



# **Agro-pastoralist Perceptions about the Impacts of Rainfall Variability on Livelihoods in the Lowlands of Marakwet West Sub-County, Kenya**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. All the authors managed the analyses of the study and literature searches. Also, the authors read and approved the final manuscript.*

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## **ABSTRACT**

For farmers to decide whether or not to adopt a particular measure, they must first perceive that rainfall variability has actually occurred. It is necessary to have full knowledge of farmers' perception on rainfall variability. Therefore, the present study sought to understand agro-pastoralist perceptions of rainfall variability and its effect on their livelihoods. The study adopted a descriptive survey design that incorporated both quantitative and qualitative approaches. Stratified random sampling was done to sample respondents for household survey. This consisted of 310 household heads. Structured questionnaires, field observations and secondary data were used to collect data. The data from interview schedules was analyzed using content analysis, described and summarized. Results show that majority of the households had noticed variations in rainfall and its impact on their livelihoods. They perceived that rainfall variability to be increasing causing food shortages (82%), poor crop yields (72%), water scarcity (64%) and reduced livestock holdings (60%). Consequently, households had adopted both on-farm and off-farm. At farm level,

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diversification into drought-tolerant and commercial crops (80%) reduced livestock numbers (78%) timing farm operations (76%) and changing to heat-tolerant breeds (60%) were the main strategies adopted by the respondents. Off-farm strategies included observing early signs of weather (50%), terminating schooling for children (39%) and diversifying income sources into mainly charcoal burning (34%) and sand harvesting (31%). Therefore, to secure livelihoods and improve food security in the lowlands of Marakwet West Sub-County, rain-fed agriculture needs to be complemented with irrigation agriculture and water harvesting techniques.

*Keywords: Livelihood; rainfall variability; perception; agro-pastoralist.*

## 1. INTRODUCTION

According to [1], impacts of rainfall variability are already visible, especially in developing countries like Kenya which are more vulnerable due to their inability to cope with it. In addition, rainfall variability is a critical issue for Kenya due to her dependency on agriculture [2]. Increasing number of natural disaster like rainfall variability have been reported to directly impact livelihoods of people in several parts of the world. In the last decade, more than 200 million people were affected annually by rain variability [3]. Kenya's marginal areas comprise both the arid and semi-arid (ASAL) areas and cover approximately 88% of the country's total area [4], with livestock as the main livelihood. Mixed agro-livestock farming is the main source of livelihoods in ASALs like Marakwet. Rainfall variability has been reported to influence the livelihood of agro-pastoralist both direct and indirect [5]. Crop cultivation is exceptionally delicate to rainfall variability with various impacts. The study further explained that occasional variations in rainfall could affect agro-climatic conditions, can adjust growing seasons, planting and harvesting timetables. Another study by [6] reported a significant relationship between variability of rainfall and disease transmission of vector-borne ailments. [7] added that rainfall variability impacts livestock production dynamics. Climate variability is also known to have an impact on market, access to inputs and food availability. A study by [8] showed that growing-season vegetation production is related to the price of millet at the annual and the seasonal timescales in Sub-Saharan countries. Thus, a growing season characterized by erratic, sparse rainfall resulted in higher prices, and well-distributed abundant rainfall resulted in lower prices. Marakwet is classified as ASAL and is characterized by high rainfall variability, which causes wide fluctuations in water availability for agriculture, livestock keeping and domestic use [2] This has left 41.76% of the population relying on relief food

and over 30,000 children under school feeding program.

Since Marakwet west is predominantly occupied by agro-pastoralists, rainfall variability is likely to provoke the drivers of conflict in many livelihoods, including both crop and livestock production. Despite the efforts to support adaptation of households, people of Marakwet west continue to suffer from poor living conditions due to unreliable rainfall and a weak adaptive capacity. Perception refers to the process of acquisition and understanding of information from one's environment. Farmers have to perceive first that the rainfall pattern has changed, and then identify useful adaptations and implement them.

For farmers to decide whether or not to adopt a particular measure they must first perceive that rainfall variability has actually occurred. Therefore, perception is a necessary prerequisite for adoption. To enhance policy towards tackling the challenges that rainfall variability poses to agro-pastoralist, it is necessary to have full knowledge of farmers' perception on rainfall variability. Though knowledge of people's perceptions and adopted adaptation measures are paramount to inform future actions to ameliorate impacts of climate change, [9] recorded that this seems to have elicited little interest from researchers going by the number of available literatures on climate change awareness.

