

The nature of food insecurity and agro-pastoral production in the Kerio river basin

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Abstract

This paper encompasses a study that was conducted to assess the nature of food insecurity and agro-pastoral production in Kerio Valley, a semi-arid basin in north-western Kenya. The study targeted 2600 households in the region from which a sample of 387 households was obtained using Yamane's (1967) sample size determination formula. Both quantitative and qualitative data were obtained through a questionnaire that also incorporated and adapted the phased index of the Food Insecurity Experience Scale (FIES), Key Informants Interviews (KIIs) and Focused Group Discussions (FGDs), respectively. The study established that 67 per cent of the households experienced inadequate access to food, and 87.2 per cent of the households experienced inadequate access to preferred food. More so, 75 per cent of the households had been engaged in subsistence agricultural production with the use of limited technology. The key occupation for most of the households (74%) reported was agro-pastoral activities. The study concluded that the nature of agricultural production was among the drivers of food insecurity in the Kerio Basin. The study recommends a need to pay more attention to resilient and transformative agricultural production.

Key terms: Agro-pastoral production, arid and semi-arid lands, food insecurity, topography, transformative.

INTRODUCTION

Food insecurity continues to be a major challenge in various regions, with over one-third of the global population experiencing food insecurity. Many of them live in Sub-Saharan Africa (SSA), particularly East and Horn of Africa (EHOA); a region usually considered one of the most vulnerable to severe food insecurity. The Eastern and Horn of Africa is also characterised by arid and semi-arid lands (ASAL), which extend to a large part of northern Kenya, particularly north-western Kenya and the Kerio River Basin. Accordingly, the region experiences inadequate, irregular, and erratic nature of rainfall. In addition, the region is organised largely around a community agro-pastoral production (CAPP) based on community land-use rights (CLUR) and agro-pastoral livelihoods (APL) consisting of crop production, livestock production, and herding.

The vulnerability to food insecurity in the region has been associated with varied topography, inadequate, irregular, and erratic nature of rainfall, eroded pastures, erosive rain and wind, bared and marginal soil, and related resource conflicts (World Bank, 2014; GOK, 2019; FAO, 2015; Huho & Mugalavai, 2010). By 2018, 30 per cent of the global population (2.3 billion people) experienced a relative (moderate to severe) shortage of food. Among the food-deficient population, 11 per cent globally (equivalent to 821 million) experienced a severe shortage of food (FAO, 2018a; FAO, 2018b; FAO, 2017). In addition, 124 million people in over 51 countries around the world experienced chronic food shortages and crisis levels of food insecurity in 2017 (FSIN, 2018; FAO, 2018). Agro-pastoral practices, considered one of the key determinants of food insecurity in the Kerio valley basin, have been traced to as early as 8000 BC around ancient Turkey and Mesopotamia region (Laugier, 2020; Casana, 2013; Abdi, 2003). These practices have evolved to the present based on community (customary) land-use rights (CLUR) to support agro-pastoral livelihoods. Available estimates indicate that around 120 million people globally are engaged in agro-pastoral production, out of which 50 million reside in SSA (FAO, 2018; World Bank, 2014). To this end, this study assessed the nature of food insecurity and agro-pastoral production in the Kerio River Basin.

LITERATURE REVIEW

Kerio River is typically characterised by three (3) agro-ecological zones, notably the highland zone (> 2,500-3,000 m) to the west of the Valley, the escarpment zone (1,300-2,500 m) on the intermediate, and the Valley Zone (floor 1,000-1,300 m). With an altitude of approximately 1200 meters, the floor of the valley is a low land along the Kerio River in which the escarpment, particularly on the Marakwet side, rises to some 1,830 meters above the floor of the Valley. The valley stretches along the Kerio River, which flows northwards to Lake Turkana in the North and major tributaries along the triangle border include Chesegon, Embobut, Embolot, Enou, and Embomon rivers. The composition of the livelihoods at the floor of the Valley remains; livestock, notably cattle, goats, sheep, and poultry, as well as cultivation of crops that include millet, sorghum, cassava, maize, groundnuts, green grams, and fruits with considerable risk of soil erosion, landslides, and rock, falls (World Bank, 2014; Changach, 2018). Cassava was introduced by the British Government in the 1940s as a drought/famine-resistant crop and has remained one of the most reliable food crops in times of drought.

While history indicates that the early settlers in the Kerio Basin as late as the 1700s engaged in agro-pastoral activities, the Basin has a long history of chronic food insecurity. A study by Kimosop (2010) traced drought cycles in Kerio Valley Basin to 1886, when a drought cycle affected water and food availability. Similar incidences were repeated in 1918, 1925, 1934, 1938, 1842, 1973, to 2009. The most severe drought cycles included 1925, 1938, the early 1940s, and 1973-74 where about 50 per cent of the livestock were lost, and a considerable number of human lives were also lost. The Basin has witnessed three major drought cycles since the year 2000, which claimed loss of lives and livelihoods. With drought cycles reduced to an interval of 2-3 years, the Basin has lived with chronic food insecurity.

By 2018, the Basin was experiencing the twin challenges of poverty and food insecurity with the former at 67 per cent compared to the national average of 46 per cent and 73.3 per cent of the population experienced a shortage of food. In addition, over 40 per cent of the children below five years were characterised by stunted growth because

of malnutrition (GOK, 2019; Cherop et al., 2019; EMC CIDP, 2018). The drivers of food insecurity have revolved around five (5) interrelated processes, namely population increase, environmental variability,

conflict, limited adaptive capacity, and agricultural production (FAO, 2018; Jones et al., 2017; Thornton et al., 2014; WFG, 2017).

