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# Institutional Response on Adaptation to the Effects of Climate Change in Selected Parts of Makueni County, Kenya

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***Abstract***— *Climate change has been experienced across the globe, with the most affected being smallholder farmers in least and moderately developed countries. Floods and drought which constitute some of the climatic extreme events have negative impacts on the socio-economic development, with devastating consequences on a country's economy. The main objective of this study was to assess institutional response on adaptation to climate change and variability at the household level, in three agro-ecological zones in Makueni County, Kenya. The study used survey research design. The three agro-ecological sites were selected using stratified sampling, while simple random method was used to select 289 households for interview. Selection of key informants was done through purposive sampling method. Data was collected through administration of semi-structured and open-ended questionnaires to the selected households, and also through interview of key informants, focus group discussions, observation and photography. Findings indicated that there was significant correlation between the climate change and the agro-ecological zones studied ($X^2$=13.3, df=2, P<0.01). The study established that CBOs were actively engaged in the campaign against climate change across the three agro-ecological zones. Among the reviewed institutional responses, disaster preparedness by the government and training/capacity building among smallholder farmers were found to have significant correlation with climate change and handling of extreme weather events ($X^2$ =17.557, df=1, sig. 0.00). The study revealed that those who reported to have experienced extreme weather events agreed that there was some level of government mitigation in place, in form of disaster preparedness. The findings revealed that there was no significant correlation between the presence of institutions assisting to mitigate climate change and their distribution across the three agro-ecological zones (p-value > 0.05). The study established that, government disaster preparedness programs were statistically significantly associated with reduced exposure to climate change and extreme weather events.*

***Keywords***— ***Smallholder farmers, institutional responses, climate change adaptation, Makueni County, Kenya***

## I. INTRODUCTION

Climate change has led to adverse effect to every region across the globe, with many irreversible changes, such as the rise of $CO_2$ concentrations in the atmosphere, increase of the global surface temperatures and also the rise of the global mean sea levels (IPCC, 2021). The continued climate change has threatened food security and livelihoods, as well as disrupting the global movement towards sustainable development (Harvey *et al.,* 2018; FAO, 2015). Evidence of experienced climatic changes across the entire globe of extreme events such as heavy precipitation leading to floods, heatwaves, droughts and

tropical cyclones has strengthened and are more likely to reach unbearable threshold for agriculture, health and may also lead to adverse effect to natural water cycle (IPCC, 2021).

In Sub Saharan Africa (SSA), it is frequently accepted that change in climate is on the rise and has a detrimental effect on smallholder farmers, who rely heavily on the rainfall provided by smallholder farmers for their livelihoods (IPCC, 2007; Baudoin *et al.*, 2013; Muema, Mburu, Coulibaly, & Mutune, 2018). The smallholder farmers occupy 80% of land resources for farming which are limited, and they are particularly vulnerable to the effects of climate change (Mbuli *et al.,* 2021). Poverty, limited technology, poor management of natural resources and poor access to support systems and safety nets from the government expose them to high levels of vulnerability for their survival (FAO, 2015; Mbuli *et al.,* 2021).

Kenya has been impacted negatively by climate change due to its nascent economic growth trends. Majority of Kenyan agriculture totally relies on rainfall, with only less than 5% under irrigation, and the sector has suffered from increasing variability in rainfall. Floods and drought which constitute some of the climatic extreme events have negative impacts on the socio-economic development, with devastating consequences on the country's economy (GOK, 2018). Agricultural activities are the main sources of economic growth, livelihood, food security, foreign construction and job creation and foreign exchange earnings for the majority of the population of Kenya (KEPSA, 2014; Ochieng, Kirimi & Mathenge, 2016). Demand for food, fuel wood and forest products have increased tremendously over the years, leading to unprecedented environmental degradation. An estimation of over 57% of Kenyan population lives below poverty line (FAO, 2015) while, most of smallholder farmers (70%), basically rely on climate-sensitive economic activities including agriculture (Simotwo Mikalitsa, & Wambua, 2018; Ylva, Mattias, Emmeline, Johanna, & Ingrid, 2020), therefore, increasing farmers' vulnerability and affecting the Sustainable Development Goal (SDG) 13, Target 13.1, aimed at strengthening adaptability and resilience so as to enable farmers respond to risks associated to climate change and natural calamities (GOK, 2018).

It has been proven that effects of change of climate in Kenya have devastating impacts to smallholder farmers in a situation where adaptation and coping mechanisms present a challenge to them when it comes to their vulnerability. Most of these farmers are constrained by poverty and inappropriate coping mechanisms beyond their immediate ability, even when they are aware of the appropriate climate adaptation measures (Muema *et al.,* 2018).

Makueni county, one of the 47 counties in Kenya, has been a champion in matters climate change actions, led by the county government environmental sector, the county has been able to develop policies, strategies, project governance structures which have been shared across the other departments for implementation. The National government have supported the county, through implementation of projects, which are geared towards climate change adaptation. Other climate actors from the private sector have also actively participated in the same.

The County Government of Makueni leads the implementation of various climate change programmes in collaboration with other national government stakeholders, Non-Governmental Organisations, private, community and faith-based organisations involved in mitigating climate risks in the county. Some of government actors include NDMA and NEMA (MoALF, 2016). There are collaborations between governmental organisations like NEMA and NDMA and Non-Governmental Organisations like USAID, Christian Aid, Alliance for a Green Revolution in Africa (AGRA), Bread for the World, Land O' Lakes International and Transform Aid international (MoALF, 2016). The other NGOs include Business Initiative for Survival and Eradication of Poverty (BISEP), which is involved in capacity building, promotion of selected value chains, identification of gaps in the value chains, farmer linkages to markets and also collaborating with other research organization for dissemination of climate smart technologies. Pathways to Resilience in Semi-Arid Economies (PRISE) is another active organization in the county dealing with research on climate change issues (MoALF, 2016). The institutions have played key roles in helping mitigate the effects of climate change among the farmers. The aim of the present study was therefore to determine the institutional responses to adaptation to climate change at the household level in the study area, Makueni county, Kenya.