Furthermore, the association between climate variability and household livelihood responses are largely unexamined yet improving resilience of communities and households to effects of rainfall variability impacts requires understanding of local practices. This gap is predominantly true in agro-pastoralist in remote areas of Marakwet west. With the projected future climate variability and its impacts on rural livelihoods which in Kenya is estimated to cost 3% of Gross

Domestic Product (GDP) per year by 2030, there is also need to develop a menu of livelihood options to serve as a guide for enhancing sustainable households' resilience in the region [10] As to the knowledge of the researcher, no earlier study has been conducted on the knowledge and perception of the local towards rainfall variability on the livelihoods in Marakwet west, Kenya. It is against this background that this paper seeks to understand agro-pastoralist perceptions of rainfall variability and its effect on their livelihoods.

## **2. METHODOLOGY**

### **2.1 Study Area**

The study was conducted in Marakwet West Sub-County, Kenya. Geographically, it lies between latitude 0° 51' N to 1°19'N and longitude 35° 29' E °. The area receives low precipitation between 500mm to 1000mm, high temperatures of up to 40 °C and high dissipation rates thus, the area becomes marginalized for agricultural activities. Seasonal variation occurs in this arid area and rainfall reliability decreases. The region is used principally for pastoralism and agro-pastoralism. The valley floor is of medium potential, appropriate for raising animals like goats, local sheep, beef cattle and bee keeping while crops grown include; cassava, bananas, pawpaw's, sorghum, finger millet, pigeon peas, cow peas, mangoes and cotton.

### **2.2 Research Design**

A descriptive research design was used in the present study. The design enabled generalization of the findings to a larger population of agro-pastoralists in the lowlands of Elgeyo Marakwet County because of its high level of representation. The study utilized a mixed methodology which consolidates both subjective and quantitative examination plans to develop relationship among the key variables, confirm results and enable more noteworthy precision in estimation. This methodology is aimed at overcoming the restrictions of one technique by another and it permits an extensive comprehension of the intricate social world [11].

### **2.3 Target Population**

The study focused on subsistence agro-pastoralist households in the lowlands of Marakwet West Sub-County, a semi-arid zone in

the sub-county. Two locations of Aror and Chesuman were focused with a total households of 1578 households, where Aror location had 1008 individuals and Chesuman had 570 individuals. One key informant from KVDA and two focus groups formed of 8 members were part of the survey.

### **2.4 Sample Size and Sampling Procedure**

Aror and Chesuman locations were framed as strata taking into account their topographical area. Stratified sampling was in this way used to choose the sample for household survey. The sample size for household survey was chosen from the target population of 1578 households and computed utilizing [12] equation such that the sample size was within plus or minus 0.05 of the population proportion with a 95% level of certainty. The study subsequently examined 310 as the base number of respondents for household study where 198 and 112 were households within Aror and Chesuman location, respectively.

Simple random sampling was then used to identify respondents for household survey where household heads or in their absence, a senior member available participated. The researcher purposively chose the key informant from the Kerio Valley Development Authority (KVDA) which is a dynamic establishment in the region. The decision of this establishment was for the most part taking into account their importance to the issue under scrutiny and their accessibility.

### **2.5 Data Collection Instruments**

Questionnaires, interview, field observations and secondary data were utilized to gather information.

### **2.6 Questionnaires**

Primary data on the socio-economic characteristics of the households and impacts were collected using structured questionnaires which were administered to 310 household heads randomly selected. They permit the researcher to achieve a substantial sample inside a constrained time [13] The questionnaire concentrated on issues including demographic information of the respondents and perception of rainfall trends and impacts on livelihood.

## 2.7 Field Observations

Field observation of physical conditions, social contrasts, activities and images give important data. Field visits were made on various zones with various exercises both on-farm and off-farm bearing in mind the end goal to observe and increase comprehension of the livelihood activities of the rural households. These visits additionally empowered blending with individuals at the site of these livelihood exercises. Photos were taken at various locations where it was regarded vital.

## 2.8 Secondary Data

Accessible public, private and other recorded data identified with institutions effort in enhancing response procedures in the zone to supplement essential information were gathered from relevant offices. The information for precipitation patterns was gathered from Cheptebo meteorological station for five years spreading over from 2010 to 2015.

