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Assessing the Influence of Rainfall and Temperature on Adoption of Organic Farming in Laikipia West Sub County, Kenya

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ABSTRACT

Organic farming is a new strategy that helps farmers to cope with climate variability affecting several regions including East Africa. This farming strategy helps farmers to bring to an end the perennial problems of agriculture such as erosion, soil depletion, decline of crop varieties, low quality food and livestock feed, and rural poverty. Organic farmers embrace a holistic notion that the health of a nation is built on agriculture which is dependent on the long-term vitality of its soil. The research assessed the influence of rainfall and temperatures on adoption of organic farming in providing solutions to food insecurity and ensuring safe and environmentally sound food production in the area of study. This study collected and analysed the current agricultural practices and how they have been influenced by rainfall and temperature and assessed their effectiveness. The research was guided by Person-situation interaction theory, which purports that interactionism holds personal and situational factors that are multiplicative. The research adopted a cross sectional research design. One hundred and nine (109) respondents were interviewed in this study. Quantitative data was analysed using Statistical Package for Social Sciences (SPSS version 25). Regression analysis was employed to establish any association between the independent and dependent variables within the study.

Keywords: Organic Farming; Interactionism; Climate Variability; Phenomenon, Laikipia West Sub County (LWSC).
JEL Classification: Q01, Q15, Q24, Q28, Q54.

1. Introduction

Kenya is food insecure due to low food production, climatic changes, demographic characteristics and weak agricultural policies. Saina et al (2013) observed that the cause of deteriorating food security in Kenya is frequent drought in recent years. World Bank (2017) realised that the national food security situation per capita in Kenya reduced by more than 10% over the last 3 years. Gebresenbet

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and Kefale, (2012); Gitau et al, (2008) has pointed out that through government's intervention, farmers will minimise their suffering if the traditional farming strategies will give way to new farming strategies. A review of farming strategies and policies that support farming need to be done in Kenya to enhance food security so as to attain food security. As for agriculture in Kenya and Africa, in order to ensure that our tables remain full of food, there is need to abandon unsustainable, business-as-usual agriculture (UNEP 2011).

Today, the agriculture sector is highly affected by climate change globally. A study by Hulme (1996) revealed that there are four ways in which climate would have a physical effect on crops: changes in temperature and precipitation, atmospheric carbon content, water availability, and increased frequency of extreme climate events such as floods and droughts. Organic agricultural practices allow farmers to reduce production costs due to efficiency gains and potentially to avoid additional costs that may arise as a consequence of climate change or unsustainable practices. The bulk of research on organic farming has been done on national and regional scales. Very little research has been conducted in local places about how small scale farmers have responded to the introduction of organic agricultural practices and how factors such as climate, ecology and governance has influenced organic farming. The adoption of organic agriculture is site specific and it is worthwhile to find out the factors affecting or promoting its adoption in different locations. This place based study provides useful insights on the adoption of organic agriculture as a poverty mitigation strategy in rural Africa.

In Kenya, drought is a recurrent phenomenon occurring every year in arid and semi-arid lands (ASALS) resulting in a chronic food shortages (Huho, 2010). LWSC is one of those areas that lies within the ASALS. The Kenya Economic Survey (2018) confirms that agricultural sector recorded a mixed performance in 2017 and there was a decline in production. Drought coupled with pest such as desert locust, fall army worm and diseases was the major cause of this decline particularly on maize production. The production of maize for instance in Kenya declined from 37.8 million bags in 2016 to 35.4 million bags in 2017 (Kenya Economic Survey, 2018). The dry weather conditions led to a decline in production of most of the agricultural commodities during the year in all counties. LWSC is among the areas worst affected by drought resulting to hunger and famine and this has threatened food security in the area. According to FAO (2011), drought in Kenya is becoming more severe and frequent and its spatial extent is increasing. County governments in Kenya have the responsibility of reviewing policies and formulating new ones to help review and revive the agricultural sector (Constitution of Kenya, 2010).

LWSC experiences climatic variability (rainfall and temperature) and this cause's unpredictable crop yield (Deborah L. 2018). Soils in LWSC have been over used due to continued farming throughout the year and through inappropriate use of mineral fertilizers hence reducing the level of food production. Kenya has committed to achieve the sustainable development goals signed by the year 2030. County Governments in Kenya including Laikipia county government are putting in place measures to achieve food security and improve nutrition and promote sustainable agriculture. Although majority of farmers in Laikipia County rely on rain fed agriculture, there are 203,965 hectares for irrigation in the medium potential areas (Laikipia County 2018).

The agriculture sector in the area of study employs up to 60% of the labour force (Laikipia County, 2018). Research conducted by Ulrich, A. (2014), shows that smallholders in Kenya and particularly Laikipia County are faced by increased water scarcity leading to drought, and food insecurity. There are County and National Government programs aimed at reducing the burden on farmers through provision of certified seeds, fertilizers and pesticides to deal with pests such as Army Worms, Desert Locusts and Quelea birds. The County Government of Laikipia is also promoting the growth of millet, sorghum, sunflower and black beans (dolichos) to counter the climate variability and boost food production. Organic farming provides a viable solution to food security, environmental conservation and soil fertility when implemented fully. This study assessed rainfall and temperatures to determine their impact on food security in LWSC.

2. Literature review

There are 2.6 billion people who depend on agriculture for livelihood and most of them are rural dwellers who survive on less than 1 $ US dollar per day (FAO, 2009). Agriculture is a major backbone of most countries in the sub-Sahara Africa. The method of farming practices differs from place to place.