## II. METHODS

### *General Study Area*

Makueni County is among the 47 counties in Kenya, located in the South Eastern region. The neighbourhood include Kitui County to the East, Kajiado County to West, Machakos County to the North and Taita Taveta County to the south. It has an area of 8,008.7 Km2 and is between Latitude 1º 35 ′ and 3 ° 00 ′ South as well as Longitude 37º10 'and 38º 30 ′ East. The county experience frequent droughts as it is in the Arid and Semi-Aid area. It has six sub-counties including Makueni, Kibwezi East, Kaiti,

Mbooni, Kilome and Kibwezi West sub-counties. The county is then sub-divided in to further 30 wards, containing 60 sub-wards (G.O.K, 2013).

The study was done in selected parts of Makueni County which were classified according to agro-ecological zones (Jaetzold, *et al.,* 2006). The agro-ecological zones were classified as Semi Humid zone (upper part) covering Mbooni Sub County area, Semi-Arid areas (middle part) which covered Makueni Sub County and Arid area (lower part) which covered Kibwezi East Sub County.

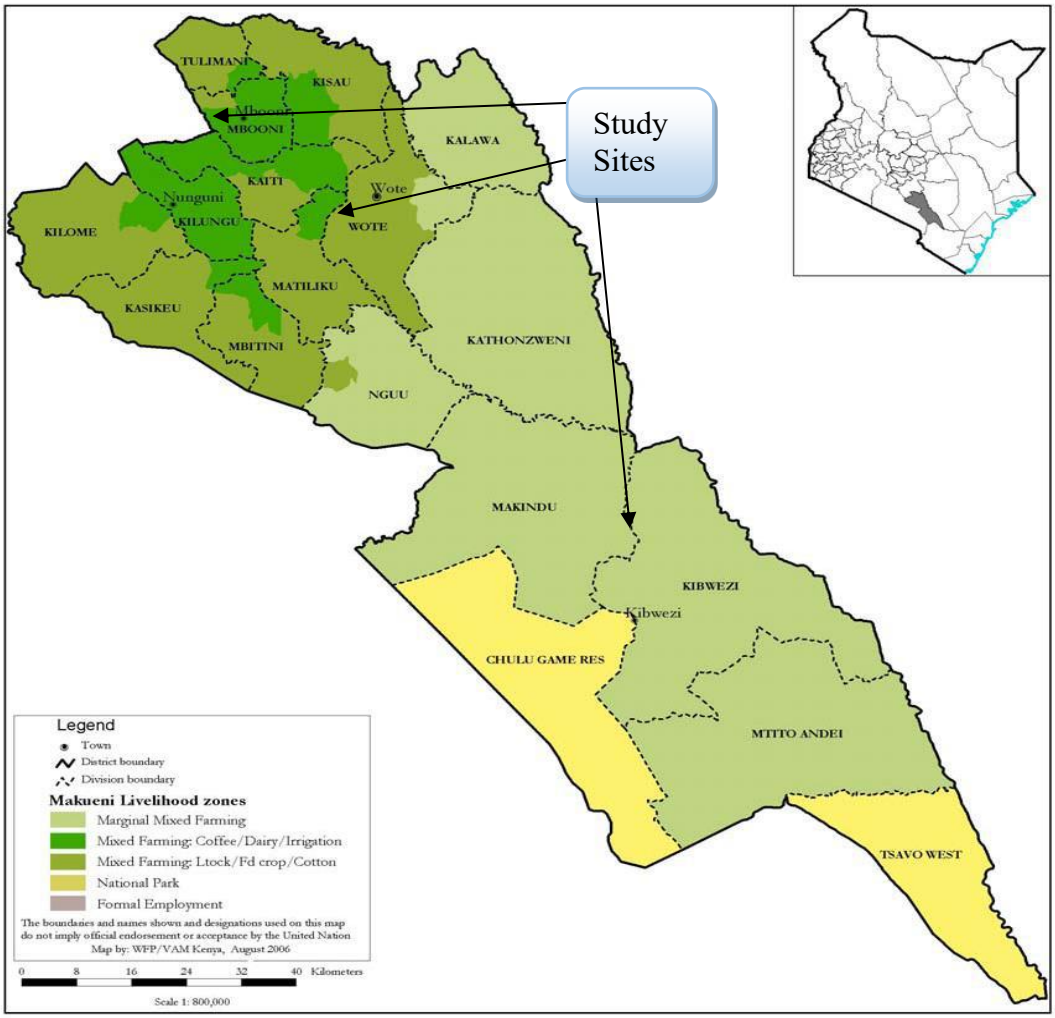


*Fig.1: A Map of Makueni Livelihood Zones*

*Source: Makueni LRA Report, 2013.*

***Research Design***

Descriptive research design was embraced to examine and calculate the susceptibility of smallholder farmers due to changes in climate and variability, including factors that affect their vulnerability. The design was also used to explore their climate change strategies (Asfaw *et al.,* 2021). Mixed methods of both quantitative and qualitative methods were used to collect primary data. Information was collected from family heads regarding socio-economic, biophysical and demographic factors of the study area.