## 2.9 Focus Group Discussions

Focus group discussions consisting of 8 members were used to aggregate livelihood strategies returns and trends in effective activities and changing circumstances. Participants were identified from respective community leaders and youth groups engaged in agriculture-related activities.

## 2.10 Validity of Research Instruments

Validity is the extent to which a test measures what should quantify, its precision and weightiness of deductions, which depend on exploration results [14]. It is the degree to which results acquired from the investigation of the information really speak to the issues under study. Content validity was controlled by making coherent connections amongst inquiries and the targets of the study. The exploration instruments were additionally introduced to the supervisors for their recommendation and fitting changes made before the study.

## 2.11 Reliability of Research Instruments

Reliability is the extent to which the measure of a construct is predictable or consistent (Bhattacherjee, 2012). To check the internal consistency, the questionnaire was pre-tried

through pilot study to find out dependability in requesting data from the households and to distinguish any challenges that the respondents were prone to face when reacting to the items. The pilot study was done in Mon area, a neighboring ward that has comparable characteristics with the two locations. This example was excluded in the study. The questionnaire was controlled to fifteen households, (5% of the sample) from the range to guarantee the device is successful and that the data acquired is legitimate and solid. Amid the pre-test, the participants evaluated the design, legibility, clarity, importance and strategies for safeguarding the anonymity of the participants in the study instrument.

## 2.12 Data Analysis

The data gathered was both subjective and quantitative in nature. The returned questionnaires were checked for consistency, cleaned and the valuable ones coded and analyzed using descriptive statistics by applying the Statistical Package for Social Sciences (SPSS) database form 20. Categorical variables were presented using frequency tables, graphs and pie charts.

## 3. RESULTS AND DISCUSSION

### 3.1 Demographic Characteristics of the Respondents

Gender, age level of education and occupation formed the demographic characteristics of the respondents.

Majority (52.32%) of the respondents were female while 47.67% were males. The farmers' mean age was 31 to 40 years. The participants' level of education is low as shown by a big percentage of primary education attainment (45.7%) and 11.9% of those who had no formal education at all. About 45.0% of the households rely on farming as their main source of income despite that it is subsistence, 25.2% are employed and, 21.2 % are local traders who do business while a small percentage (8.6%) live on casual jobs. This shows the high influence of climatic vagaries on household production.

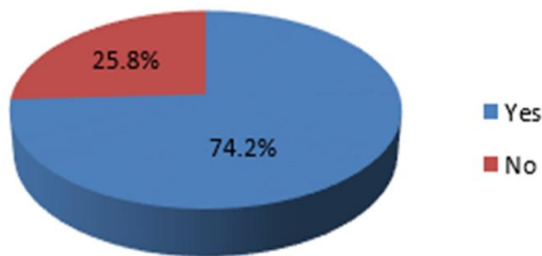
### 3.2 Perceptions of Rainfall Variability and Impacts on Livelihoods

Majority of the respondents (74.2%) professed having noticed variations in rainfall and dire

impacts on their livelihoods (25.8%) expressed ignorance on rainfall variations as in the Fig. 1.

**Table 1. Demographic characteristics of the respondents**

Characteristic	Frequency (n)	Percent (%)
<b>Gender</b>		
Male	144	47.68
Female	158	52.32
<b>Mean age</b>		
10-20 Years	18	6
21-30 Years	41	14
31-40 Years	142	47.0
Above 41 Years	101	33
<b>Level of education</b>		
Primary	138	45.7
Secondary	94	31.1
Tertiary	34	11.3
Informal	36	11.9
<b>Occupation</b>		
Formal Employment	76	25.2
Local trade	64	21.2
Farmer	136	45.0
Casual Labor	26	8.6



**Fig. 1. Responses on noticeable variations in rainfall**

Most of those who noticed variations in rainfall and impacts on livelihoods, 76% sought local indigenous knowledge on climate prediction as opposed to 58% and 74% who sought government agents and media respectively. This indicates that as much indigenous knowledge on climate prediction is still paramount, the adoption of expert information through extension officers and various forms of media is also being embraced albeit slowly.

Correlation analysis showed a significant strong positive correlation ( $r=0.730$ ,  $p=.000$ ) between noticeable variation in rainfall and the source of climate information. This indicates that

awareness on rainfall changes and variations is positively influenced by the source of that information.