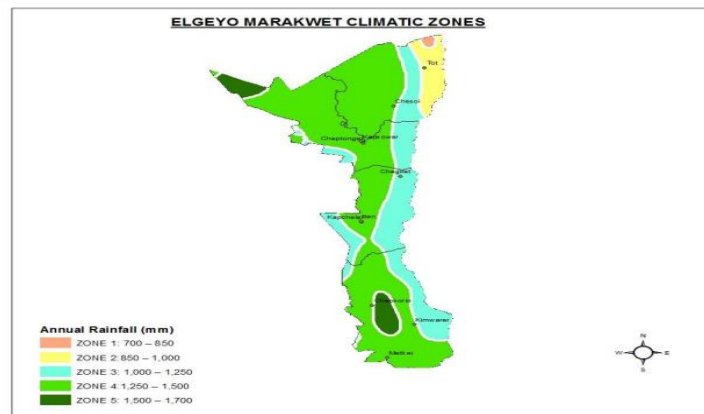


Figure 1: Elgeyo Marakwet Climatic Zones

Inhabitants in arid and semi-arid regions, particularly in SSA, EHOA, and north-western Kenya, including Kerio Basin, have been organised around community agro-pastoral production (CAPP). This is an organisation where land use and related resources are shared among members of a household, family, clan, and/or community (Flintan, 2019; Nkonya, 2018). Such an organisation has also been described as a collective use of land and related resources by family, clan, or community members. The community agro-pastoral production has also been referred to as customary land tenure or customary land insecurity (Flintan, 2019; Wily, 2018; Flintan et al., 2013; Mwakubo, 2002).

In community (customary) agro-pastoral production, a parcel of land and related resources are held in trust by a community, clan, or family who subsequently grants limited rights of use to members, particularly to establish a homestead, subsistent cultivation, and livestock herding (Flintan, 2019; Flintan et al., 2013; Mwakubo, 2002). However, CAPP has also been associated with increased environmental degradation, limited agricultural productivity, chronic food insecurity, and increasing socioeconomic vulnerability. Community agro-pastoral production (CAPP) was described in economic and environmental sciences as the tragedy of the commons where collective users compete for shared resources leading to overuse, depletion, and conflict among the various users. Common or shared use of land resources was

described initially by Lloyd (1833) in a hypothetical analysis of unregulated grazing on common land in Britain and Ireland. The same perspective was popularised by Hardin (1968) in an analysis of the overgrazing of common land. Elinor Ostrom received the Nobel Prize in Economic Science for using the concept in her book governing the Commons.

Over the years, community (collective, common) agro-pastoral production came to be associated with key processes and challenges, including 1) collective use of parcels of land and related resources by members (entities) of a household, family, clan, or community; 2) a tendency to overuse, deplete the parcels of land and related resources resulting to increased competition, contestation and varied forms of conflicts, particularly intra-and inter-ethnic conflicts (Berry, 1993); 3) lack of exclusive formal land rights including title deeds because the land rights have been vested with either the clan or the community; 4) limited rights of some hectares are typically granted toward the establishment of the homestead, crop cultivation and livestock production; 5) accordingly limited right of use has been accompanied by no or limited incentives for investment towards improved agricultural production and overall socioeconomic development (DM et al., 2013).

METHODOLOGY

This study used a survey research method to collect data at identified locations and times. The design helped establish the difference between resource conflicts, environmental variability, and food insecurity. The study was carried out in north-western Kenya, specifically the Kerio River Basin. Specifically, the study was carried out in three Wards in the

Northern Kerio Valley (NKV); a triangle border between the North-West of Baringo County (NWBC), the Elgeyo Marakwet County (EMC), and the West Pokot County (WPC). The three Wards were Kolowa in Tiaty (NWBC), Endo Marakwet of the EMC and Cheptulel in WPC; which also include their respective communities; namely the Pokot of Tiaty (NWBC), Marakwet of the EMC and the Pokot of the WPC.