***Sample frame and sampling techniques***

The sample frame for the study was drawn from farmer beneficiaries from the Kenya Cereals Enhancement Program – Climate Resilient Agricultural Livelihood (KCEP-CRAL). KCEP-CRAL is a national government funded and implemented program in selected counties in Kenya, with Makueni county being a beneficiary. KCEP-CRAL program, which kicked off in 2018 in Makueni, aimed at reducing rural poverty and food insecurity among smallholder farmers in arid and semi-arid lands by developing their economic potential, while improving their natural resource management capacity and resilience to climate change in an increasingly fragile ecosystem. At least 16,000 subsistence farmers benefited from the program through the provision of farm inputs through e-

voucher system, financial inclusion, post-production management practices and market linkages for targeted value chains, along with other agricultural resources to enhance their resilience. The current study dwelt on three sub-counties selected on the basis of their agro-ecological zone localities and which were beneficiaries of the KCEP-CRAL program.

*Table 1: Sampling Frame of Farmer beneficiaries from KCEP-CRAL program*

| Area (Sub-County) | KCEP-CRAL Beneficiaries | Percentage |
|---|---|---|
| Mbooni Sub-County | 140 | 44.9 |
| Muvau Sub-County | 79 | 25.3 |
| Masongaleni Sub- County | 93 | 29.8 |
| Totals | 312 | 100.0 |

*Source: Ministry of Agriculture Makueni County*

The survey research used a randomized multi-stage sampling process to select households (Asfaw *et al.,* 2021).

***Sample Size Determination***

The following formula was embraced for the study (Asfaw *et al.,* 2021).

$$n = \frac{Z^2 * N * p * q}{e^2(N-1) + Z^2 * p * q} \quad \text{..... (Eqn. 1)}$$

Where; N represents the total targeted population for smallholder farmers, n is the sample size, and Z is the set standard deviation picked at 95% confidence level, which is 1.96. *P* is the alpha levels of 0.5, showing the estimated proportion present while *q* (1-p)(0.5) represents the estimated proportion of the attribute not present in the population, while *e* is the required accuracy level, usually set as 0.05 (5% of acceptable sample error). From the calculations, the entire sample size was 244 households spread at 140 for Mbooni, 79 for Makueni and 93 for Kibwezi East.

***Research Instruments***

The study used the following data collection tools; Household questionnaire, Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). The tools are explained below:

*Household Questionnaire:* The questionnaire was the main data collection instrument. It was divided into five sections. The first section captured household demographic information. The second section was capturing household general information, while section three was capturing socioeconomic activities and livelihood options. Section four was on adaptations to climate change and variability. The last section was on institutional support. The questions were distributed across the five sections capturing demographics and socio-economic responses, their livelihoods, outcomes and experiences of climate change in agriculture, land use practices related mitigations to climate actions provided by County Government and other climate actors in the study area.

*Focus Group Discussion Guide:* The guide had open questions on areas on climate change and variability, and the adaptation strategies embraced by farmers. The FGD tool had questions on farming and livestock rearing activities among farmers, identification and observation of climate change and variability indicators, how climate change has affected crop production, livestock rearing, and livelihood options, and the mitigation measures taken. The guide also had questions on mitigation efforts against climate change and variability in Makueni by governmental, non-governmental and individual households.

***Data Analysis***

The data collected was analyzed by both quantitative and qualitative approaches. The study used Statistical Package for Social Sciences (SPSS) software for analyzing data obtained from the questionnaire and the generated results were presented through frequencies, tables, charts, and statistics. Relevant data from key discussions, FGD notes and policy reviews was processed and analyzed to establish leading themes, trends/patterns, relationships or correlations, and conclusions obtained in line with research objectives (Gray, 2004).

Simple linear regression was used to analyze the correlation between a single quantitative effect and a single descriptive quantity indicator. The method was used to determine and detect the long-term trend as well as variation in weather elements like temperature and rainfall on the annual and monthly time scale.

Multinomial logit regression model was used to analyze factors that contribute to the choices of climate change mitigation strategies embraced by smallholder farmers. The model clarified the association between the probability of selecting a particular adaptation strategy and the descriptive variables.

The significance of relationship between independent variables i.e. demographic and socio-economic

characteristics, and existing livelihood actions and dependent variable (implementation of adaptation strategies), was analyzed using chi- square contingency (×2) statistical test. This allowed the establishment of assurance on whether there is a correlation between two indicators in the study population. The chi-square (×2) value was interpreted relative to its associated statistical significance levels taken as $p < 0.05$. In interpretation, a *P* value greater than 0.05 denoted lack of association or relationship between the variables in the population.

***Ethical Considerations***

The study was guided by research ethics. The six elements of research ethics were considered including informed consent, beneficence, confidentiality, anonymity, no harm and the right to withdraw from the exercise. Farmers, who were the main respondent, were first informed of the intentions and objectives of the study, requesting for their informed consent. Once the informed consent was given, then the other ethical considerations were also worked on. Confidentiality was also considered and adhered to, where information collected from farmers was not shared with third parties. The information collected was also kept confidential, as no farmer details were used to expose them to any unauthorized third party.

## III. RESULTS

### 3.1 Response rate and demographic characteristics of the respondents

A sample of 289 respondents was reached and the target for each specified study area within the three agro-ecological zones is shown in Table 2 below.

*Table 2: Distribution and response rate of the respondents*

| Constituency (Ward) | Targeted sample size | Reached respondents | Percentage reached |
|---|---|---|---|
| Mbooni (Mbooni) | 103 | 105 | 102 |
| Makueni (Muvau) | 66 | 79 | 120 |
| Kibwezi East (Masongaleni) | 75 | 105 | 140 |
| **Totals** | **244** | **289** | **120** |

The study response rate was 120% as six focus group discussions were reached instead of the initially intended five, which meets the threshold for sample size requirement according to Mugenda and Mugenda (2003).