**Table 2. Responses on source of climate information and noticeable variations in rainfall**

Source of information	Notice variations?			
	Yes	%	No	%
Government agents	175	58	127	42
Media	224	74	78	26
Indigenous knowledge	243	76	59	24
Own Prediction	146	48	156	52

**Table 3. Pearson correlation between noticeable variation on rainfall and source of climatic information**

	Variations weather	Source of info
Pearson correlation	1	.730**
Sig. (2-tailed)		.000
N	302	302

The participants were asked to give their experiences on rainfall variations observed in the area in the past 5 years. Most participants indicated that the main aspects of rainfall that had posed great risks to their livelihoods are associated with low annual totals, late onset of rain, dry spells between seasons and shortened rainy season; high total rainfall and no change at (72%, 71%, 69%, 52% and 8%) against a slightly lower percentage of respondents who disagreed at (28%, 29%, 31%, 48% and 52%) in that order. The respondents reported that over the years in question, the onset of first rainy season had shifted from a start in early March to third or even fourth week of March and now ended in June rather than May. Meanwhile, they claimed the second season had shifted from a start in August to September and now ended in November than December. One man in his early fifties said this about unpredictable nature of rains 'these rains are confusing, they may come and we plant then they disappear, we lose seeds, manure and it becomes expensive to replant. These days we cannot predict when they will start and end'. These are indications of varying rainfall that cannot be relied on for agricultural planning. Focus group results noted that the rainy seasons had become more unpredictable; with the rainy season ending abruptly and early with dry spells between seasons. They added that the rainy seasons had become short and the distribution

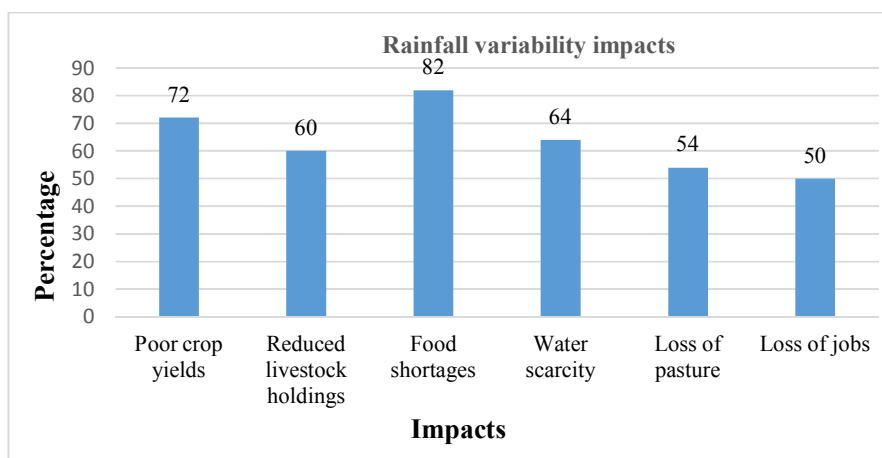
had become more and erratic while the inter-annual variation in rainfall is increasing with some years receiving slightly higher amounts of rainfall than others. These are the same results reported by the institutional representative. They pointed out that current knowledge and climate models are not yet conclusive about the nature of change and impacts, especially at such local levels.

Regarding their perceived impacts on livelihoods, 72% of the respondents indicated that they had experienced poor crop yields, 60% indicated reduced or complete loss of livestock holdings due to droughts, 82% reported food shortages as the major effect on their lives caused by increasing rainfall variability, water shortages was mentioned by 64% of respondents, 54% mentioned pasture loss and 50% associated rainfall variability to them losing casual jobs in farms. In addition, focus group responses identified decline in household income, increased poverty and conflicts over scarce resources as impacts of rainfall variability. They report that during drought and delay in the onset of rain, land becomes dry and becomes difficult to

cultivate. Seed cultivation and germination is hindered, crop desiccation and spoilage of harvested crop, and this was found to have significant difference on the harvest and deprived household livelihoods. Even weeks delay in the onset of rain was found to have significant difference on the harvest. The households reported that the situation had also created an opportunity for weeds to stay in the cropping land so that later they emerge with the crops out-competing them. Erratic rainfall pattern was found to increase opportunities for crop pests and diseases. Drought and delay of rain led to poor regeneration of pasture, shortage of water and heat stress on livestock, consequently increased mortality of the livestock, vulnerability to diseases and physical deterioration due to long distances travel for water and pasture. The problem was further challenged by the shortage of livestock clinics, experts and drugs. The institutional representatives' results are in tandem with the household representatives concerns and pointed out that such effects led generally to acute poverty in the region. The Fig. 2 gives a summary of impacts of rainfall variability in the region.

