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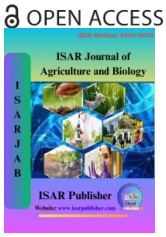


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# ASSESSING THE EXISTING ECOSYSTEM-BASED ADAPTATION STRATEGIES IMPLEMENTED AMONG SMALLHOLDER MAIZE FARMERS IN MOIBEN SUB-COUNTY

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**Abstract:** In Moiben Sub-County, climate change poses significant challenges, particularly impacting the agricultural community. The study's main objective is to evaluate existing ecosystem-based adaptation strategies implemented among smallholder maize farmers in Moiben Sub-County. Resilience Theory guided the study. The study used a mixed-methods research design. The target population was 7536 respondents, including Smallholder maize farmers, local government officials and community leaders. The sample size of 390 respondents was determined using the Krejcie and Morgan formulae. The study used systematic random sampling to select smallholder maize farmers (residents) and a purposive sampling technique to select the key informants. This study used a questionnaire for farmers to collect quantitative data and interviews for government officials to collect qualitative data. Quantitative data from filled questionnaires were entered into SPSS version 24 for descriptive statistical analysis. Quantitative data was analyzed using descriptive statistics in the form of means, standard deviation, and percentages and presented in tables and figures. Inferential statistics, including correlation and linear regression, were conducted at a 0.05 significance level to determine the relationships and predictive power of the study variables. The analyzed data was presented in the form of tables and charts. Study findings indicate that there was a positive and statistically significant relationship between ecosystem-based adaptation strategies implemented and climate change vulnerabilities ($\beta_1$=.227, p=.001). The study concluded that smallholder maize farmers in Moiben Sub-County have embraced positively a number of ecosystem-based adaptation (EbA) practices that include soil conservation, agroforestry, rainwater harvesting, as well as crop diversification practices, which have led to positive agricultural sustainability and decreased climate change risks. The research suggestd that agricultural stakeholders and county agricultural departments can improve the adoption of EbA by improving extension services, providing helpful training, and creating favourable policies such as subsidies and access to credit to encourage sustainable land management. Bring out the global. Africa and Kenyan feel in the abstract.

**Keywords:** *ecosystem-based adaptation strategies, smallholder, maize farmers, Moiben Sub-County.*

**Cite this article:**

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# I. Introduction

Climate change is a pressing global challenge with far-reaching impacts on ecosystems sustainability (Garg, 2023). The rise in global temperatures, altered precipitation patterns, and increased frequency of extreme weather events pose substantial risks to communities and ecosystems worldwide (Raihan, 2023). In response to these challenges, the concept of ecosystem-based adaptation (EbA) has gained prominence as a nature-based approach to enhance resilience. The global discourse on climate change resilience has shifted towards integrating nature-based solutions, acknowledging that healthy ecosystems can act as buffers against climate-induced impacts (Scarano, 2019). Protecting and restoring natural habitats, such as forests, wetlands, and mangroves, this can act as buffers against extreme weather events and provide essential services like water regulation (Muthee et al., 2021).

Ecosystem-based adaptation is a strategy that uses biodiversity and ecosystem services as part of an overall approach to help people adapt to the adverse effects of climate change. This strategy recognizes the importance of healthy ecosystems in increasing resilience and reducing vulnerability to climate change impacts (Donatti, Harvey, Hole, Panfil, & Schurman, 2020). Unlike traditional or "hard" engineering approaches, which often involve building infrastructure, ecosystem-based adaptation focuses on the sustainable management and restoration of ecosystems. Preserving and promoting biodiversity, as diverse ecosystems tend to be more resilient to change. Biodiversity provides a range of options for adaptation as different species may respond differently to climate variations (Donatti, et al., 2020).