***Summary of demographic characteristics***

Most of the respondents were drawn from Kibwezi East and Mbooni (Table 3), both sub-counties having a representation of about 36.3%. Makueni had the least representation at 27.4%, in terms of relations to the household head. Majority of the respondents were spouses at 48.1%, while respondents who were the household heads were 38.1%. Further, there were 10.0% and 3.8% of the respondents who identified themselves as children and parents of the household heads. In terms of gender representation, more of the respondents at 64.0% were female, while the other 36% were male. In terms of level of education, majority of the respondents at 56.4% had achieved primary level education, followed by 29.8% who reported to have attained secondary education level. Respondents who had achieved college and university education were 5.5% and 1.4% respectively.

The distributions of respondents in terms of their age, the majority were aged between 26 to 40 years, representing 34.9% of the population. This category was followed by those aged between 41 to 60 years at 33.6%. The study revealed that 20.1% and 11.4% of the respondents were aged above 61 years and below age 25 years respectively. In terms of occupation, majority of the respondents (66.1%) indicated that they were farmers. Those engaged in small scale business and casual laborers were 10.4% and 10.0% respectively. A further 4.2% of the respondents reported to have been engaged with other different occupational roles, while 3.5% of the respondents indicated that they were not engaged in any form of economic activities.

Majority of the respondents in the study area were married in monogamous union at 78.2%. The study established that 12.5% of the respondents were widowed while 5.2% reported to have had orphans in their households. There was a small percentage of respondents (1.7%) who were in polygamous marriage.

*Table 3: Summary of Demographic Characteristics*

| Variable | Category | Frequency | Percentage |
|---|---|---|---|
| Relations to household head | Household head | 110 | 38.1 |
| | Spouse | 139 | 48.1 |
| | Child | 29 | 10.0 |
| | Parent/guardian | 11 | 3.8 |
| Gender | Female | 185 | 64.0 |
| | Male | 104 | 36.0 |
| Education | College | 16 | 5.5 |
| | None | 20 | 6.9 |
| | Primary | 163 | 56.4 |
| | Secondary | 86 | 29.8 |
| | University | 4 | 1.4 |
| Age of respondent | 18-25 years | 33 | 11.4 |
| | 26-40 years | 101 | 34.9 |
| | 41-60 Years | 97 | 33.6 |
| | Above 61 years | 58 | 20.1 |
| Occupation | Students | 8 | 2.8 |
| | Business | 30 | 10.4 |
| | Casual Labourer | 29 | 10.0 |
| | Farmer | 191 | 66.1 |
| | Teacher | 9 | 3.1 |
| | Not employed | 10 | 3.5 |
| | Other roles | 12 | 4.2 |
| Marital Status | Married (Monogamous) | 226 | 78.2 |
| | Married (Polygamous) | 5 | 1.7 |
| | Separated/Divorced | 8 | 2.8 |
| | Single | 14 | 4.8 |
| | Widowed | 36 | 12.5 |
| Type of Household | Dejure female headed (widow, never married, divorced) | 13 | 4.5 |
| | Female headed | 32 | 11.1 |
| | Male headed | 242 | 83.7 |
| | Polygamous | 2 | 0.7 |
| Presence of an orphan | No | 274 | 94.8 |
| | Yes | 15 | 5.2 |
| Sub-county | Kibwezi East | 105 | 36.3 |
| | Makueni | 79 | 27.4 |
| | Mbooni | 105 | 36.3 |

### 3.2 Farmer's perception on climate change in the study area

**Experience of extreme weather conditions**

The study established that 76.8% of the farmers experienced extreme weather conditions, with only 23.2% not experiencing extreme weather conditions. In relation to the agro-ecological zones, more farmers in Kibwezi East and Makueni at 88.6% and 70.9% respectively experienced extreme weather conditions, compared to 69.5% in Mbooni (Table 4). There was significant correlation between the climate change and the agro-ecological zones studied ($X^2$=13.3, df=2, P<0.01). The Pearson correlation portrayed that the agro-ecological zones studied experienced some form of climate change.

*Table 4: Experience of extreme weather conditions*

| | Sub County | | | | | | |
|---|---|---|---|---|---|---|---|
| | Kibwezi East | Makueni | Mbooni | Total | Pearson Chi-Square Value | df | Asymptotic Significance (2-sided) |
| No | 12 | 23 | 32 | 67 | 13.297a | 2 | 0.001 |
| | 11.4% | 29.1% | 30.5% | 23.2% | | | |
| Yes | 93 | 56 | 73 | 222 | | | |
| | 88.6% | 70.9% | 69.5% | 76.8% | | | |
| Total | 105 | 79 | 105 | 289 | | | |

### 3.3 Institutional Responses to Adaptation to Climate Change at Household Level

#### 3.3.1 Agricultural Related Services (ARS) from Government

The study revealed that government had offered agriculture related services with, 31.8% who testified they received such services (Table 5). However, a substantial number of the respondents reported that they never got such services. Those who indicated to have received, the various services were fairly distributed across the three agro-ecological zones. In total there were 85 or (92.4%) of the farmers who received agricultural extension services, with majority from Mbooni Sub- County at 51.8%, while the least were from Kibwezi East at 15.3%. Overall, agricultural extension services were not significantly correlated with the sub-counties ($X^2$ *p value*=0.104). Farmers who received early warning systems were 22.8% across the three agro-ecological zones, with majority from both Mbooni and Makueni (42.9%). Similarly, early warning systems were not significantly correlated with the agro-ecological zones ($X^2$ *p value*=0.745).