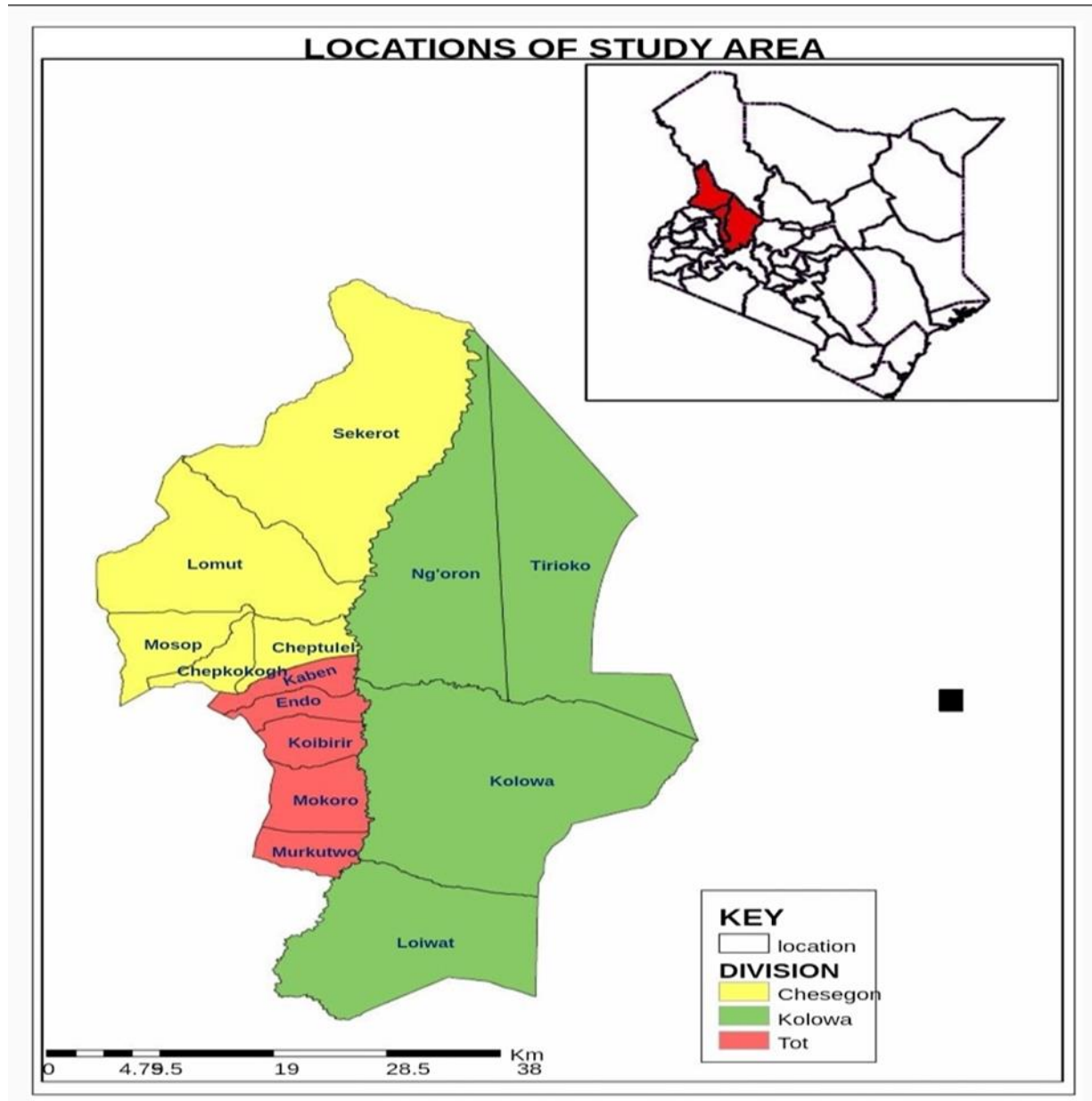


Figure 2: Location of the Kerio Valley Basin in Kenya

The study population comprised households from the three wards, with 2600 households forming 878 households in Kolowa, 915 households in Endo, and

807 households in Lomut. In view of the 2600 households, the formula by Yamane (1967) was used to determine a representative sample at a 95 per cent

level of confidence. Accordingly, with the population of 2,600 households and the use of the Yamane formula below with a 95 per cent probability of confidence, the required sample was 335.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

In addition, a contingency of 15 per cent was added to address non-responses i.e., 335+52, resulting in a total sample of 387.

Table 1: Proportional Distribution of the Sample to the 3 Wards in 2019

No	Location	Number of households	Percentage (%)	Sample
1.	Endo	965	37	145
2.	Lomut	807	31	120
3.	Kolowa	828	32	122
	Total	2,600	100	387

In this respect, a sample of 145 was required in Endo, 120 in Lomut, and 122 in Kolowa to represent the respective sub-populations in the three Wards and to support necessary generalisation.

Data were collected from fifteen (15) key informants, including a chief; a local religious leader (Catholic, African Inland Church); a head teacher at a local school; a local security personnel or agent; and agricultural personnel from each of the wards. In addition, focused group discussions (FGD) of twelve (12) members were conducted from each Ward. This included; 2 local chiefs; 2 local religious leaders (Catholic, African Inland Church); 2 head teachers at a local school; 2 local security personnel; 2 business representatives; and 2 agricultural personnel. Finally, a survey questionnaire was used to collect both structured and open-ended questions.

The study adopted the Food Insecurity Experience Scale (FIES), an experience-based index, developed by FAO as a standard measure (indicator) of the prevalence of food insecurity in a population. The

study used a five-phase scale to assess the experience of the households on food insecurity in the triangle of the North Kerio Basin; namely 1) always adequate access and availability of food, 2) limited access-availability only to basic food, 3) mild (or occasionally) inadequate access and availability of food, 4) extensively inadequate access and availability of food, and 5) severely inadequate access and availability of food. Therefore, the five-phase scale of FIES was incorporated into the questionnaire. Data analysis was done using SPSS version 23, where qualitative and quantitative data were analysed in line with the study's objectives.

RESULTS AND DISCUSSION

Nature of Food Insecurity

The responses of the households with respect to the Wards in Northern Kerio Valley (NKV) were summarised in Table 2 below. The principal Wards for the study were Kolowa in Tiaty, Baringo, Endo in Elgeyo-Marakwet, and Lomut in West Pokot.

Table 2: Household Response in Kolowa, Endo, and Lomut Wards Northern Kerio Valley

	Wards	Frequency	Per cent
1.	Kolowa	122	31.5
2.	Endo	145	37.5
3.	Lomut	120	31.0
	Total	387	100.0

It was noted that 32 per cent of the households were from Kolowa, 38 per cent from Endo Ward, and 31 per cent from Lomut Ward. In assessing the nature of food insecurity in the northern part of the Kerio Valley Basin, the three communities included in the study were the Marakwet in the South, the Pokot of Tiaty (Baringo) in the Southeast and the Pokot of the West Pokot in the North. The hypothesis was that food insecurity would remain considerably higher (above the national average) in the northern part of the Kerio Valley. To address this objective, the study analysed data from the five-phase scale of FIES (FAO, 2017) intended to indicate the experience of the households

on access or availability of basic food, preferred food, and food with required nutrition.

Household Experience of Access to Food

Accordingly, the study analysed the experience of the households on access to (and availability of) basic food based on the five-phase scale of FIES. Responses indicated that 67 per cent of the households experienced inadequate access to food (Table 3), in which 43 per cent experienced mild inadequate access, and 23 per cent experienced severely limited access to food, as demonstrated in Table 3 below.