Ecosystem-based adaptation (EbA) is a heterogeneous approach that draws on various interconnected factors to enhance the resilience of both ecosystems and human communities in the face of climate change (Malhi, et al., 2020). One fundamental factor is biodiversity conservation. The relationship here is intricate, as diverse ecosystems tend to exhibit greater adaptability and resilience (Manrique, 2023). EbA strategies prioritize the protection of biodiversity, recognizing the role of different species in maintaining ecosystem functions and ecological balance (Karki et al., 2021). Safeguarding biodiversity, EbA contributes to the overall stability of ecosystems and their capacity to withstand climate-induced stressors (Chaudhary, Adhikari, Chaudhary, Dorji & Poudel, 2021).

Ecosystem-based adaptation strategies and local knowledge form a third pivotal factor in EbA. The relationship is participatory, involving collaboration with local communities in planning and implementing adaptation measures (Nalau, Becken & Mackey, 2018). EbA recognizes that communities, often on the front lines of climate impacts, possess valuable traditional knowledge about their environments. Involving local stakeholders, EbA not only ensures the relevance and effectiveness of adaptation strategies but also strengthens social cohesion and empowers communities to take an active role in building their resilience to climate change. These factors collectively underscore the holistic and integrated nature of EbA, emphasizing the interconnected relationships that are essential for effective climate adaptation (Vasseur, 2021).

In Kenya, climate change presents a significant threat to various sectors, including agriculture, water resources, and biodiversity. The country has experienced shifts in precipitation patterns, prolonged droughts, and increased frequency of extreme weather events (Seneviratne et al., 2021). Kenya's diverse ecosystems, ranging from arid and semi-arid lands to mountainous regions, offer a unique context for studying the effectiveness of EbA (Marigi, 2018). The country has implemented projects focused on restoring degraded landscapes, promoting agroforestry, and enhancing community-based conservation initiatives (Seddon et al., 2020). Evaluating the outcomes of these initiatives in Kenya provides valuable insights into the scalability and adaptability of EbA strategies within specific national contexts.

Uasin Gishu County in Kenya is characterized by its agricultural importance, but climate change poses risks to crop yields and water availability. The County's Climate Change Action Plan emphasizes the integration of ecosystem-based adaptation strategies to enhance the resilience of agricultural systems (Biwott, 2023). The county has implemented EbA strategies, such as agroforestry and soil conservation practices, but the effectiveness of these strategies in reducing climate change vulnerabilities among smallholder farmers remains uncertain due to challenges like limited resources, inconsistent adoption rates, and the lack of long-term monitoring and evaluation mechanisms (Yatich, 2023).

In Moiben Sub-County, climate change presents severe challenges, particularly for the agricultural sector, which is vital to the region's economy. Smallholder maize farmers, who rely heavily on rain-fed agriculture, are increasingly vulnerable to shifting precipitation patterns, prolonged droughts, and erratic rainfall. These climatic changes lead to reduced crop yields, increased susceptibility to pests and diseases, and greater water scarcity, all of which contribute to economic losses and food insecurity. Although Ecosystem-based Adaptation (EbA) strategies, such as agroforestry and soil conservation, have been recognized in regional climate policy frameworks, there is a significant gap in understanding their actual effectiveness, success factors, and limitations within local contexts like Moiben Sub-County. This study aims to fill this gap by thoroughly evaluating the effectiveness of EbA strategies in mitigating climate change vulnerabilities among smallholder maize farmers in Moiben Sub-County, providing essential insights for evidence-based decision-making and the development of sustainable adaptation strategies. The purpose of the study is to evaluate ecosystem-based adaptation strategies in mitigating climate change vulnerabilities among smallholder maize farmers in Moiben Sub-County, Uasin Gishu County, Kenya.

# Methodology

**Study Location/ Area**

The study was carried out in Moiben Sub-County, one of the sub-counties in Uasin Gishu County, located in the Rift Valley region of Kenya, and it is known for its diverse and vibrant characteristics. "It lies between longitudes 34 degrees 50' east and 35 degrees 37' West and latitudes 0 degrees 03' South and 0 degrees 55' North. It is a highland plateau with altitudes falling gently from 2,700 meters above sea level to about 1,500 meters above sea level. Moiben Sub-County has five wards Moiben Ward, Sergoit Ward, Kimumu Ward, Tembelio Ward and Karuna/Meibeki Ward.