Provision of farm inputs was considered a significant factor that correlated with the sub-counties ($X^2$ *p value*=0.015), where 26.1% of the farmers received the support from the government, where majority were from Makueni at 58.3%. Financial services were available in Makueni sub-county (1.1%) while insurance services were found in Makueni and Mbooni sub-counties, each at 1.1%. Disease surveillance was common at 14.1% across the three agro-ecological zones, with Mbooni recording the highest at 53.8% (n=7, out of 13).

*Table 5: Agricultural related services from Government*

| **Get ARS from government** | **%** | **Type of Agricultural Related services** | **Kibwezi East** | **Maku-eni** | **Mboo-ni** | **Total (n)** | **Total (%)** | **Pearson $X^2$** |
|---|---|---|---|---|---|---|---|---|
| No (n=197) | 68.2 | Agricultural extension services | 13 | 28 | 44 | 85 | 92.4% | 0.104 |
| Yes (n=92) | 31.8 | Early warning Information Systems | 3 | 9 | 9 | 21 | 22.8% | 0.745 |
| | | Farm Inputs, (seeds, implements, & tools) | 4 | 14 | 6 | 24 | 26.1% | 0.015 |
| | | Financial services | 0 | 1 | 0 | 1 | 1.1% | 0.405 |
| | | Insurance services | 0 | 1 | 1 | 2 | 2.2% | 0.808 |
| | | Disease surveillance | 1 | 5 | 7 | 13 | 14.1% | 0.716 |

### 3.4 Institutions in the community addressing climate change extremities on livelihoods

The study revealed that apart from the government, there were other non-governmental organizations and institutions that addressed climate change extremities across the three agro-ecological zones, (Table 6), though minimal (8.3%, n=24). All the positive responses (n=24) confirmed that the County government/national government line ministry and the private sector had played a major role in addressing climate change, while a frequency of 23 respondents were of the view that both NGOs and CBOs were actively engaged in the campaign against climate change. Church organizations were also deemed helpful in addressing climate change. The study indicated that a significant number of the famers with a frequency of 15 believed that Church organizations have played a major part in addressing climate change.

*Table 6: Organizations acting against climate change (n=24)*

| Are there Institutions handling CC Extremities? | n | % | Organization/Institution | n | % |
|---|---|---|---|---|---|
| No | 265 | 91.7 | Church Organization | 15 | 5.2 |
| Yes | 24 | 8.3 | County government/ministry | 24 | 8.3 |
| | | | NGOs | 23 | 8.0 |
| | | | CBOs | 23 | 8.0 |
| | | | Private sector | 24 | 8.3 |
| | | | Other entities | 19 | 6.6 |

#### 3.4.1 Presence of institutions in the study area

The study established that out of the 8.3% (Table 7) of the organizations addressing climate change extremities in the three agro-ecological zones, 11.3% of them were from Kibwezi East, while the remainder were from Makueni and Mbooni agro-ecological zones. There was no significant correlation between the presence of institutions in assisting to mitigate effects of climate change and the agro-ecological zones (Pearson chi-square 2.197, p-value > 0.05).

*Table 7: Presence of institutions addressing climate change across the agro-ecological zones*

| Presence of institutions to address climate change extremities | | | | | Chi-Square Tests | Value | df | Asymp. Sig. |
|---|---|---|---|---|---|---|---|---|
| | Kibwezi East | Makueni | Mbooni | Totals | Chi-Square | 2.197a | 2 | 0.333 |
| No | 94 | 73 | 98 | 265 | Likelihood Ratio | | | |
| | 88.70% | 92.40% | 94.20% | 91.70% | | | | |
| Yes | 12 | 6 | 6 | 24 | | 2.176 | 2 | 0.337 |
| | 11.30% | 7.60% | 5.80% | 8.30% | | | | |

#### 3.4.2 Distribution of non-governmental organizations

The distribution of the organizations in the study area was not significantly correlated to the agro-ecological zones (p-values >0.05) (Table 8). Makueni agro-ecological zone had more church organizations (46.7%) that supported mitigation efforts against climate change compared to Mbooni (33.3%) and Kibwezi East (20.0%). There were more mitigation efforts supported by the County government and NGOs in Kibwezi East, at 50.0% and 43.5% respectively while more CBOs (39.1%) were present in Makueni agro-ecological zone.

*Table 8: Distribution of organizations mitigating climate change in the agro-ecological zones*

| | Sub County | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Kibwezi East** | **Makueni** | **Mbooni** | **Total** | **Pearson X2** | **df** | **Asymp. Sig. (2-sided)** |
| Church Organization | 3 | 7 | 5 | 15 | 3.130a | 2 | 0.209 |
| | 20.0% | 46.7% | 33.3% | 100.0% | | | |
| County dept/ ministry | 12 | 6 | 6 | 24 | 3.378a | 2 | 0.185 |
| | 50.0% | 25.0% | 25.0% | 100.0% | | | |
| NGOs | 10 | 8 | 5 | 23 | 4.295a | 2 | 0.117 |
| | 43.5% | 34.8% | 21.7% | 100.0% | | | |
| CBOs | 8 | 9 | 6 | 23 | 1.043a | 2 | 0.593 |
| | 34.8% | 39.1% | 26.1% | 100.0% | | | |

### 3.5 Trainings to handle extreme weather conditions

The study established that farmers had received various forms of trainings regarding extreme weather conditions that were offered by different institutions in the study area. At least 14.5% of the farmers had been trained on early warning alerts, followed by 12.8% who had been trained on periodic weather updates, and only 5.5% had received training on observation and mitigation strategies of extreme weather conditions (Table 9).