Table 3: Rating of Access to Food in Kerio Valley

	Level of experience	Frequency	Per cent
1.	<i>Always adequate</i>	44	12
2.	<i>Limited access only to preferred food</i>	82	22
3.	<i>Mildly inadequate</i>	161	43
4.	<i>Extensively inadequate</i>	53	13
5.	<i>Severely limited/hunger</i>	8	10
	Total	378	100.0

In addition, the study analysed the experience of the households on access to (and availability of) basic food in the last five years. The data for the 5 years were collected to account for the 3 to 5 years of environmental variability, particularly the drought cycle. Responses indicated that 63 per cent of the

households experienced inadequate access to food in the last five (5) years (Table 4), in which 48 per cent experienced mild inadequate access to food, and 15 per cent experienced severely inadequate access to food.

Table 4: Rating of Experience of Adequate Access to Food in the Last 5 Years

	Level of experience	Frequency	Per cent
1.	Mostly adequate	34	9.1
2.	Adequate	97	25.9
3.	Mildly inadequate	179	47.7
4.	Extensively inadequate	56	14.9
5.	Severely limited	9	2.4
	Total	375	100.0

From the findings presented in Table 4, it was observed that, on average, 65 per cent of the households did not have access to adequate food.

Adequate Access to Preferred Food

The study also analysed the experience of the households on access to (and availability of) preferred

food based on the five-phase scale of FIES. Responses are summarised in Table 5. The results indicated that 87.2 per cent of the households experienced inadequate access to preferred food, 44 per cent experienced extensive maintenance of preferred food, and 20 per cent experienced severely inadequate maintenance of preferred food, as shown in Table 5.

Table 5: Experience of Household Access to Preferred Food in 2019

	Level of experience	Frequency	Per cent
1.	Always adequate	7	1.9
2.	Limited access only to preferred food	41	11.0
3.	Mildly inadequate	89	23.8
4.	Extensive inadequate/Reduced quantities	164	43.9
5.	Severely inadequate/experience of hunger	73	19.5
	Total	374	100.0

Similarly, households were requested to indicate their experience of access to preferred food in the last five years to address the cycle of environmental variability among other considerations. Responses indicated that 88.3 per cent of the households experienced inadequate access to preferred food in the last five (5) years (Table 6), in which 42 per cent experienced

extensive inadequate maintenance of preferred food, 23 per cent experienced mildly inadequate maintenance of preferred food, and 23 per cent experienced severely inadequate maintenance of preferred food and the findings are presented in Table 6.

Table 6: Experience of Household Access to Preferred Food in the Last 5 Years

	Level of experience	Frequency	Per cent
1.	Mostly adequate	9	2.4
2.	Adequate	34	9.2
3.	Mildly inadequate	86	23.2
4.	Extensively inadequate	155	41.9
5.	Severely inadequate	86	23.2
	Total	370	100.0

Experience of Access to Food with Nutrition

The study further analysed the experience of the households on access to (and availability of) food with required nutrition based on the five-phase scale of FIES. The study also assessed the nature of food insecurity in Kerio Valley, using the indicator of maintenance of nutritional needs; and responses were summarised in Table 7. From the finding, 78.3 per cent of the households experienced inadequate

maintenance of required nutritional needs: which 33 per cent experienced mildly inadequate maintenance of required nutritional needs; a larger proportion of 34 per cent experienced extensively inadequate maintenance of required nutritional needs, and 10 per cent reported severely inadequate maintenance of required nutritional needs (or essentially the experience of hunger) as demonstrated in Table 7.

Table 7: Experience of Access to Food with Nutrition

	Level of experience	Frequency	Per cent
1.	Always adequate	14	3.7
2.	Limited access only to preferred food	68	18.0
3.	Mildly inadequate	126	33.3
4.	Extensively inadequate/reduced quantities	131	34.7
5.	Severely inadequate/experience of hunger	39	10.3
	Total	378	100.0

The study also assessed the nature of food insecurity in Kerio Valley, using the indicator of maintenance of nutritional needs in the last five years; and responses

presented in Table 8. It was clearly found that 83.7 per cent of the households experienced inadequate maintenance of required nutritional needs, 37 per cent

of the households experienced extensively inadequate maintenance of required nutritional needs, 33 per cent mildly inadequate, and 14 per cent experienced severely inadequate required nutritional needs.

Table 8: Experience of Access to Food with Nutrition in the Last 5 Years

Level of experience	Frequency	Per cent
Mostly adequate	10	2.7
Adequate	51	13.6
Mildly inadequate	124	33.2
Substantially inadequate	137	36.6
Severely inadequate	52	13.9
Total	374	100.0

Meals per Day

Several studies have used meals per day as an indicator of food insecurity (Coates et al., 2007). These studies have reasoned that food is a necessity and that three meals a day are a basic indicator of food security. However, a considerable segment of the population did not have the luxury or pleasure of three meals a day. In extreme food insecurity, many would even be

fortunate to survive with one meal a day. Accordingly, the study assessed the experience of the household on the number of meals in a day in the last six (6) months, and responses are summarised in Figure 3 below. Responses indicated that 54 per cent of the households lived on 2 meals per day in the last three (3) years.