Other countries are still practising traditional farming while others have embraced modern farming. Today, organic farming is becoming a sustainable farming practice that has helped to reduce food insecurity where many nations across the world have embraced. Koohafkan et al. (2012) suggests that the policies and strategies used to promote organic farming are supposed to be embodied in the support for organic agriculture, climate change adaptation and mitigation. In the Kenyan context, organic farming is practiced as sustainable agriculture. However, there is lack of awareness that organic farming can be a mechanism for drought management. Organic farming technologies and waste utilization can make an important contribution to GHG emissions reductions as is happening in Thailand. This method if well utilised in Kenya can provide sustainable environmental management.

In Europe, organic farming is well organised due to heavy investments in agriculture and realisation of the importance of consuming organically grown products (Baret P et al, 2015). The European Action Plan on Organic Food has created awareness on organic farming among farmers in the EU with the aim of promoting consumption of organically produced food. If such can be implemented in Kenya, most farmers might adopt organic farming which in turn would increase food basket in most regions in the country thus counties would be stable with food security.

Although agriculture has been identified as a core sector in most African economies, recently it has been greatly affected by climate variability. A report by IPCC, (2017) shows that global temperatures have risen by about two degrees Celsius in the past 100 years. Without intervention measures such as reducing greenhouse gas emissions and conserving the environment, temperatures are expected to rise in the next 15 years with more pronounced negative effects. As the impact becomes more frequent and severe, the already fragile socio-economic activity of the continent is more likely to escalate.

A study released by the University of Virginia in early May (2018) indicated that East African countries including Kenya will experience heat stress later this century as temperatures hit new highs buoyed by greenhouse gases (UVA today, 2018). This warming is definitely hazardous for agricultural activities in the continent as many of the crops are grown close to the thermal tolerance limit of high temperature and inadequate rainfall. The warming by a few degrees and increase in frequency of extreme weather will strongly influence the agricultural production and make the society especially the small- scale farmers more vulnerable. Agriculture is Kenya's main economic activity contributing up to 24 per cent of its national GDP directly and another 27 per cent indirectly (KPMG Kenya, 2012). About 98% of Kenya's agriculture is rain fed with some 2% relying on irrigation (Kenya Climate Smart Agriculture Strategy 2017-2026). Kenyan's Vision 2030 envisages an annual growth rate of its economy by 10% (GOK 2007). The vision document has identified agriculture as one of the sectors to deliver this growth rate. Kenya government's current 'Big Four Agenda' is a 5 year development initiative that hopes to transform smallholder subsistence agriculture to be more productive. Despite the expectations of improved agricultural production, Kenya is still food insecure.

Kenya's agricultural sector is facing major draw backs including stagnant or declining productivity levels, under-exploitation of land and inefficiencies in the supply chain due to limited storage capacity and climatological factors. Unless agricultural farming is managed and utilised well through improving ecological management and conservation, natural ecosystems will suffer serious degradation. Hillel et al (2008) identified that most modern monoculture systems are particularly vulnerable to climate change and little has been done to enhance their adaptability to changing patterns of precipitation, temperature and extreme weather events. Local Farmers in LWSC are also at a risk due to the nature of farming activities in the area which greatly depend on climatically conditions that prevails.

Schutter et al (2010) suggested that the use of ecologically based management strategies in agricultural farming may increase the productivity, sustainability and resilience of agricultural production while still reducing the undesirable impacts of climate change. Poor agricultural performance in Kenya has negative impacts on other economic sectors thus endangering the livelihoods of many people. Research has shown that vulnerable groups in Kenya such as pastoralists, the landless, and subsistence farmers also depend on agriculture for their survival (Alila & Atieno, 2006). Improved food production in fertile parts of Kenya such as LWSC can ensure food security and help in reducing poverty in Kenya.

To address these problems, organic farming has been identified as one possible avenue towards food security in Kenya. The agricultural sector provides income to more than 80 per cent of the population, employing over 40 per cent of the total population and over 70 per cent of the rural population in Kenya (Ogaloh G. (2016). Organic farming presents an efficient pathway to sustainable agriculture because it can sustain the health of soil, ecosystem and people. Organic farming combines traditional innovations of science to benefit the shared environment and promote fair relationship and a good quality of life for all involved. Some of the key principles of organic farming include; the integration of crops, crop rotation, environmentally friendly pest and weed control practices. This farming practices aims at improving food production and the well-being of individual farmers and society in general while reducing environmental risks (Molly Scott Cato, 2009) such as environmental and soil degradation.

For further optimization of organic product quality and yield stability, new varieties are required that are adapted to organic farming systems. The desired variety traits that determine product quality and yield include climatic factors (that is rainfall, temperature, humidity, wind and others). The study therefore seeks to assess the influence of climatic conditions such as rainfall and temperatures in adoption of organic farming by local farmers in LWSC as an adaptation strategy to climate change.

2.1 Statement of the problem

Farming is one of the economic pillars of Laikipia County in Kenya and the largest sector at Ksh. 35.5 billion (Laikipia County 2018). Farmers in LWSC are often affected by droughts which affect their agricultural produce. Sound agricultural practices have enhanced food production, economic growth and reduced poverty in many countries. However, coping with the changing climate patterns is a great challenge facing many small scale farmers in Kenya and LWSC is also affected. Adoption of organic farming has been used as an adaptation strategy for the impacts of climate change in LWSC. However, no research has been done to understand how rainfall and temperatures influence its adoption. Thus, this research investigated how rainfall and temperatures factors have influenced adoption of organic farming in the area of the study.