*Table 9: Training services*

| Training service | Frequency | Percentage |
|---|---|---|
| Weather forecast services | 27 | 9.3 |
| Periodic weather updates | 37 | 12.8 |
| Extreme events | 16 | 5.5 |
| Disaster preparedness | 20 | 6.9 |
| Early warning | 42 | 14.5 |
| Financial aid | 34 | 11.8 |

### 3.6 Institutions' interventions on climate change adaptation

From the Pearson correlation analysis, it was established that institutions played a significant role in injecting interventions to promote climate change adaptation across the three agro-ecological zones ($X^2$ =0.405, df=2, p<0.05). There were statistically significant differences in terms of how the institutions promoted climate change adaptation for smallholder farmers in the three agro-ecological zones (Table 10). It was revealed that eight of the 12 institutions in Kibwezi East (66.7%), six (100.0%) in Makueni and six (100.0%) in Mbooni offered training to farmers on agricultural smart technologies. Seven of the 12 institutions in Kibwezi east (58.3%) offered Food for work programme, a service that was not reported in the other two agro-ecological zones. The institutions that provided drought resistant crops and livestock breeds were five in in Kibwezi East (41.7%), three in Mbooni (50.0%) and three in Makueni (50.0%). Cash donation services were offered by 16.7% of the institutions in Makueni while 66.7% of the institutions in each of the agro-ecological zones gave seeds for planting. Market linkage services were offered by 16.7% of the institutions in Kibwezi east, 33.3% in Makueni, and 50.0% in Mbooni. Only 8.3% and 33.3% of the institutions in Kibwezi East and Makueni respectively offered assistance to farmers inform of farm machineries.

*Table 10: Institutional interventions across the agro-ecological zones (n=24)*

| | | | |
|---|---|---|---|
| Pearson chi-square values | **Pearson $X^2$** | | 0.405 |
| | **df** | | 2 |
| | **Asymp. Sig. (2-sided)** | | 0.050 |
| Institutional interventions | Sub County | | |
| | Kibwezi East (n=12) | Makueni (n=6) | Mbooni (n=6) |
| Training on smart technologies | 8 | 6 | 6 |
| | 66.7% | 100.0% | 100.0% |
| Giving relief food | 6 | 0 | 0 |
| | 50.0% | 0.0% | 0.0% |
| Giving food for work | 7 | 0 | 0 |
| | 58.3% | 0.0% | 0.0% |
| Providing farmers with drought resistant crop/livestock breeds | 5 | 3 | 3 |
| | 41.7% | 50.0% | 50.0% |
| Cash donations | 0 | 1 | 0 |
| | 0.0% | 16.7% | 0.0% |
| Seeds for planting | 8 | 4 | 4 |
| | 66.7% | 66.7% | 66.7% |
| Creating market linkages for produce | 2 | 2 | 3 |
| | 16.7% | 33.3% | 50.0% |
| Assisting farmers with farm machineries | 1 | 2 | 0 |
| | 8.3% | 33.3% | 0.0% |

### 3.7 Participation in climate change related decision-making forums

The study revealed that, a significant number of farmers participated in decision-making across the ecological zones ($X^2$ =15.11, df=2, p<0.001). Majority of the farmers, at 86.5% did not participate in decision making processes. There were 25.3% farmers in Makueni, 13.3% in Mbooni and 4.8% in Kibwezi east who reported to have participated in climate change decision making forums (Table 11).

*Table 11: Smallholder farmers' participation in climate change decision making (n=289)*

| | | | |
|---|---|---|---|
| Pearson Chi-Square | 15.119a | | |
| Df | 2 | | |
| Asymptotic significance | 0.001 | | |
| | Participation in decision making | | Total |
| | No | Yes | |
| Kibwezi East | 100 | 5 | 105 |
| | 95.2% | 4.8% | 100.0% |
| Makueni | 59 | 20 | 79 |
| | 74.7% | 25.3% | 100.0% |
| Mbooni | 91 | 14 | 105 |
| | 86.7% | 13.3% | 100.0% |
| Totals | 250 | 39 | 289 |
| | 86.5% | 13.5% | 100.0% |

The study also indicated that majority of those who had participated in climate change decision-making (n=39) were involved in water resource management issues at 82.1% (n=32 out of 39), followed by 79.5% (n=31 out of 39) who were involved in soil and water conservation matters, while 59.0% (n=23 over 39) were involved in identification of community needs. There were further 20.5% of the farmers who participated in decision-making on other roles, as shown in Table 12.

*Table 12: Farmers participation in climate change related issues (n=39)*

| Option | Kibwezi East (n=5) | Makueni (n=20) | Mbooni (n=14) | Totals (in all zones) | |
|---|---|---|---|---|---|
| | N (%) | N (%) | N (%) | Frequency | Percent |
| Identification of community needs | 3 (60.0%) | 12 (60.0%) | 8 (57.1%) | 23 | 59.0 |
| Water resource management | 4 (80.0%) | 16 (80.0%) | 12 (85.7%) | 32 | 82.1 |
| Soil and water conservation | 5 (100.0%) | 18 (90.0%) | 8 (57.1) | 31 | 79.5 |
| Other roles | 1 (20.0%) | 4 (20.0%) | 3 (21.4%) | 8 | 20.5 |

### 3.8 Challenges of climate change and variability mitigation programs in the three agro -ecological zones

The study revealed that climate change and variability mitigation programs faced some challenges in the study area, which were not significantly different in the three agro-ecological zones ($X^2$ =2.811, df=2, p<0.245). The greatest challenges facing effective implementation of climate change and variability mitigation programs in the study area were corruption (88.2%) inadequate infrastructure (85.8%), top-down implementation strategies (83.4%), duplication of roles and institutional inefficiency in government agencies (73.7%), lack of meaningful community involvement and participation (73%), lack of proper communication (69.9%) and ineffective law enforcement (45.7%) in that order (Table 13).