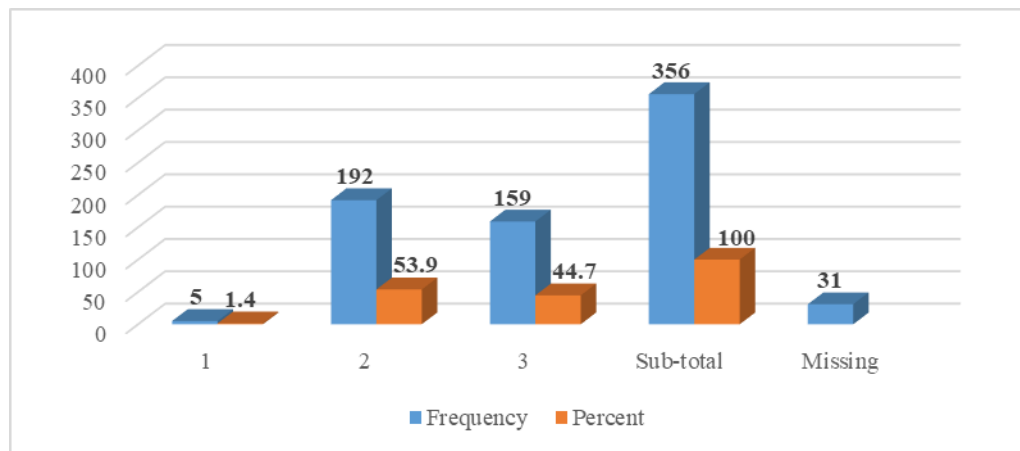


Figure 3: Number of Meals per Day in the Last 3 Years (2019)

All the key informants in the three wards agreed that most people take 2 meals per day, that is, in the morning and evening. During the day, most people take fruits or water, and they do not prioritise meals during lunch hour.

Worst Years for the Households

The study assessed the indication of the year that the household experienced the greatest food shortage; responses are summarised in Table 9. It was noted that most of the households (25.6) indicated 2016 and 2017 as the worst years for accessing required food, necessary preferences, and nutrition.

Table 9: Worst Years for the Households as Reported in 2019

Years	Frequency	Per cent
2020	63	16.8
2018	34	9.1
2017	96	25.6

2016	96	25.6
2009	23	6.1
Total	370	100.0

Indeed, most experts and key informants indicated that 2016 and 2017 were the worst years in which research communities experienced drought, and most crops did not yield much. There was low rainfall, and they had to depend on government relief and NGOs to provide food for the residents.

Nature of Agro-Pastoral Food Production

The importance of the agricultural sector cannot be over-emphasised. In terms of the national perspective, the agricultural sector contributes an estimated 27 per cent of GDP, remains the principal source of rural livelihoods and income, and supports an estimated 75 per cent of informal employment (World Bank, 2014). However, agriculture and food production in arid and semi-arid zones have been associated with considerable challenges (Shimeles & Nabassaga, 2018; WB, 2014). Available literature had indicated that Kerio Valley, in general, was a low-lying semi-arid zone with the potential and challenge the semi-arid zones. Part of the key challenges included limited rainfall and, therefore, limited productivity for rain-based production. The study also assessed the nature and the characteristics of food production in the Kerio Valley. The specific hypothesis was that the levels of agricultural production would be different among the three communities.

Land Tenure and Ownership

The system of land tenure in Kerio Valley had traditionally been based on common ancestral land rights (CALR), a system where a group of people with common ancestry maintained common rights over a given parcel of land. This system has been practised for centuries, not only in Kerio Valley but also in most of the arid and semi-arid regions (Opiyo et al., 2011).

Available reports indicated that community lands covered approximately 6 billion hectares globally and supported about 2.5 billion people (Wily, 2018; FAO, 2015). The estimated 2 billion hectares of customary/community lands in Sub Sahara Africa (SSA) supported livestock production, agricultural production, development of urban centres, and extraction of natural resources.

Of course, several scholars opposed such a system persistently, among others. In an article on the over-use of a common resource, Lloyd (1833) provided a scientific foundation against the sustainability of a common resource such as common grazing land. Following the logical framework provided by Lloyd. Hardin (1968) advanced the theory of the "Tragedy of the Commons", re-emphasised the inevitable overuse of the common resource, and again, with the example of overuse of common grazing land (Lloyd, 1883; Hardin, 1968). Indeed, Lloyd and Hardin considered the inevitable challenge of the increased population, diminishing resources, and the customary practice of common resources.

Previous studies considered land a fundamental natural resource supporting various products, including livestock, agriculture, and minerals. In addition, studies re-emphasised land access, control, and security as key assets (mechanisms) of production and productivity of the land (Wily, 2018; Bollig & Österle, 2008). Finally, these studies considered land as an asset that provided opportunities for social and economic empowerment. Given these fundamental considerations, the study assessed land ownership. Responses are presented in Table 10.

Table 10: Land Tenure and Household Ownership

Land ownership	Frequency	Per cent
Community land	269	69.9
Clan/Range	113	29.4
Household title deed	2	0.5
Any other	1	0.3
Total	385	100.0

Accordingly, responses showed that 99.3 per cent of the households lived on community land based on clan-customary rights (CCRs), in which 70 per cent lived on community land and 29 per cent lived on clan-range land. 99.3 per cent of the households had no exclusive land rights and no secure access or control of the land that hosted their residence and livelihood activities. This observation was substantially like those from other sources (KNBS, 2019; KIHBS, 2018).

Several authorities have emphasised that without exclusive land rights, secure access, and control of the land, there would be no sustainable production and development (Akuja & Kandago, 2019; Wily, 2018). These reports have argued that the system of land tenure continued to be a major barrier to the socioeconomic empowerment of the local population, particularly in arid and semi-arid regions. In addition, experts, key informants, and members of FGD reported that although some of the households had been making efforts to achieve food security and surplus for commercialisation, the system of land tenure had continued to be a major barrier.