2.2 Purpose of the study

The goal of this study was to understand the adaptation needs for organic farming as a mitigation strategy of food security in Laikipia West sub-county, Kenya.

2.2.1 Objective of the study

The study aimed to assess the influence of climatological factors on adoption of organic farming in Laikipia West sub-county, Kenya

2.2.2 Specific objectives

The specific objectives of the study were:

a) To examine the influence of rainfall patterns on the adoption of organic farming in Laikipia West sub-county.

b) To examine the influence of temperature on the adoption of organic farming in Laikipia West sub county, Kenya.

In order to achieve the set objectives, a mixed methods approach was used to acquire meaningful data that would provide a clear understanding on the influence of rainfall and temperatures in organic farming.

3. Data and methods

3.1 Study site

Laikipia West sub-county is in Laikipia County has an area of 4,185.6 km2 with a population of a total of 283,967 persons and a population density of 68 persons per km2 (KNBS, 2019). The study area lies within latitude 00° 18" and 00° 51" North and between longitude 36° 11" and 37° 24' East. It has a wet and dry climatic condition with the highest altitude between 1500m and 2,611m above the sea level (ASL) around Marmanet forest and low altitude towards Rumuruti and Ol Moran with an altitude of less than 1,000m. The sub county consists of mainly of Laikipia plateau bordered by the Great Rift Valley.

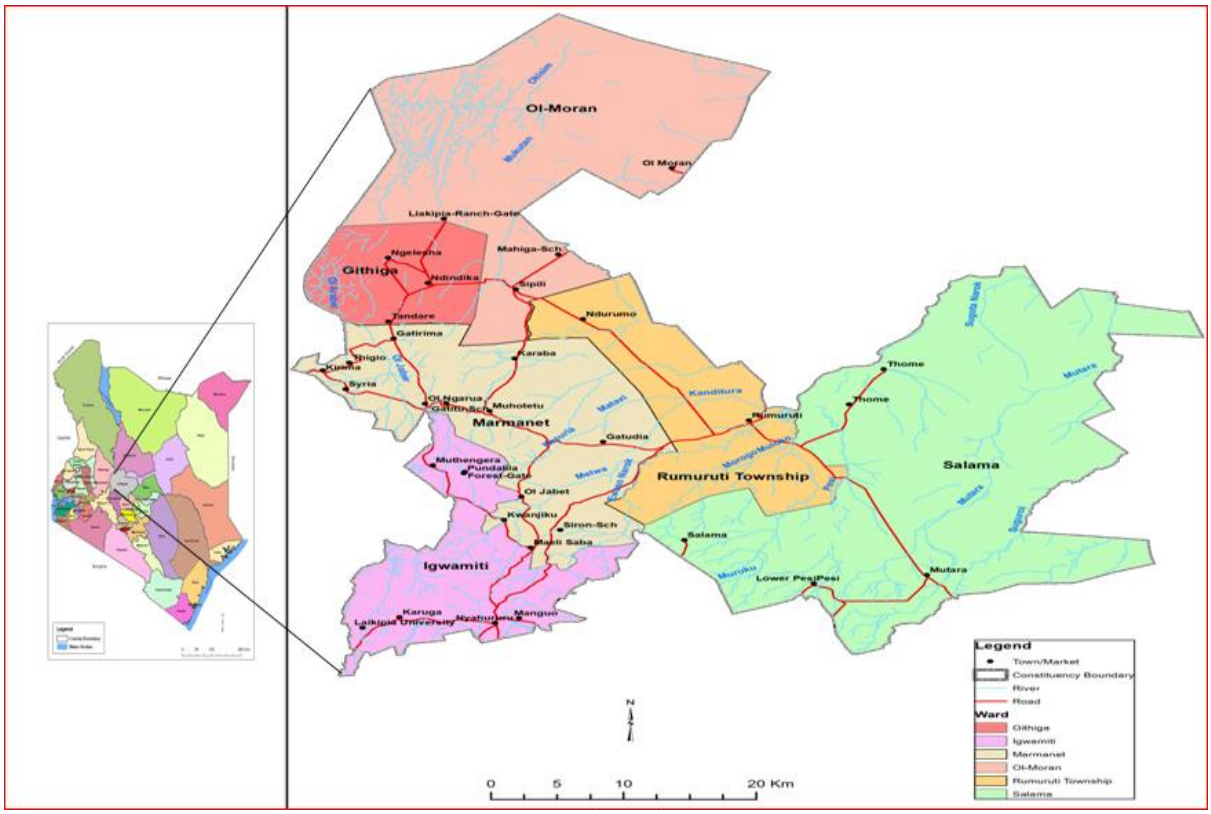

Figure 1. Map of Laikipia West Sub County, Laikipia County, Kenya.

Both mixed farming and pastoralism are commonly practiced within these areas. The average farm size for small scale holders was 2 acres where mixed farming was practiced while for large scale holders was 20 acres mainly for wheat and maize production. The major types of soils are loam, sand and clay soil. Black cotton soil which has inherent fertility is widely spread in most part of the area. The dark reddish brown soils and rocky soils are found on the hillside around Karandi and Mithiga areas (Laikipia County 2018). Destruction of vegetation has reduced agricultural production in the area due to poor weather conditions characterized by low and poor rainfall distribution despite the flooding experienced in 2018. The climate of this region has changed due to the effects of global warming and climate change (McCarthy et al., 2001 Parmesan, C., Yohe, G., 2003).

