full-time education completed	Main economic activity	Average monthly income (Ksh)
Nairobi	69	4	1	Married/Living with Partner	Male	38	Secondary	13	Work for pay	10,000 – 14,999
Mombasa	40	3	1	Married/Living with Partner	Male	28a	Secondary	12	Work for pay	10,000 – 14,999
Kwale	49	2	0	Married/Living with Partner	Male	49	No Formal Education	0	Work for pay	10,000 – 14,999
Kilifi	68	3a	1	Married/Living with Partner	Male	40a	No Formal Education	0	Own Family Business	0 – 9,999
Tana River	40	5	1	Married/Living with Partner	Male	28a	Primary	7a	Work for pay	10,000 – 14,999
Taita Taveta	51	4	1	Married/Living with Partner	Male	58	Primary	8	Work for pay	0 – 9,999
Marsabit	49	5	1	Married/Living with Partner	Male	40a	No Formal Education	0	Own Family Business	10,000 – 14,999
Isiolo	40	5	1	Married/Living with Partner	Male	40	No Formal Education	0	Work for pay	0 – 9,999
Tharaka Nithi	50	4a	1	Married/Living with Partner	Male	57a	Primary	0	Own Family Agricultural holding	0 – 9,999
Embu	50	3	1	Married/Living with Partner	Male	33a	Primary	8	Own Family Agricultural holding	10,000 – 14,999
Kitui	59	7	1	Married/Living with Partner	Male	40	Primary	8	Work for pay	10,000 – 14,999
Machakos	69	6	2	Married/Living with Partner	Male	48	Primary	8	Work for pay	0 – 9,999

Makueni	60	4	2	Married/Living with Partner	Male	40	Primary	8	Work for pay	10,000 - 14,999
Garissa	50	7	1	Married/Living with Partner	Male	40	No Formal Education	0	Work for pay	0 - 9,999
Mandera	48	7	0	Married/Living with Partner	Male	35a	No Formal Education	0	Work for pay	n/a
Siaya	55	4	1	Married/Living with Partner	Male	60	Primary	8	Work for pay	n/a
kisumu	57	6	1	Married/Living with Partner	Male	60	Primary	8	Work for pay	0 - 9,999
Homa Bay	59	5	1	Married/Living with Partner	Male	40a	Primary	11	Work for pay	0 - 9,999
Turkana	50	7	0	Married/Living with Partner	Male	40	No Formal Education	0	n/a	n/a
West Pokot	50	8	0	Married/Living with Partner	Male	30	Pre-Primary	0	Work for pay	0 - 9,999
Samburu	42	3	1	Married/Living with Partner	Male	25a	No Formal Education	0	Work for pay	0 - 9,999
Baringo	50	4	1	Married/Living with Partner	Male	28	TVET	8a	Work for pay	0 - 9,999
Elgeyo Marakwet	49	5	0	Married/Living with Partner	Male	26	Primary	8	Work for pay	n/a
Laikipia	47	4	1	Married/Living with Partner	Male	35	No Formal Education	0	Work for pay	0 - 9,999
Narok	61	4	1	Married/Living with Partner	Male	30a	Primary	8	Work for pay	10,000 - 14,999
Kajiado	43	4a	1	Married/Living with Partner	Male	70	No Formal Education	0	Work for pay	10,000 - 14,999
Busia	59	5	1	Married/Living with Partner	Male	40	Primary	8	Work for pay	0 - 9,999

Data source: KIPPRA (2018) Survey

Appendix 3: Impact of drought and floods on cattle numbers

County	Number of cattle before drought/floods			Number of cattle after drought/floods		
	max	mean	sd	max	mean	sd
Nairobi	5	2	3	3	2	2
Mombasa	-	-	-	-	-	-
Kwale	36	6	9	13	4	4
Kilifi	100	18	36	20	4	7
Tana River	15	9	9	8	5	4
Taita Taveta	10	4	3	6	2	2
Marsabit	200	36	62	30	6	8
Isiolo	170	36	49	65	8	15
Tharaka Nithi	8	2	2	10	2	2
Embu	6	2	2	4	2	1
Kitui	22	4	4	10	2	2
Machakos	20	3	4	15	2	3
Makueni	70	7	11	28	4	5
Garissa	50	10	18	20	4	7
Mandera	70	19	17	20	6	5
Siaya	12	5	4	10	4	3
Kisumu	24	8	9	24	7	9
Homa Bay	40	5	7	10	3	3
Turkana	90	9	24	30	3	8
West Pokot	100	12	17	75	7	13
Samburu	100	15	24	6	2	2
Baringo	60	13	14	40	7	10
Elgeyo Marakwet	19	6	4	12	3	3
Laikipia	150	21	38	40	5	10
Narok	170	12	30	70	7	12
Kajiado	300	44	64	120	16	33
Busia	4	3	1	4	3	1