Experts, key informants, and members of FGD called for ways to register and regulate community land

(demarcation and adjudication) in Kerio Valley to minimise uncertainties and related conflicts and maximise the use of land productivity and socioeconomic empowerment. It was argued that the constitution of Kenya (2010) and related laws, namely the Land Act (2012), no. 6 of 2012 and the Land Registration Act (2012) (Sections 6, 7 and 8), the Community Land Act (2016) provided the legal framework to support registration and regulation of the community land.

Household Land Holding

Even though communities did not have exclusive land rights and/or secure control, individual households had typically been allocated some portion of land, which they would use to maintain homestead and subsistent cultivation (Kipkorir & Kareithi, 2013). Accordingly, the study assessed the household land allocation, specifically average household land holding (AHLH), intended to support homestead and subsistent cultivation. Responses were presented in Table 11. From the responses, the study established that the overall average land allocated to the households was 2.7 Acres across the three wards.

Table 11: Average Household Holding as Reported in 2019

Average household land allocation in hectares (Acres)	Frequency	Per cent
Less than 1	22	5.9
1 – 2	188	50.0
3 – 4	132	35.1
Over 5	34	9.0
Sub-total	376	100.0

In addition, responses revealed that 50 per cent of the households occupied an average of 1-2 acres, and 35 per cent occupied 3-4 acres. In principle, households had some small parcels of land to establish a homestead and to attend basic livelihoods. Other studies had reported an average of 2 to 3 acres toward the maintenance of the homestead and meeting basic livelihoods, and the rest of the land remained common grazing areas (Kipkorir & Kareithi, 2013). Other reports indicated that by 1997, it was estimated that the average household land in Tot Division ranged from

one to six acres, and a majority had two and four acres spread across the valley.

Household Livestock Holding

In addition to cultivation, Livestock production had been a key source of livelihood in the Kerio Basin. Each household, family, or clan maintained a certain number of livestock used to secure livestock products, including milk, blood, and meat, which in part support food security and some income. Livestock in Kerio Valley consisted of varied types of cattle, goats, sheep,

and poultry, some of which had witnessed progressive upgrades. It would be noted that in the relatively more arid zones, extensive pastoralism had remained the main source of livelihood, revolving principally around cattle, small ruminants (mostly goats and sheep), and camels (Shimeles et al., 2018; World Bank, 2014). In transitional and semi-arid areas, where the rainfall is

relatively limited and varied, maize, pulses, roots, and tubers have continued to be dominant food crops alongside livestock. Given the importance of the livestock in the Valley, the study assessed the number of cattle a household maintained, and the findings are presented in Table 12 below.

Table 12: Average Herd of Cattle as Reported in 2019

Average household herds	Frequency	Per cent
1 – 10	203	65.5
11 – 20	78	25.2
21 – 30	29	9.4
Total	310	100.0

Responses indicated that 91 per cent of the households had less than 20 cattle; with an average of 3 cattle per household; in which 66 per cent had less than 10 cattle and 25 per cent had less than 30 cattle. These responses were more or less similar to the estimates provided by

other studies (Murkomen, 2019; WBG, 2017). The study also assessed the number of goats that a household maintained, whose findings are presented in Table 13.

Table 13: Average Herd of Goats as Reported in 2019

Average household Goats	Frequency	Per cent
1 – 20	165	45.4
21 – 30	120	33.0
41 – 50	79	21.6
Total	364	100.0

The study established that 78.4 per cent of the households had less than 30 goats; with an average of 5 goats per household; in which 45 per cent had less than 20 goats and 33 per cent had less than 30 goats. Similarly, these responses were similar to the estimates provided by other studies (Murkomen, 2019; WBG, 2017). Experts, key informants, and members of FGDS indicated that every household had some goats because of their adaptability to the environmental conditions, ease of management, food supplement, social – relation, as well as exchange and commercial value. In addition, experts and key informants reported that both the cattle and goats were of an average grade that supported household food security and limited generation of income.

Type of Food Crops Cultivated

Other studies indicated that the Valley is part of the extended ASALs, which cover approximately 88 per cent of the land in Kenya, characterised by a mean

annual temperature (MAT) greater than 18 °C and annual precipitation in the range of 250 mm to 500 mm. In such agro-ecological zones, the productivity of rain-fed agriculture was limited and vulnerable. In addition, as the zone reduced gradually from the escarpment to the floor of the valley, the composition of the livelihoods changed from reduced agricultural crop production to increased livestock production, which progressed to extensive livestock and pastoralism in the substantially arid zone (Huho & Mugalavai, 2010; Singh et al., 2006; Scholes, 2020).

Although they maintained livestock and considered it a divine blessing, the Marakwet community had also been cultivating food crops for a considerable period (Kipkorir & Welbourn, 2008). Among the key traditional crops included finger millet and sorghum, in which the production of finger millet was particularly important in social relations and economic functions. Finger millet was also used to improve the diet of the

household in addition to milk, meat, and vegetables (Kipkorir & Kareithi, 2013). Studies revealed that millet and sorghum were sustained because the two crops were relatively resistant to high temperatures and low precipitation during droughts. In addition, millet could be stored (preserved) in skin bags for 5 to 10 years and not easily attacked by pests such as weevils. The same crops were maintained by the other two communities in the Valley.

The study assessed the type of cultivation by the households in Kerio Valley, and responses were summarised in table 16. Accordingly, responses indicated that 47 per cent of the household cultivated maize, 17 per cent millet, 16 per cent mangoes, and 12 per cent other types of cereals, including cassava and sorghum. These findings are shown in Table 14.