Uasin Gishu County has a mix of natural habitats, including farmlands, forests, and grasslands. The Burnt Forest, located in the

county, is an important ecological feature. It contributes to the region's biodiversity and supports various plant and animal species. The county is well-connected by road, with Eldoret being a major transportation hub. The Eldoret International Airport facilitates both domestic and international travel. The road network ensures the smooth flow of goods and people, enhancing economic activities in the region. Uasin Gishu has 300 kilometers of tarmac roads, 549 kilometers of murram roads and 377 kilometers of earth roads. It also has 17 kilometers of railway line with 8 railway stations in addition to an inland container depot. The Eldoret International Airport and two airstrips are also located in the county, all combining to make it the regions service hub. The major urban center in Moiben Sub-County is Eldoret, which serves as an administrative, economic, and educational hub. Other smaller towns and rural settlements contribute to the overall landscape of human habitation in the county. The settlements are characterized by a mix of traditional and modern housing structures (Wanjira, & Muriuki, 2020).

Moiben Sub-County faces various climate change challenges, including erratic rainfall, droughts, floods, and extreme temperatures. These vulnerabilities threaten agricultural productivity, livelihoods, and overall community resilience. Implementing and evaluating EbA strategies in Moiben Sub-County, which is directly impacted by climate change, can provide crucial insights into effective adaptation practices and mitigation measures.

## Materials and Methods

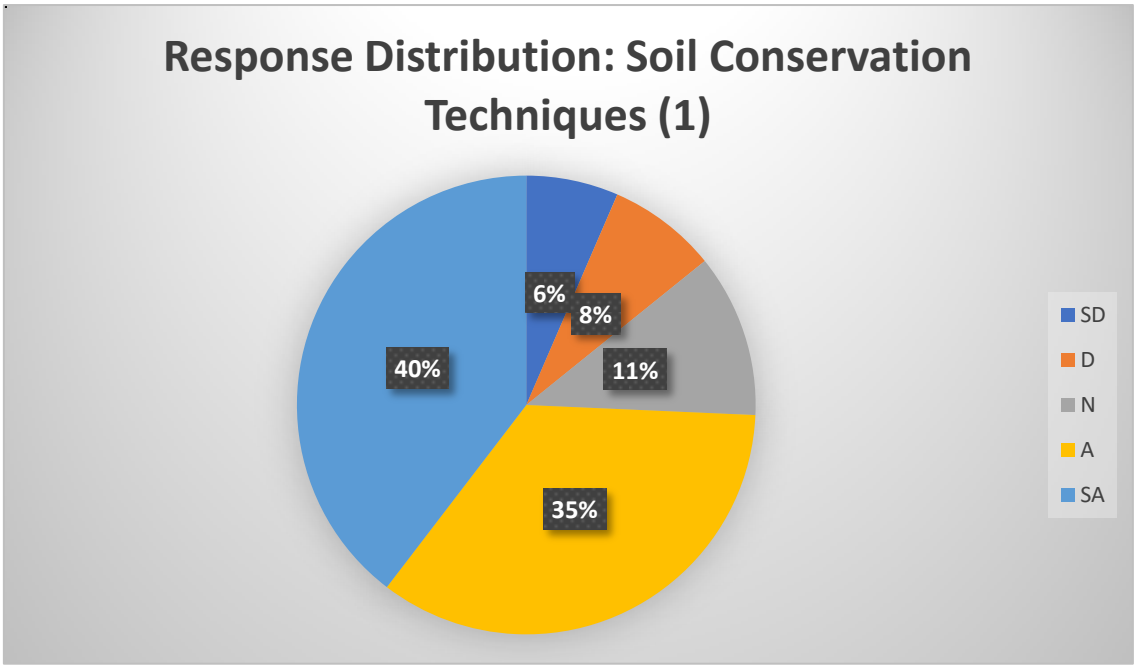
The proposed study used a mixed-methods design that incorporates both quantitative and qualitative methods to determine the overall fitness of Ecosystem-Based Adaptation (EbA) measures in Moiben Sub-County. The quantitative side of the design was demonstrated by the use of structured questionnaire to quiz smallholder maize farmers, whereas the qualitative portion of the design was established through the use of interviews of county government officials and focus group discussions (FGDs) of both community leaders and farmers. A total of 7,538 targeted respondents were identified to include 7,512 heads of farming smallholder maize farms, 9 representatives of county government officials with expertise in the field of agriculture and the environment purposively sampled to reflect the expertise they have on the topic and 17 community leaders purposively selected on the basis of their deep understanding of the context such as village elders, chiefs, religious leaders and heads of cooperatives. On the formula of Krejcie and Morgan, the size of sampling is 366 farmers and simple random sampling technique took care of representativeness in the sampling of the farmers. Data were collected by use of closed and open-ended questionnaires to farmers, semi-structured interesting to county officials and FGDs in five wards covering a wide range of opinion in the community. The informed consent to study participation was part of ethical considerations, the confidentiality of study participant information by anonymizing the data and the data security around storing the information, voluntary interest in the study that could be withdrawn without consequences, cultural sensitivity by involving local leaders first before data collection, and the approval of the study by the Institutional Review Board aimed at ensuring the rights and welfare of the study participants.