The area is characterized with a distinct land use pattern that is heavily influenced by climatic conditions and the ecological zones. This include pastoralism in the northern part, ranching and wildlife, mixed farming, informal grazing, charcoal burning, irrigated cultivation in Thome, Maruri, Mia Moja, Melwa, Ngarachi, Wangwachi and Thigio(Laikipia Wildlife Forum , 2017).

3.2 Climatic conditions

The area experiences a relief type of rainfall due to its altitude and location. Two weather stations which are located in Nyahururu and Rumuruti monitor daily changes in the atmosphere.

Table 1.

Mean Annual Rainfall in Millimetres (mm) 2008-2016 in Laikipia west Sub County.

Station	2008	2009	2010	2011	2012	2013	2014	2015	2016
Nyahururu	812.2	638.8	1375.5	1201.2	1500	1560.3	810.2	690.0	913.5
Rumuruti	741.4	535.1	1069.1	1342.0	822.0	1159.5	554.4	713.4	848.6

Source: Kenya Meteorological Department, Laikipia county office, 2018.

The annual average rainfall varies between 800mm and 500mm though Marmanet receives over 900mm of rainfall annually and Rumuruti slightly over 400mm annually. The mean annual temperature ranges between 16° c and 26° c. The average duration of sunshine in the area of study is between 10 hours to 12 hours daily (Kenya Meteorological Department Laikipia County, 2018). Due to the rainfall patterns varying in different times of the year, there is a need to sensitize farmers on the

best time for planting. Some parts of LWSC that used to be the basket of food production are becoming unreliable on food production. This is due to low rainfall, high temperatures, degraded soils, use of outdated farming practices and unreliable or lack of information by the farmers.

3.3 Research design

The study used a cross sectional research design whereby qualitative and quantitative research techniques were employed. Data was collected on the influence of rainfall and temperature on adoption of organic farming practices and the newly employed mitigation strategies against drought in LWSC.

3.4 Participatory approach method

Participatory research approach is based on the assumption that ordinary people such as local farmers in this case are capable of intelligently analysing their actions and that their knowledge is relevant to the modern society today (Slocum et al., 1998). Participatory research emerged in Geography and other social sciences as a critique of research approaches that excluded the researched people in their research process. The ethics, purposes, and outcomes of research conducted on behalf of other people were being questioned (Chambers 1994; Cooke and Kothari 2001). Chambers (1994) argues that participatory research can be an opportunity for rural people such as local farmers to share their perceptions and enhance their knowledge on the local conditions in farming, prioritise, appraise and to plan issues affecting them and solve them together. This approach was used in rural households particularly in the area of study because it was very effective in dealing with rural communities set up. Participatory research approaches are increasingly popularity in developed and developing countries as critical qualitative methodologies which at their best work with participants to effect change (Rachel Pain & Peter Francis, 2003).

In participatory approach, researchers become facilitators of the research process, in order to learn and share knowledge with the local people (Medley & Kalibo 2005). Its methods of data collection include participant observation, focused groups, semi structured interviews; and collaborative activities that help to compile and share new learning within the sphere in which the research was under taken. The participatory approach best suited to this research due to ownership of the research that was shared by participants who negotiate the ideas with the academic researcher. All what the researcher was doing was to evaluate and analyse the data for a comprehensive feedback. In this research a collaborative and a non-hierarchical approach was employed so that the respondents felt free to participate fully in this research study.

Moser and McIlwaine (1999) realised the benefits of participatory approach in research due to its effectiveness in exploring interrelationships, which contribute to community projects. It has also helped in joining up those participants with a different opinion and in terms of capacity building that often involves learning experiences. By using this method, I was able to highlight the spatial and temporal dimensions through the use of techniques such as mapping and timelines. Participatory approaches helped to look into details on relations of farmers in regard to place, space and the environment. Investigation of how certain cultural identities are tied to place and activities such as agriculture was also a common concern when using this method (McIntyre, 2003; Kindon, 2003; Offen, 2003).

This study was designed to be context specific, fore fronting local conditions and local knowledge, and producing situated, rich and layered accounts of events and scenarios in the area of the study. This approach describes a place into details because it represents the views of local respondents within the area of study during the interviews and data collection activities (Mattingly, 2001). A participatory approach encouraged the building of multiple connections toward processes and on issues from various scales. The outcomes of this research through participatory approach were new knowledge and ideas from the local farmers who were the source of information.

3.5 Sampling and sample size

Gay (2003) identified that population in research refers to all items that has similar characteristics which the researcher is interested in the area of study. In this study, the target population was small scale rural households' farmers in LWSC. Since the study was interested in

identifying the adaption needs required in the adoption organic farming in LWSC, the study employed a multiple linear regression analysis. Sample size for this type of analysis can use the 20:1 thumb rule which states that the ratio of the sample size to the number of parameters in a regression model should be at least 20 to 1.

In the study, six independent variables were employed which included; rainfall, temperature, farmer's education level, adoption of organic farming, soil type and government policies. The 20:1 rule means that the minimum number of respondents employed by the study should be n= (20*6) =120. This rule corroborated with Green's (1991) which provides a comprehensive overview of the procedures used to determine regression sample sizes. Green suggested that the sample size (n) for testing multiple correlation should be given by:

Sample size $n \geq 50+8k$,

Where K represent the number of independent variables.

He further explains that for testing individual predictors (assuming a medium-sized relationship), the sample size (n) should be given as follows

$n \geq 103+k$,

Where K represents the number of independent variables

From Green's establishment of sample size, we note that the appropriate sample size for this study should be given by;

Sample size $n \geq 103+6=109$

In that respect, the sample size for this study was 109 rural households who were selected randomly from a target population of 2,990 small scale farmers in which interviews were conducted in 5 wards.