Table 14: Types of Food Crops Cultivated by the Household as Reported in 2019

		Frequency	Per cent
1.	Maize	181	47
2.	Millet	67	17
3.	Mangoes	60	16
4.	Cereals	47	12
5.	Other types of cereals, including cassava and sorghum	32	0.08
	Total	387	100

These responses were consistent with previous reports, which also indicated that maize was grown in the three agro-ecological zones and generated higher incomes than other crops (Changach, 2018; Kipkorir & Kareithi, 2013). According to a key informant, "sorghum was the old variety that was good for wealth. We sold it locally, and we hoped that the Kenya Breweries Limited (KBL) would provide us with better prices".

The study also established that although 84 per cent of the agricultural produce was cereals, 16 per cent were fruits, particularly mangoes. These observations were also consistent with those of the previous reports (Shimeles et al., 2018; WB, 201; Kipkorir & Kareithi, 2013). However, although the proportion of mangoes was relatively small, mangoes have witnessed a phenomenal expansion in the last decade. Indeed, experts, key informants, and members of FGD reported impressive expansion of the mangoes and the hope of expanded household income, more so with the establishment of the Tot Mango factory operated by Kerio Valley Development Authority (KVDA) that produced mango juice.

Household Land under Cultivation

Greater importance was to establish the size of land cultivated by the households to address their food security, livelihoods, and socioeconomic empowerment. However, several studies have reported that the size of land under household cultivation has continued to decline, particularly in Sub-Sahara Africa, because of various processes, including increased population, poverty, environmental variability, and degradation (FAO, 2013); Indeed, the concept and principle of the size of land under household cultivation had attracted considerable attention because of challenges related to increased population, poverty, environmental variability, and degradation.

Accordingly, the study assessed the size of land under household cultivation, or specifically the average land under household cultivation, to address food security, livelihoods, and possibly socioeconomic empowerment. Responses summarised in table 15 revealed that 89 per cent of the households cultivated an average of 1-2 acres, of which 66 per cent cultivated an average of 1-2 acres, and 23 per cent cultivated less than one acre. These findings are summarised in Table 15.

Table 15: Land Cultivated by Households in 2019

No of Acres	Frequency	Per cent
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< 1	87	23.1
1 – 2	249	66.2
3 – 4	27	7.2
> 5	13	3.5
Total	376	100.0

On average, 1.5 acres of land were under cultivation in each household, and the average acres of land which were under household cultivation in the three Wards were 1.8 in Endo, 1.2 in Kolowa, and 1.3 in Lomut. The study also observed that the size of land under household cultivation was relatively smaller in Lomut and Kolowa. It was interesting to note that these indicators were consistent with the national statistics. By 2013, the national average household size was 0.2–3 acres, which generated roughly 75 per cent of the total agricultural output in Kenya (FAO, 2015; World Bank, 2014). It had also been reported that the households cultivating less than 10 acres of land generated approximately 80 per cent of the agricultural production in sub-Saharan Africa (FAO, 2012), thereby emphasising the importance of smallholder production in sub-Saharan Africa.

Ploughing and Planting Technology

The use of technology in agricultural production in most arid and semi-arid areas has remained considerably limited (Bjornlund et al., 2020; Kipkorir & Kareithi, 2013). These studies reported that the use of technology remained inadequate in four key areas: 1) ploughing, 2) planting (seeds and fertiliser), 3) harvesting, and 4) storage. A Series of inventions and

innovations had been applied to ploughing or turning over the uppermost soil from woods, through to hoe tools, wheeled plough by oxen, to the invention and use of the tractors. Varied forms of hoe tools, wheeled ploughs by oxen, and tractors were still common in Semi-Arid Areas. Planting involved the use of manual to mechanised tools, the use of home or certified seed, and the use of manure or organic fertilisers. Similarly, harvesting technologies varied from manual to mechanised harvesting.

Using a review of literature, experts, and key informants, the study established that the levels of technology used in ploughing, planting, and harvesting continued to be limited, a combination of traditional tools and relatively modern and mechanised tools. The production of technologies used in ploughing, planting, and harvesting supported largely subsistent production. With the challenge of inadequate levels of technology, the study assessed the type of seed that the household had been using in the last three (3) years, and responses are presented in Table 16 below. Accordingly, responses indicated that 61 per cent of the households used local seeds and 39 per cent used certified seeds.

Table 16: Type of Seeds Used in Planting Agricultural Produce as Reported in 2019

	Frequency	Per cent
Local	231	61
Certified	145	39
Total	376	100

Experts, key informants, and members of FGD reported that the use of certified and related technologies had improved considerably from 2010 when an estimated 23 per cent used certified seeds and related technologies. In addition, experts, key informants, and members of FGD reported a smaller proportion of the household used a tractor and or fertiliser to increase the production of their agricultural produce. Accordingly, the study concluded

that the mechanisation of agricultural production was still low and would need a transformative policy and approach.

Rain-fed and Irrigation Options

As part of the lowlands with high temperatures and low precipitation, the productivity of the rain-fed agriculture in the Valley continued to be limited and vulnerable, therefore increasing demand and/or calls

for irrigation (Huho & Mugalavai, 2010; Kipkorir & Kareithi, 2013; Scholes, 2020). The studies have indicated the risk of crop failure in rain-fed semi-arid areas at 25 per cent to 75 per cent, and in arid areas, it ranged from 75 per cent to 100 per cent, with the risk increasing during the period of droughts. In this situation, agricultural crop production was typically the most affected sub-sector of livelihoods.

Several recommendations portray that irrigation would be a sustainable option in arid and semi-arid areas (Cherop et al., 2019; Kipkorir & Kareithi, 2013). Similarly, the escarpment and the Valley had a long history of irrigation. As early as the 17th century, the

Marakwet community used water furrows to irrigate agricultural production, streams of different perennial rivers descending from the escarpment provided water that supported irrigation furrows, which stretched 40 kilometres of the Escarpment from the Arrow River in the South to Embobut River to the North (Cherop et al., 2019; Kipkorir & Kareithi, 2013).