## Results

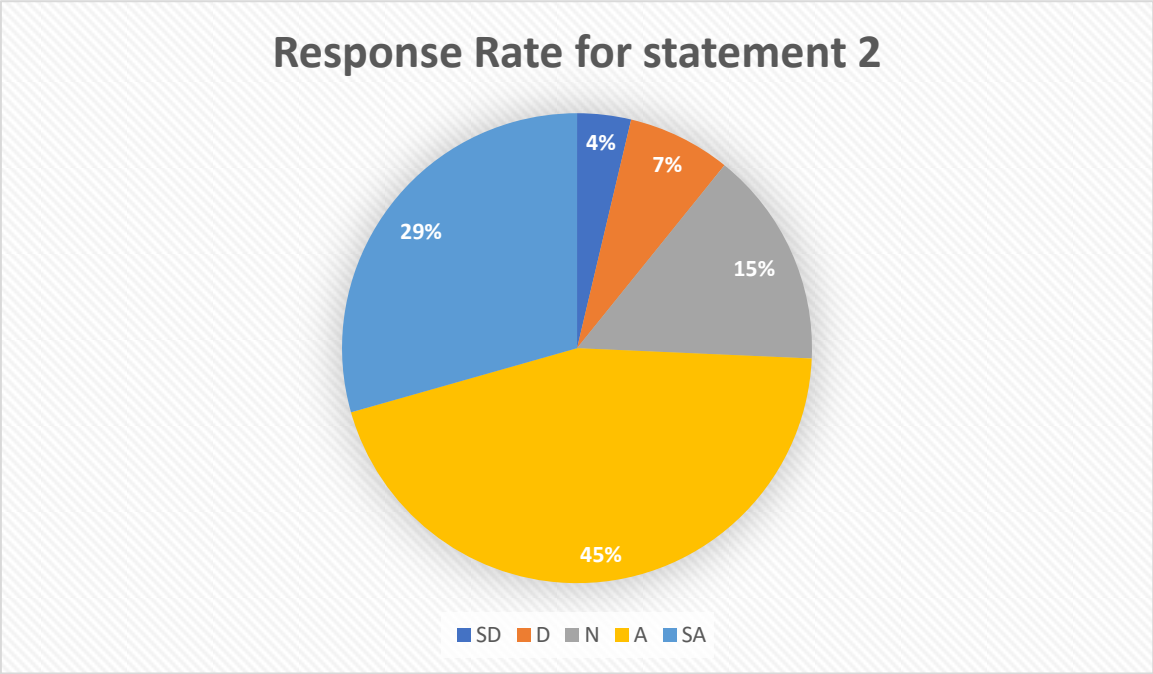
### 3.1. Descriptive statistics Findings for existing ecosystem-based adaptation strategies implemented.