Table 2.

Selection of Farmers from the five Wards in Laikipia west Sub County:

Ward	No. of farmers selected
Ol Moran	21
Rumuruti	21
Marmanet	22
Githiga	22
Igwamiti	23
Total	109

Farmers with prerequisite information on organic farming within LWSC were selected through snow ball method for the semi structured interviews. Primary data was collected using GPS receivers, structured questionnaires, key interviews and focus group discussion while secondary data were obtained through review of related organic farming report and existing organic farming literature. Prior to the study, Google Earth was used to identify specific household targeted during field data collection through a simple random method.

3.6 Validity of the research instrument

The validity of the instrument is demonstrated when an instrument is seen to be enquiring the questions framed in the least ambiguous way. According to Mugenda and Mugenda, (1999) validity refers to the degree to which an instrument accurately measures what it intends to measure. Validity can be verified in three major dimensions which include; content validity, construct validity and criterion validity.

Content validity indicates the extent to which items adequately measure or represent the content of the property or trait that the researcher wishes to measure. While construct validity checks the extent to which the measurements method accurately represents a construct (which include unmeasurable items such as attitude and belief). On the other hand, criterion validity indicates the extent to which the instrument's scores correlate with an external criterion. In this study, the validity of the research instrument was verified. Each question in the instrument in relation to the objectives and topic under study and their comments were used to improve the research instruments prior to the actual data collection.

3.7 Reliability of the research instrument

Mugenda and Mugenda, (1999) further describe reliability as to the degree to which an instrument yields consistent results. Common measures of reliability include internal consistency, test-retest, equivalent form technique, and the split half technique. In this study, the questionnaires were pre-tested to a selected sample in a different population group. In this study, Samburu Central Sub County and LWSC were selected to pre-test the questionnaire. Samburu County was selected due to its climatic conditions which are similar to LWSC and its closed proximity to LWSC.

In line with Mugenda and Mugenda, (1999), the pre-test sample was 10% of the sample size. Therefore, 12 respondents divided into 6 small scale farmers from Samburu County and 6 including agricultural officers from the five wards in LWSC were randomly selected to determine the reliability of the research instrument. The purpose of the pilot study was to refine the research tools so that the respondents in the study will not have a problem while answering the questions. Pre-testing was aimed at determining the reliability of the research tools including the wording, structure and sequence of the questions. Internal consistency of the questionnaire was tested where Cronbach's alpha reliability coefficient was calculated and alpha of 0.70 and above implies a high degree of reliability of data collected and was adopted for the study.

4. Results and discussion

4.1 Farmers views toward climatic change in Laikipia west Sub County

The climatic factors are abiotic or non-living components of the environmental factors that affect plant growth and development. Agriculture is highly dependent on climatic factors. Some climatic factors are risky as they are unavoidable and unexpected. In this study, respondents were asked their views on climate change in Laikipia West sub-county, Kenya.

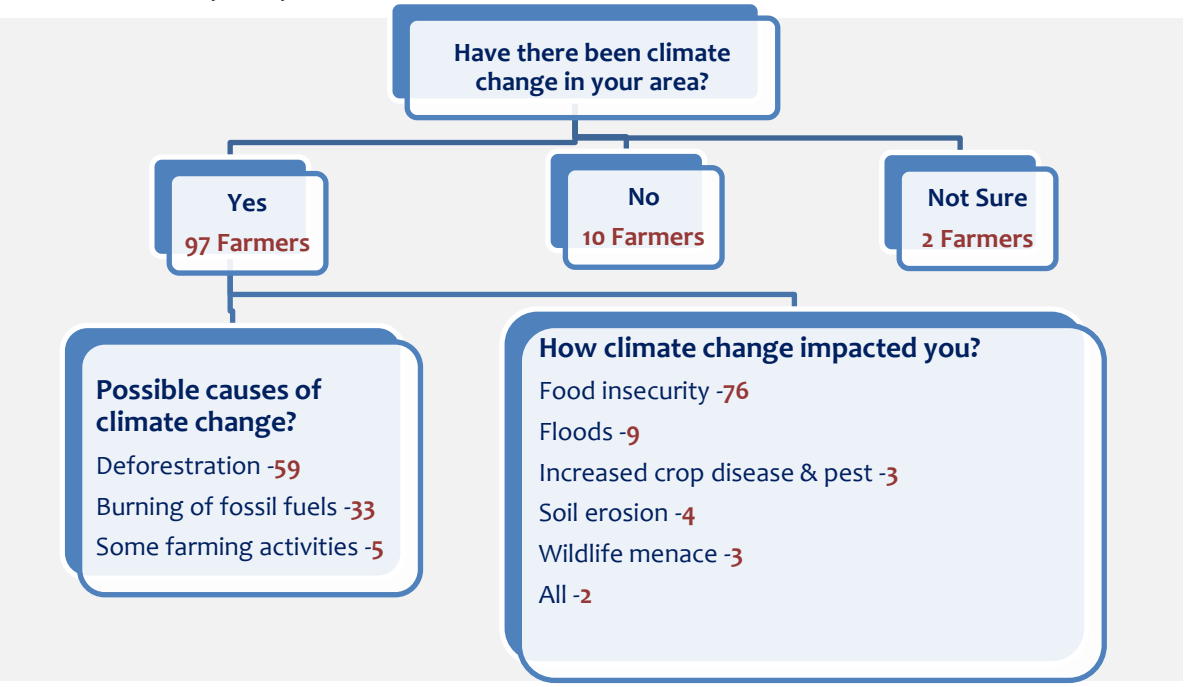

Figure 2. Respondents' views on climate change in Laikipia West Sub-County, Kenya.