**Table 4. Responses on perceived variations in rainfall**

Source of information	Weather variations			
	Yes	%	No	%
Dry spells between seasons	208	69	94	31
Late onset of seasonal rain	214	71	88	29
Shorter rainy season	209	69	93	31
Low Total rainfall	216	72	86	28
High Total rainfall	156	52	146	48
No change	145	48	157	52



**Fig. 2. Perceived impacts of rainfall variability**

### 3.3 Trends of Rainfall in the Lowlands

Information on rainfall variability was accessed from the rainfall data collected by the Kenya Meteorological Department (KMD) Cheptebo in the lowlands of Elgeyo Marakwet County. Data consisted of daily rainfall amounts, monthly totals and annual rainfall totals from the years 2010 to 2015. This data is summarized in Figs. 3 and 4.

Analysis of annual rainfall over the six years revealed that it has been fluctuating between highs of 1576.5 mm in 2010 and lows of 1155.5mm in 2015 as shown in Fig. 3. There is one peculiar peak in 2012 of 1675.1mm. In the first peak of the six years, (2010-2012), the mean annual rainfall is 1451.9 mm compared to 1286.3mm for the following years (2013-2015). This indicates that annual rainfall totals are decreasing over years. Mean monthly rainfall for the period depicts the same trend of rainfall oscillating from one year to another. In 2010 for example it was 131.4mm and by 2015 it was 96.3 mm. This clearly indicates variation in rainfall.

Fig. 4 shows that the total number of rainy days for the first three years 2010-2012 was 318 while for the remaining three years 2013-2015 was 283. Generally, the number of rainy days decreased by 11.0% between the two peaks. The seasonal rains varied from month to month. During the main growing season (March, April and May) rainfall showed a general decline in the three months. When they fail in March, they shift to April or May. During the short rains season in August, the season has shifted to October and

November in most of the years. These trends are in line with respondents' perceptions where majority of them stated that there was late onset of rain, short rainy season given the decreasing number of rainy days in the period, unpredictable seasonal rains and decreasing annual totals. A small percentage of respondents felt the annual totals were high and this is also true considering the annual totals in every year. However, for them, seasonal variability was not factored in. This is a clear shift in weather patterns that can be attributed to rainfall variability. The decrease in rainy days can lead to the failure of seasonal rainfall to sustain crop and pasture growth to reach maturity stage and so does for subsistence agriculture. Fig. 4 summarizes this information.

### 3.4 Discussion

The respondents perceived that rainfall variability was increasing by associating it with decreasing annual totals, late onset of seasonal rain, dry spells between seasons and poor distribution over time and space. This caused food shortages, crop failure, reduction in livestock holdings and shortage of water. This indicates that rainfall variability has a negative impact on agro-pastoral livelihoods. This is owed to the fact that water availability is a critical factor for sustainable crop and livestock production in areas dependent on rainfall. The findings agree with similar studies on perception done in Northern Kenya by [15] in 13 ASAL Divisions in Kenya that found out that an overwhelming majority of farmers (91%) n=710 households ) had perceived increase in rainfall variability and adverse risks on livelihoods.