Data source: KIPPRA (2018) Survey

Appendix 4: Impact of drought and floods on goat numbers

County	Number of Goats before drought/floods			Number of Goats after drought/floods		
	max	mean	sd	max	mean	sd
Nairobi	1	0	1	1	1	1
Mombasa	50	13	25	33	8	17
Kwale	26	7	7	15	6	5
Kilifi	64	13	17	25	8	7
Tana River	45	15	18	9	6	2
Taita Taveta	8	2	3	3	1	2
Marsabit	260	43	60	40	11	9
Isiolo	200	29	42	40	9	11
Tharaka Nithi	46	7	9	42	4	8
Embu	7	4	2	18	4	3
Kitui	34	13	8	25	7	6
Machakos	30	4	6	20	4	4
Makueni	200	16	33	39	7	10
Garissa	300	67	72	50	21	14
Mandera	150	51	43	120	22	24
Siaya	15	5	6	9	3	3
Kisumu	1	0	1	-	-	-
Homa Bay	21	3	5	15	3	4
Turkana	400	57	85	80	11	17
West Pokot	200	20	41	150	14	32
Samburu	200	33	42	26	9	9
Baringo	105	23	28	50	8	11
Elgeyo Marakwet	5	0	1	5	0	1
Laikipia	100	23	30	45	11	16
Narok	300	19	57	200	14	38
Kajiado	200	22	43	150	527	2,784
Busia	.	.	.	.	.	.

Data source: KIPPRA (2018) Survey

Appendix 5: Variable description

Variables	Variable Codes	
County		
Mombasa	0	1
Kwale	0	1
Kilifi	0	1
Tana River	0	1
Taita Taveta	0	1
Marsabit	0	1
Isiolo	0	1
Tharaka Nithi	0	1
Embu	0	1
Kitui	0	1
Machakos	0	1
Makueni	0	1
Garissa	0	1
Mandera	0	1
Siaya	0	1
Kisumu	0	1
Homa Bay	0	1
Turkana	0	1
West Pokot	0	1
Samburu	0	1
Baringo	0	1
Elgeyo Marakwet	0	1
Laikipia	0	1
Narok	0	1
Kajiado	0	1
Busia	0	1
Hh_size	1	22
Sex1		
Male	0	1
Age1	16	100
Age_sq	256	10000

Marital_Status		
Divorced/~d	o	1
Widowed	o	1
Married/l..	o	1
Education		
Pre-primary	o	1
Primary	o	1
Secondary	o	1
TVET	o	1
University	o	1
Economic Activity		
Own famil..	o	1
Own famil..	o	1
Seeking ..)	o	1
Seeking ..)	o	1
Retired	o	1
Home maker	o	1
Full time..	o	1
Incapacit~d	o	1
Other ina..	o	1
Rainfall variability		
Lower	o	1
No change	o	1
Temperature variability		
Lower	o	1
No change	o	1
Drought variability		
Lower	o	1
No change	o	1
Rainfall impact		

Moderate ..	0	1
No impact	0	1
Temperature _impact		
Moderate ..	0	1
No impact	0	1
Drought_impact		
Moderate ..	0	1
No impact	0	1
Remittances		
Measur~Ke_B4	0	1
Measure~d_B4	0	1
Measur~Ke_Dg	0	1
Measure~d_Dg	0	1
Measur~Ke_AF	0	1
Measure~d_AF	0	1

Data source: KIPPRA (2018) Survey

Appendix 6: Multi-logit regression results for determinants for food security

(Base outcome =3 meals a day)		
	2 meals a day	**1 meal a day**
Variables		
County		
Mombasa	1.35* (0.694)	0.12* (0.736)
Tana River	2.43*** (0.653)	-1.04 (1.150)
Taita Taveta	1.89*** (0.590)	0.269778 (0.614)
Isiolo	-0.87 (0.780)	-1.44* (0.744)
Kitui	2.34*** (0.598)	0.24 (0.655)
Makueni	1.46* (0.577)	0.37 (0.557)
Garissa	1.73** (0.618)	0.35 (0.700)
Mandera	1.63* (0.654)	-0.50 (0.820)
Turkana	3.67*** (0.875)	2.07* (0.886)
Elgeyo Marakwet	-1.80 (1.139)	1.17* (0.534)
Education		
Primary	-0.79** (0.279)	0.10 (0.269)
TVET	-1.78*** (0.492)	-0.03 (0.414)
University	-1.74* (0.687)	-0.52 (0.590)
Economic Activity		
Own family business	0.16 (0.238)	-0.16 (0.242)
Own family agricultural holding	-0.55* (0.273)	-0.49* (0.254)
Rainfall variability		
Lower	0.91*** (0.266)	0.41* (-0.231)
Rainfall impact		

No impact	1.14* (0.522)	-0.57 (-0.556)
Temperature impact		
Moderate impact	0.79** (0.270)	-0.09 (0.287)
Drought impact		
Moderate impact	-1.14** (0.401)	0.07 (0.339)
No impact	-1.41* (0.740)	-0.05 (0.665)
Remittances		
Remittance from within Kenya	-2.65* (1.349)	-1.32 (1.219)
_cons	-2.15* (1.058)	-1.23 (1.013)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Data Source: KIPPRA (2018)