A study by Hulme (1996) revealed that there are four ways in which climate would have a physical effect on crops: changes in temperature and precipitation, atmospheric carbon content, water availability, and increased frequency of extreme climate events such as flood and drought.

From the figure 2, 97 respondents claimed that they feel that climate had changed in Laikipia West sub-county, Kenya, 10 of them felt otherwise while 2 of them were not sure. Of the 97 who felt that climate had changed in LWSC, 59 attributed the change to deforestation, 33 to burning of fossil fuels while 5 stated that some farming activities could have caused the change in climates.

The study also sought to know how climate change in Laikipia West Sub-County, Kenya impacted the farmers. On this note, about 76 of the respondents reported that climate change had increased food insecurity. Nine (9) claimed that climate change had caused floods, three (3) of the respondents stated that climate change had increased crop diseases and pest. Some four (4) farmers

attributed soil erosion to the change in climate while three (3) said that climate change had caused wildlife menace.

This study majored in rainfall and temperature as they are the main climatic factors that greatly affects farming. These two factors are the main determiners of how farmers implement organic farming practices. Both rainfall and temperature affects crop yield in different ways as discussed in the following sections:

4.2 Temperature and its influence on farming in the study area

Temperature is a measure of intensity of heat energy. Temperature influences distribution of crop plants and vegetation as well as germination, growth and development of crops. Temperature also affects leaf production, expansion and flowering.

The range of temperature for maximum growth of most of the agricultural plants is between 150c and 40°C. The respondents in this study gave their views regarding temperature changes in Laikipia West Sub- County, Kenya. Up to 99 of the respondents said that temperatures had increased in the past 10 years, while 7 noted that the temperature levels had reduced. Only 3 of the respondents that reported they had not noted any changes in temperature levels. The increased temperatures have made farmers to diversify their farming activities unlike previous where they used to rely in one type of crop farming such as maize and wheat. Under irrigation farmers are doing horticultural farming, organic farming and mixed farming as a strategy of mitigating drought like scenarios which would occur from time to time.

4.3 Rainfall influence on farming in the study area

Rainfall is one of the most important factors that influence the kind of vegetation to be grown in a particular place. In LWSC, 24 of the respondents employed in this study stated that they had noted in an increase in the amount of rainfall while 85 said the amount of rainfalls had actually reduced. Besides, a majority of the respondents (101) stated that rainfall patterns had become so inconsistent. Only 6 reported that rainfall pattern were consistent, 2 of them had not noted any changes in rainfall patterns.

Table 3: summaries the respondents' view on the two climate factors, that is, temperature and rainfall.

Table 3.

Temperature and rainfall changes in Laikipia West Sub –County.

	Increased	Reduced	No changes	Total
Rainfall	24	85	0	**109**
Temperature Levels	99	7	3	**109**
Drought Frequency	97	10	2	**109**

4.3.1 Respondents' experiences on climate changes and its impact

The study sought to understand the various experiences the respondents had witnessed due to climate change and their equivalent impacts. Majority of respondents reported to have been affected by climate changes in their farming activities. , Only Six (6) respondents reported no effects of climate changes on their farming activities. One respondent was not sure. Table 4 below shows the experiences of climate change reported by the respondents.

Table 4.

Respondents' specific climate changes experience

Climate condition	No. of respondents affected
Intense and prolonged rains (El Niño)	3
Prolonged dry spell (La Niña)	2
Inadequate rainfall	103
Unpredictable rains/mid- season uncertainties	99
Too much heat	25
All	6
Total	238

Respondents were allowed to identify more than one specific climate change they may have experienced. Majority of the respondents (103) reported to have experienced inadequate rainfall which affected their crop yield. A number of them (99) reported unpredictable rains and mid-season uncertainties. Too much heat as well as intense and prolonged rains was reported by 25 and 3 respondents respectively. Besides, 2 respondents noted that prolonged dry spell had affected their farming activities.

4.4 Factors contributing to low crop production in the study area

According to the respondents employed in this study, LWSC had encountered low crop production, 61 respondents attributed the low crop production to unpredictable rainfall. However, 28 of the respondents attributed low crop production to high price of farm implements while eight attributed the shortage to poor agricultural practices. Inadequate farm land and low soil fertility were mentioned by 7 and 5 respondents respectively. Table 5 summarizes causes of low crop production as reported by the respondents.

Table 5.

Causes of low crop production in Laikipia West sub-county, Kenya.

Factors contributing to low crop production	Respondents' score
Unpredictable rainfall/ mid-season uncertainty	61
Increased pests and diseases	0
Low soil fertility	5
High price of farm implements and inputs	28
Shortage of labour	0
Poor agricultural practices	8
Inadequate farm land	7
Total	109

4.5 Strategies to mitigate reduced rainfall and increased temperatures in Laikipia West Sub-County, Kenya

Respondents engaged in the study were asked to give their views on some of the mitigation strategies for reduced rainfall and increased temperatures. Their responses are shown below;