*Table 13: Challenges facing climate change and variability mitigation programs in the study area*

| | | |
|---|---|---|
| Pearson chi-square | 2.811a | |
| Df | 2 | |
| Asymptotic significance (2-sided) | 0.245 | |
| **List of Challenges** | **Frequency** | **Percent** |
| Lack of meaningful community involvement and participation | 211 | 73.0 |
| Inadequate infrastructure | 248 | 85.8 |
| Duplication of roles and institutional inefficiency | 213 | 73.7 |
| Top-down implementation strategies | 241 | 83.4 |
| Ineffective law enforcement | 132 | 45.7 |
| Lack of proper communication | 202 | 69.9 |
| Corruption | 255 | 88.2 |

### 3.9 Suggestions and recommendations for effective climate change programme management

Amongst the recommendations made by the respondents, the need for creating awareness and sensitization on climate-change and variability, and also support on water harvesting to enhance effective climate change intervention programmes led, each reported by 20.8% of the respondents, followed by educating farmers on new farming technologies (19.7%), availability of more agricultural extension officers (18%) and adaptation to climate smart agriculture (17%) among others (Table 14).

*Table 14: Recommendations for effective mitigation on climate change*

| Recommendation | Frequency | Percentage |
|---|---|---|
| Adaptation of climate smart agriculture | 49 | 17.0 |
| Involvement of community groups in development programmes | 34 | 11.8 |
| Availability of Agricultural Extension Officers to educate locals | 52 | 18.0 |
| Awareness on climate-sensitive practices, and aiding in water harvesting | 60 | 20.8 |
| Conserve our environment through community initiatives | 28 | 9.7 |
| Desilting of existing earth dams and digging boreholes | 33 | 11.4 |
| Educate farmers on new farming technologies | 57 | 19.7 |
| Loans for community environment conservation measures | 46 | 15.9 |
| Harvesting of rain water in dams, gabions, and farm ponds. | 39 | 13.5 |
| More Training and support | 44 | 15.2 |
| Planting trees | 51 | 17.6 |

### 3.10 Regression analysis of institutional responses on climate change vulnerabilities

I Institutional responses were categorized into: households receiving relief foods, financial aid from government or NGOs, government disaster preparedness, presence of institutions working on climate change initiatives, local programs to enhance farmer adaptation to climate change, and decision-making involvement in climate change mitigation forums (Table 15). Among the reviewed institutional responses, only disaster preparedness by the government was found to have significant correlation with climate change and handling of extreme weather events ($X^2$ =17.557, df=1, sig. 0.00). The findings revealed that 52.3% of those who had reported to have experienced extreme weather events agreed that there was adequate government disaster preparedness, while majority (81.2%) indicated that there was no adequate government mitigation and preparedness strategies in place. The results confirmed that government preparedness in terms of allocation of resources and sharing information with the public is deemed critical in reducing exposure to extreme weather conditions (Table 15).

*Table 15: Institutional responses on climate change*

| | | Climate change extreme weather events | | | | |
|---|---|---|---|---|---|---|
| **Indicator for institutional response** | | **No** | **Yes** | ***X²*** **value** | **df** | **Sig. (2-sided)** |
| Receiving financial aid from gov | No | 23.6% | 76.4% | .760a | 1 | 0.383 |
| | Yes | 11.1% | 88.9% | | | |
| Received any relief food from government/NGO | No | 23.5% | 76.5% | 1.224a | 1 | 0.269 |
| | Yes | 0.0% | 100.0% | | | |
| Disaster preparedness by government | No | 18.8% | 81.2% | 17.557a | 1 | 0 |
| | Yes | 47.7% | 52.3% | | | |
| Warnings on extreme weather conditions | No | 23.9% | 76.1% | .102a | 1 | 0.75 |
| | Yes | 22.3% | 77.7% | | | |
| Institutions working on climate change | No | 24.2% | 75.8% | 1.677a | 1 | 0.195 |
| | Yes | 12.5% | 87.5% | | | |
| Participation in decision making | No | 24.4% | 75.6% | 1.540a | 1 | 0.215 |
| | yes | 15.4% | 84.6% | | | |
| Local Programs | No | 19.8% | 80.2% | .929a | 1 | 0.335 |
| | Yes | 24.9% | 75.1% | | | |

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## IV. DISCUSSION

In this study, the distribution of the respondents was fair, ranging from 36.3% in Mbooni and Kibwezi East to 27.4% in Makueni sub-county. The representation allowed comparison of the distribution of variables across the three agro-ecological zones. The findings that the majority of the respondents were spouses at 48.1%, and household heads were 38.1% implied that the respondents were the key decisions makers on climate change mitigation at household level. A study by Below *et al*. (2016) reiterates, that smallholder farmers with extremely low-income levels are more likely to seek help on handling climate change and its associated effects, while families that had higher income were reluctant to depend on local institutions for climate change interventions. However, local institutions cannot be ignored in their role that they play in assisting smallholder farmers mitigate the effects of climate change (Below *et al*., 2016).