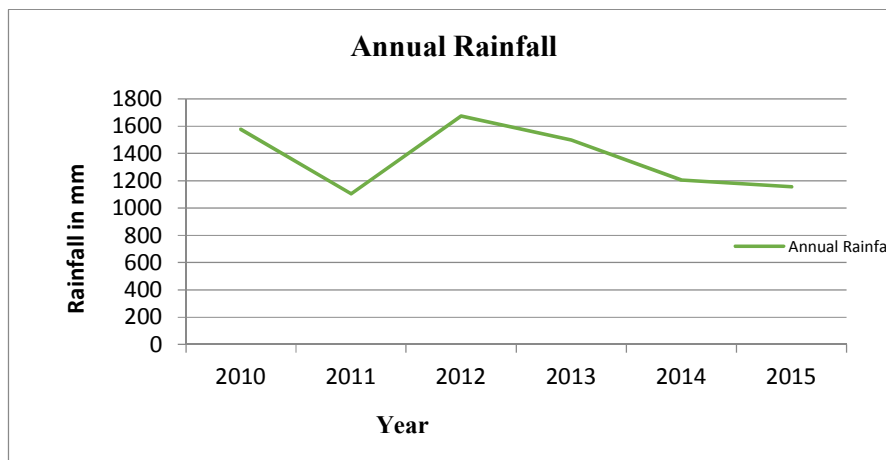
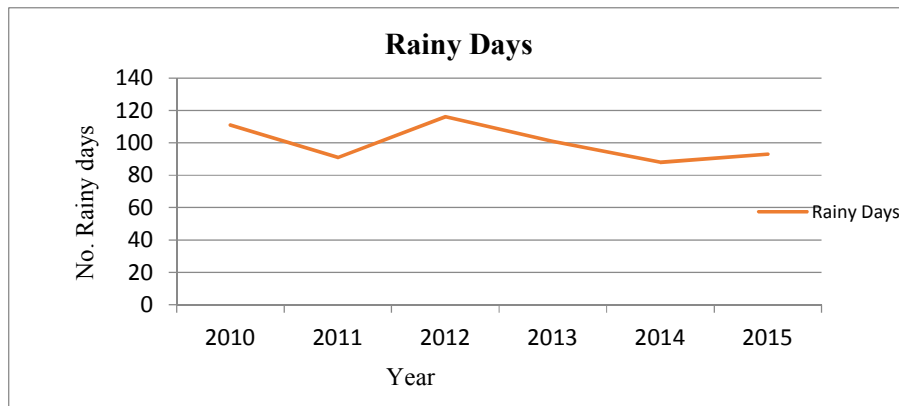


Fig. 3. Line graph for rainfall trends for the lowland from 2010-2015



**Fig. 4. Line graph of rainy days from 2010-2015**

Crop and livestock failure are reported to have led to increased poverty that also increased the inability to meet various domestic and social obligations like buying food and paying school fees, decline in income and conflicts over resources. This is owed to the fact that crop and livestock production are the major lifeline of rural households in such rural semi-arid areas. A study in Northern Kenya by [16] on climate effects concurs with the above findings and blame rainfall variability for increase in general poverty in the region. Crop failure as a common phenomenon in most ASALs while livestock are at risk with their health worsening alongside deteriorating pastures' quantity and quality and drying of water sources and he attributes this to drought which has been reported to cause failure and damage to crops and livestock leading to chronic food shortages. Several studies have been carried on effects of rainfall variability on food shortages including; [17,18,19] and [20] projected a decline in crop yields in Africa to fall by about 10 to 20 % by 2050 or even up to 50% due to rainfall variability, with small scale farmers being the most affected.

Water scarcity was reported to be caused by the drying up of water source due to increased rates of evaporation necessitated by hot seasons and this would increase household costs of acquiring water in terms of expenditure and time. The findings support those of other studies which confirm that long dry spells lead to a reduction of water in various water sources [21]. This forced people to walk long distances in search of water and wasted man hours which would have been used in productive activities. Drying up of water pans forced rural households to look for water for livestock and domestic use. This caused animals to be weak, emaciated and wasted, thereby negatively impacting on their productive capacity.

Other effects included loss of pasture and loss of casual jobs in the farm. Long dry spells have an adverse impact on local ecosystem that support livestock production. This contributes to the failure in regeneration of pastures that results in denuded rangelands increasing mortality of livestock and physical deterioration due to walking long distances looking for food and water. These problems are compounded by shortage of expert advice and drugs. [22] assert that the quality, quantity and distribution of natural pasture is determined by rainfall and the projected variations in rainfall may lead to scarce, scattered and unpredictable pastures. [23] on the other hand relates change in pasture production to increased variability of rainfall and temperatures. Some of the respondents also reported that during dry periods there was minimal and little money in circulation making it difficult for casual labor availability which most of the residents depend on. This led to loss of jobs.

#### **4. CONCLUSION**

The study established that there is a great sense of awareness on rainfall variability and its impacts among local households and there is a strong indication of efforts to respond to adverse effects of rainfall variability. Rainfall variability has negatively affected livelihoods indicated by the increasing food shortages, reduction in agricultural and livestock production and water shortages. However, households have been adapting to these effects and these entail changes in livelihood strategies such as planting drought-resistant varieties of crops, changing animal breeds; adopting conservation measures; timing of farm operations; destocking and reducing farm size; and migration with animals.



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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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