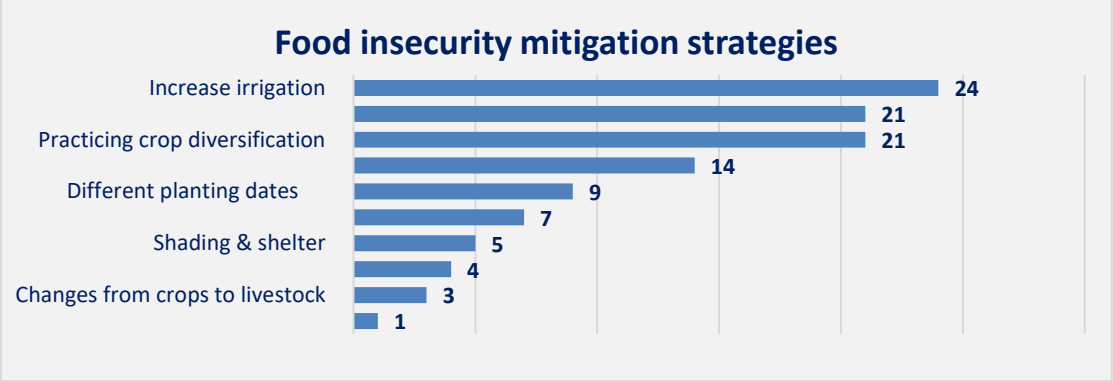

Figure 3. Food insecurity mitigation strategies.

Respondents were asked to recommend the best mitigation strategy against drought. 24 (22%) respondents stated irrigation as the best food insecurity mitigation strategy. Irrigation was recommended by the highest number of respondents followed by planting of different crops and practicing crop diversification. These strategies were mentioned by an equal number of respondents (21) representing 9.3% of the total number of respondents. Plate 1 below shows how some farmers in LWSC has opted to deal with escalating temperatures and reduced rainfall to ensure they are consistency in food production to curb food insecurity. As a result farmers who practice crop diversification by planting different crops were able to withstand drought like condition arising from climate change. A farmer in Marmanet has planting tree tomato, spinach, passion fruits, kales and fodder crop to secure a livelihood in his farm.

Plate 1: Practicing of crop diversification in Marmanet ward, Laikipia West Sub County.

Shortening length of growing period and different planting days were each voted by 14 and 9 respondents, a percentage of 12.8% and 8.3% of the respondents respectively. About 7 (6.4%) respondents recommended for increase of water and soil conservation while 5 (4.6%) recommended for shading and shelter. The use of agriculture insurance was stated by 4 respondents who argued that it could aid during food shortages while 3 of the respondents stated that change from crops to livestock would have fewer risks to farmers. One person put their trust in prayers during food shortages.

A shift from traditional farming(subsistence farming) to a modern farming where farmers call it 'Kilimo biashara' (agribusiness) is taking a new shape but most small scale farmers lack prerequisite knowledge on how it's done hence a need by national and local government interventions through the field extensional officers. Most small scale farmers despite practising modern farming seeks for advices from agro vet vendors who are in need of maximizing profit through their sales. These have resulted in small scale farmers using toxic herbicides, fungicide and pesticide which in result have caused severe impact to the environment and health wise. Escalating organic farming strategies through creating its awareness and educating small scale farmers on its benefits would help them to avoid dangers of trial and error they seek from agro vets vendors other than designated extensional field officers within their areas in LWSC.

4.6 Supply and sources of farm water in Laikipia west sub county

Water is a major factor in successful production in farming. It has been a source of major conflict in the area (Bond, 2014). An adequate water supply is needed for irrigation, pesticide application, evaporative cooling if applicable. Plants require an adequate supply of moisture for optimum growth which is affected by many variables. The amount of water needed depends on the area to be watered, crops grown, weather conditions time of year and the environment control system.

When agricultural water is used effectively and safely, production and crop yield are positively affected. On the other hand, when the supply of water exceeds the demand, plants may receive too much water which has a negative effect on their growth.

The sources of water in this study are illustrated in figure 4.

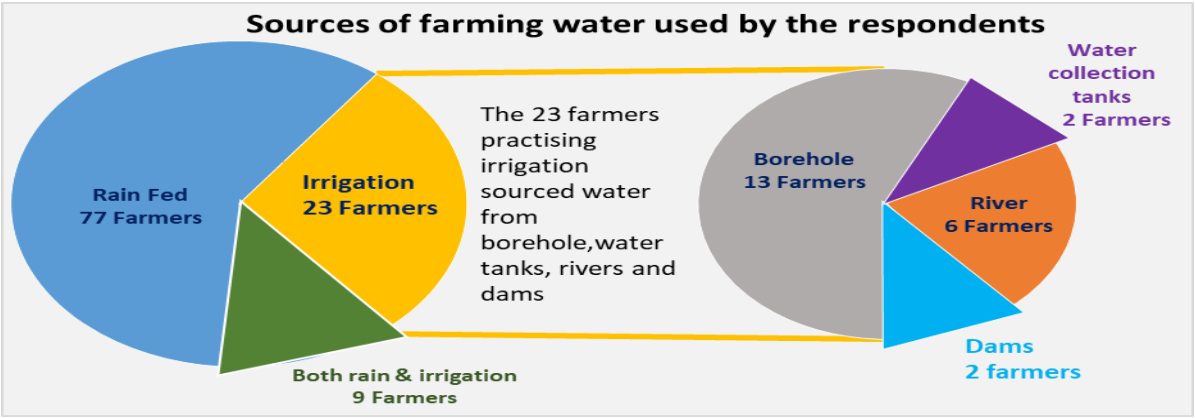

Figure 4. Supply and sources of water used by the respondents.

Figure 4 illustrate that 77 of the farmers employed in the study depended on rain water, 23 on irrigation water while 9 of them depended on both rain water and irrigation for their production.

Among the 23 who depended on irrigation for farming, 13 of them sourced their water from boreholes, 6 from rivers while 2 on dams and other 2 on water collection tanks. Plate 2 depicts how farmers are coping with water scarcity in the areas of study by building water reservoirs' such as building water pans, dams while others were digging boreholes in order to ensure sustainability of water.