Accordingly, the study assessed the use of rain-fed and irrigated agricultural production, whose findings are as presented in Table 17, indicating that 61 per cent of the households used rain-fed and 39 per cent used irrigation in their cultivation.

Table 17: Use of Rain-fed and Irrigated Agricultural Production as Reported in 2019

	Frequency	Per cent
Rainfed	222	61.3
Irrigation	140	38.7
Total	362	100.0

According to experts, key informants, and members of the FGD, although the local population was aware of the importance of irrigation, the level of irrigation was still traditional/rudimentary through furrow partly because of poverty, lack of adequate priority, inadequate awareness created, and inadequate mobilisation of resources. Therefore, they proposed the adoption of modern irrigation methods such as piped overhead, springier and drip irrigation.

Subsistence and Commercialisation of the Food Crops

By 2005, a majority (70%) of the poor in SSA lived in rural, arid, and semi-arid areas and relied largely on the subsistent production of food (WB, 2010). Following this experience, policies were developed to adopt a transformational approach (strategy) to agricultural outputs, particularly in SSA's rural, arid, and semi-arid areas, to include a greater component of commercialisation (Mlambo & Mapiye, 2015; Muricho et al., 2017). It was considered that commercialisation of the agricultural outputs would support households to generate income which in turn would reduce poverty and provide the ability the households to meet other basic needs, including health, education, and technology, among others. Commercialisation was considered as a planned agricultural output rather

than simply the sale of merely surplus production (Mlambo & Mapiye, 2015; Muricho et al., 2017).

Given this emphasis, initiatives have been carried out, particularly in SSA, to balance between subsistence and commercialisation of the food crops; with special attention to rural, arid, and semi-arid regions to enable households to secure income which would reduce poverty and meet other basic needs including health, education, and investment in technology (FAO, 2015; Muricho et al., 2017; WB, 2014). For example, Kenya maintained a policy that agriculture was to generate household incomes and stimulate the growth of productive off-farm activities in rural areas. Additionally, the Economic Recovery Strategy (ERS, 2003) and the Kenya Vision 2030 emphasised self-sufficiency and the commercialisation of agricultural outputs.

The study assessed the consumption and sale of food production, and responses are summarised in Table 18. Responses indicated that 94.6 per cent of the households cultivated food crops for household subsistence, where 75 per cent consumed their food products and 20 per cent shared them with the extended family.

Table 18: Subsistence and Sale of Cultivated food Crops, as Reported in 2019

	Frequency	Per cent
Household subsistence	281	74.7
Extended family	75	19.9
Commercial	20	5.3
Total	376	100.0

The study established that 20 per cent of the food outputs were used for extended family and other domestic purposes, including domestic exchange, and only 5 per cent were commercialised. Accordingly, the direct commercialisation of the agricultural and food outputs was considerably small. In addition, experts, key informants, and members of FGD emphasised five (5) aspects, namely 1) limited rainfall, 2) inadequate irrigated agriculture, 3) use of limited technology, 4) limited extension services and information, and 5) low income and poverty.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions: The study concludes that the Lower Kerio Valley, particularly the triangle border continues to witness severe food insecurity. The study established that 67 per cent of the households experienced inadequate access to food, and 87.2 per cent of the households experienced inadequate maintenance of required nutrition. These observations were consistent with reports that extreme poverty remained at an average of 57 per cent in parts of the North Rift Region, including the Lower Kerio Valley. In addition, the observations were consistent with reports that extreme poverty was closely linked to food insecurity. Further, it has been established that the land hosting the homestead and agricultural production remained community land, however diminishing in inverse proportion to the increasing population. More specifically, the land, particularly in the lower Kerio Valley (the triangle border), was community land that remained unregistered under the trustee of the County Governments and the council of elders.

The study also concluded that with clan-customary rights (CCRs), each household held an average of 1-3 hectares, which was reduced in inverse proportion to the increasing population. In addition, the average household livestock (AHL) had reduced to an average of 3 cattle and 5 goats per household. Technology

remained limited in the Lower Kerio Basin, particularly in Lomut and Kolowa. The crops under cultivation remained conventional, including maize, millet, cassava, and sorghum. A promising innovation is the emergence of a mango processing plant in Tot operated by KVDA. With the exception of the mangoes, a large part of the crop production is subsistence.

Recommendations: Chronic food insecurity remained considerably high in Kerio Valley, particularly in the lower Kerio Basin; the study recommended a series of mechanisms to reduce chronic food insecurity, particularly levels 3 and 4 of the IPC-Chronic Food Insecurity (CFI) and hunger. Such measures would reduce extreme poverty (SDG 1) towards the national level of 36.1 per cent. In addition, the study recommended that the same mechanisms could be designed and implemented in ways that promoted the well-being of the people (SDG 3) and the community's socioeconomic development. In addition, land hosting the homestead and agricultural production remained community land; the study recommended that the land in Kerio Valley, particularly in lower Kerio Basin, needed to be demarcated and adjudicated so that title deeds could be provided to households to enhance security and control of land tenure, to preserve and maximise the use of land. Indeed, such measures would eliminate the "tragedy of common resource use", reduce internal and opportunistic conflicts, and improve and encourage agricultural and livestock production commercialisation. Finally, the study recommends adopting non-farm productions, commercialising agro-pastoral production, and developing urban centres to reduce household land size. Such measures would reduce pressure on land, increase income opportunities, and reduce food insecurity and poverty. In addition, the development of urban centres will need to be accelerated to

support the growing population, commercial activities, and agro-pastoral industries.

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