On the perception on climate change, about 76.8% of the respondents experienced extreme weather conditions. The findings relate to previous studies that found out that most farmers in the rural areas of most developing countries bear the largest burden of climate change due to extreme weather conditions (Harvey *et al.*, 2018; Minh *et al.,* 2019). As confirmed in MoALF (2016), (there was significant correlation between the climate change and the agro-ecological zones studied ($X^2$=13.3, df=2, P<0.01). Over 93.8% of the respondents agreed that there was a general decrease in water availability for the past five years. This finding corroborated well with other findings (Amuzu *et al.*, 2018; Mbuli *et al*., 2020; Kieti *et al.,* 2016) which established that due to climate change, there has been observable reduction in water availability in most rural areas.

The study revealed that the government had offered agriculture related services as reported by 31.8% of the respondents. This is confirmed in a related study by Wamsler *et al.,* (2018) who noted that governments, non-governmental organizations and other institutions stand a better chance to help smallholders deal with climate change and its impacts.

It was established that institutions such as NGOs, Church Organizations, the Private sector, CBOs and other entities have a huge role to play in ensuring that farmers can withstand climate change and its impacts. Wamsler *et al.,* (2018) confirmed that most institutions have adequately assisted smallholder farmers to cope up with effects of climate change by providing market link outlets for their farm produce. The findings revealed that there was no significant correlation between the presence of institutions assisting to mitigate impacts of climate change and the benefits by farmers across agro-ecological zones. This could be associated with the few households (n=24) who indicated that there were institutions supporting climate change mitigation efforts. This finding agreed with Chaudhury *et al.* (2020) who observed that not all farmers might benefit across the agro-ecological zones since some farmers have limited capacity to integrate climate information in their livelihoods and development plans.

The findings on the distribution and the role of private institutions on mitigating climate change corroborate with observations by Heltberg *et al.* (2019) who found out that private players had significant role on addressing human vulnerability to climate change. The current study established that training services were a common mitigation measure against impacts of climate change. It was revealed that about eight institutions, representing 66.7% (six out of twelve) trained farmers on smart agriculture technologies from Kibwezi East, while the other six institutions (100.0%) in Makueni and six (100.0%) in Mbooni empowered farmers on smart technologies. Similar studies by Shilaho (2016) and Heltberg *et al.,* (2019), have established that capacity building among farmers on weather updates, weather forecast and projection, disaster preparedness and early warning formed part of the training services that improved farmer resilience against impacts of climate change. In addition, studies by Kieti *et al.* (2016) and Rahman and Hickey (2020) noted that farmers improved their livelihoods through trainings on how to mitigate the effects of climate change.

In terms of participating in climate change related decisions, 11.1% of the farmers indicated that they were involved in water resource management issues while only 10.7% participated in soil and water conservation decision making. The findings corroborate with a study by Mbuli *et al.* (2021) who noted that not all farmers are engaged in decision-making on climate change programs as most lack technical capacity and have poor access to support systems to enable them contribute effectively in decision making.

The fact that 82.1% of the respondents were involved in water resource management decisions, 79.5% in soil and water conservation and 59.0% in community needs assessment related to findings by Shilaho (2016) and

Below *et al.,* (2016) who noted that effective institutional contribution to climate change should involve participation by local farmers and focus on improved agricultural methods, solving water resource conflicts and promoting equitable sharing of natural resources.

Among the reviewed institutional responses, only disaster preparedness by the government was found to have significant correlation with climate change and handling of extreme weather events ($X^2$ =17.557, df=1, P< 0.00). The findings revealed that 52.3% of those who reported to have experienced extreme weather events agreed that the government had put in place adequate disaster preparedness mechanisms. The findings in this current study were similar with others done elsewhere. Some of the studies have expressed various forms of institutional responses that have significant impact on mitigating effects of climate change. For instance, Nyika (2022) on a study on climate change situation in Kenya and the adaptive management to it noted that there was need for adaptive responses from different players. Such adaptive mechanisms included infrastructural modifications of water body environments, disseminating earl warnings and forecasting weather using models to predict climate change uncertainties. Similarly, the authors called for government interventions in policy making and strong institutions to mitigate the effects of climate change in Kenya. In his study in Laikipia, Kenya, Ndiritu (2021) recommended that there is need for strengthening policy on early warning mechanisms especially in the semi-arid areas in Kenya. The study also recommended the need to improve training of farmers on mitigation practices to enhance their preparedness. Further, another study by Opoku, Filho, Hubert and Adejumo (2021) recommended that there was need for improving government policies at all levels (local, regional and even national) on climate change and the associated mitigations. The authors also noted the need to improve basic knowledge for professionals in climate mitigation to better respond to adverse effects of climate change.

## V. CONCLUSION

This study examined how institutions responded to climate change in three agro-ecological zones of Makueni county, Kenya. The various institutions involved in assisting smallholder farmers to mitigate against impacts of climate change in the study area were NGOs, CBOs, private sector, church organization and the county/national government. Majority of the respondents reported that they had experienced extreme weather conditions, signifying climate change. Only about a third of the respondents received agricultural related services from government, where only farm inputs (seeds, implements and tools) were found to be significantly correlated to effective mitigation of impacts of climate change across the three agro-ecological zones.

Of all the reported government induced mitigation strategies, disaster preparedness was found to have significant correlation with climate change and handling of extreme weather events. The study underscores the critical role of both government and non-governmental institutions in promoting effective adaptation and mitigation strategies against climate change to small scale farmers in the country. However, the study highlights the importance of need for more institutional concerted efforts in order to cushion small scale farmers against the impacts of climate change and variability.

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## DECLARATION OF CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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