Plate 2: A water reservoir in Igwamiti ward, Laikipia west Sub County. Sources: field data (November, 2019)

4.7 Climatic change and its impact in farming

Table 6.

Estimated model coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-55.028	634.717		-.087	.009		
	Rainfall Amount	.421	1.469	.029	.286	.008	.890	1.124
	Temperature	-1.541	10.312	-.016	-.149	.009	.845	1.184

Table 6, displays estimated model coefficients. A multiple linear regression model is fitted as shown below:

$$Farm\ Yield = -55.028 + 0.421(Rainfal\ Amount) - 1.541(Temperature)$$

The model intercept (-55.028) was the farm yield level when all explanatory variables are set equal to zero. The intercept is statistically significant at 0.05 alpha levels (p-value<0.010).

H0: β1=0 (Rainfall amount does not contribute significantly to the crop yield)

Against;

H1:β1≠0 (Rainfall amount contribute significantly to the crop yield)

From the analysis, the p-value obtained is 0.008, which was less than the alpha level of significance (0.05). Hence the stated null hypothesis was rejected and the conclusion arrived at was that the amount of rainfall significantly contributes to crop yield. Further, it was established that rainfall amount has a positive coefficient of 0.421 that was statistically significant at 0.05 alpha levels (p-value<0.01). This means that one unit increase in rainfall amount has a positive impact of 0.421 units to the farm yield level.

From the temperatures analysis H0: β2=0 (Temperature level does not contribute significantly to the crop yield)

Against;

H1:β2≠0 (Temperature level contribute significantly to the crop yield)

From the analysis, the p-value obtained is 0.009, which was less than the alpha level of significance (0.05). Hence the stated null hypothesis was rejected and the conclusion arrived at was that the temperature significantly contributes to crop yield. It was established that the variable "Temperature" has a negative coefficient of -1.541 that was statistically significant at 0.05 alpha levels (p-value<0.010). In this case, one unit increase in temperature levels significantly lowers farm yield level by 1.541 units. These collaborate with Saina et al (2013) who observed that the cause of deteriorating

food security in Kenya is frequent drought in recent years cause by increase in temperatures and reduced rainfall.

5. Conclusion and policy implications

The findings of this research have revealed how reduced rainfall and increase in temperatures has immensely contributed to various milestones toward farming in LWSC. According to the respondents employed in this study, it was revealed that LWSC had encountered low crop production with 61 of them attributing the low crop production to unpredictable rainfall and high increase of temperatures.

Further, 28 of the respondents attributed low crop production to high price of farm implements while 8 attributed the shortage to poor agricultural practices. Inadequate farm land and low soil fertility was mentioned by 7 and 5 respondents respectively. From the analysis, the p-value obtained was 0.05, which was equal to the alpha level of significance (0.05). Hence the stated null hypothesis was rejected and the conclusion arrived at was that adoption of organic farming methods significantly contribute to crop yield. It was also revealed that farmers who had embraced organic farming had higher farm yield than those who were practicing unsustainable farming practices by 220.423 units. However, 24 (22%) respondents stated irrigation as the best food insecurity mitigation strategy.

Up to 99 of the respondents said that temperatures had increased in the past 10 years, while 7 noted that the temperature levels had reduced. Only 3 of the respondents that reported they had not noted any changes in temperature levels. From the analysis, the p-value obtained was 0.009, which was less than the alpha level of significance (0.05). Hence the stated null hypothesis was rejected and the conclusion arrived at was that the temperature significantly contributes to crop yield. Results found that an increase in one unit of temperature had a negative impact of -1.541 which lowers the farm yields.

Majority of the respondents (101) stated that rainfall patterns had become so inconsistent. Only 6 reported that rainfall pattern were consistent, 2 of them had not noted any changes in rainfall patterns. From the analysis, the p-value obtained is 0.008, which was less than the alpha level of significance (0.05). Hence the stated null hypothesis was rejected and the conclusion arrived at was that the amount of rainfall significantly contributes to crop yield. The results found that one unit increase in rainfall amount had a positive impact of 0.421 units to the farm yields. This information is essential to policy makers and stakeholders such as National, County governments, NGOs and other relevant stakeholders in crop production to provide an insight of farmers perception, factor inhibiting their farming and how organic farming can be boosted despite challenging factors of decrease in rainfall and the rise of temperatures within Laikipia west sub county.

The study therefore recommends the introduction of climatic awareness on how organic farming can overcome rainfall and temperature abnormalities. It can be done to the grass roots through local experts' farmers who have gone beyond temperature and rainfall challenges and how they have overcome them. The County and the National Government should team up and initiate demonstration farms on organic farming in each sub county to cater for variances of climatic conditions of each area. These will greatly help local farmers of such areas whom may rely on it in terms of extensional services and other technicalities. Secondly, the already existing policy framework on organic farming from both the National and County Governments should be implemented fully in order to help farmers. These would significantly help farmers acquire new knowledge and modern existing methods of farming in mitigating drought by organic farming. These in return would sustain food production hence food security would be achieved in these area which immensely hit hard by drought and famine when it strikes.

Lastly, the research found out that there are upcoming projects of building of dams, water pans and boreholes by the County and National Governments project. These existing developments are timely and would benefit the small scale farmers in LWSC toward organic farming. This development projects will help small scale farmers mitigate drought. We therefore recommend farmers to take such existing opportunities to help achieve food sustainability.

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Conflict of interest

The authors declare no conflict of interest.

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