This section sought to evaluate the existing ecosystem-based adaptation strategies implemented among smallholder maize farmers in Moiben Sub-County. Table 1 showed the study findings. Key: For the sake of this chart, SD means Strongly Disagreed, D means Disagree, N means Neutral, A means Agree, and SA means Strongly Agree. Analysis of the response mean scores was conducted on the continuous scale <1.5 represents strongly disagree; with 1.5-2.4 disagree; while 2.5-3.4 neutral; with 3.5- 4.5 being agree and finally >4.5 represented strongly agree. Responses elicited on a 5-point Likert scale as shown in Table 1

**Table 1 Ecosystem-based adaptation strategies implemented**

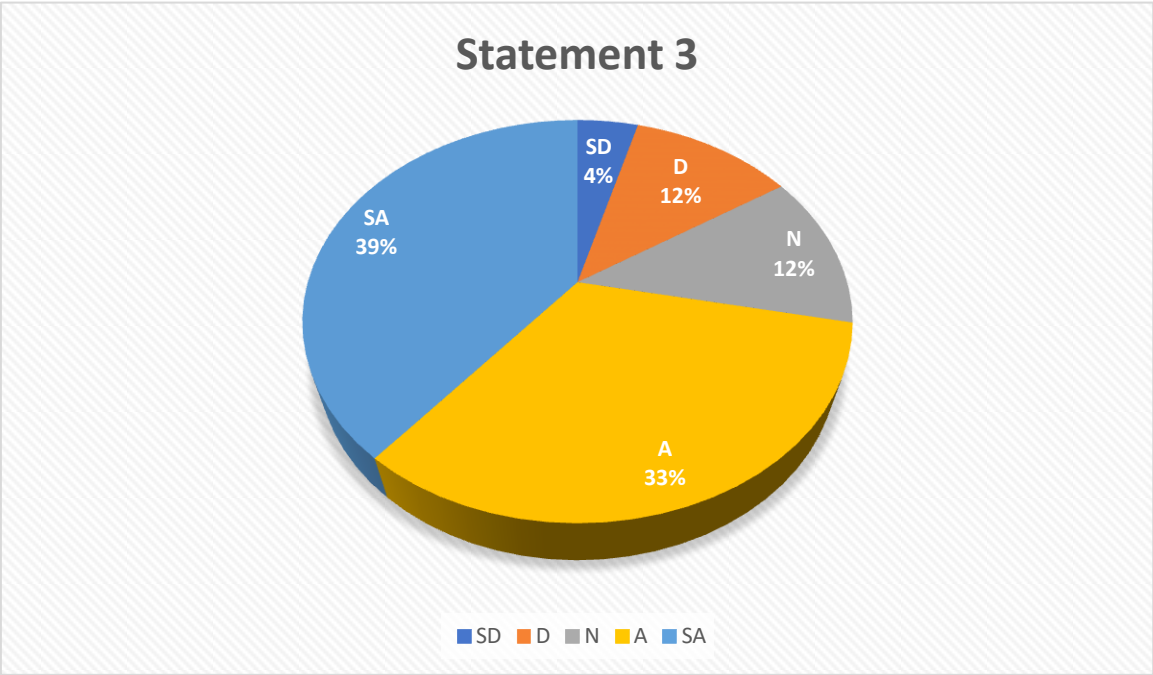


The study results in Table 1 showed that majority 240(74.3%) of the respondents agreed that they practice soil conservation techniques (e.g., terracing, contour farming) on their farm. On contrary, 46(14.2%) of the respondents disagreed that they practice soil conservation techniques (e.g., terracing, contour farming) on their farm. Further, the study results also showed, in terms of mean and standard deviation that the respondents agreed with the statement that they practice soil conservation techniques (e.g., terracing, contour farming) on their farm (Mean=3.93, standard deviation=1.19).

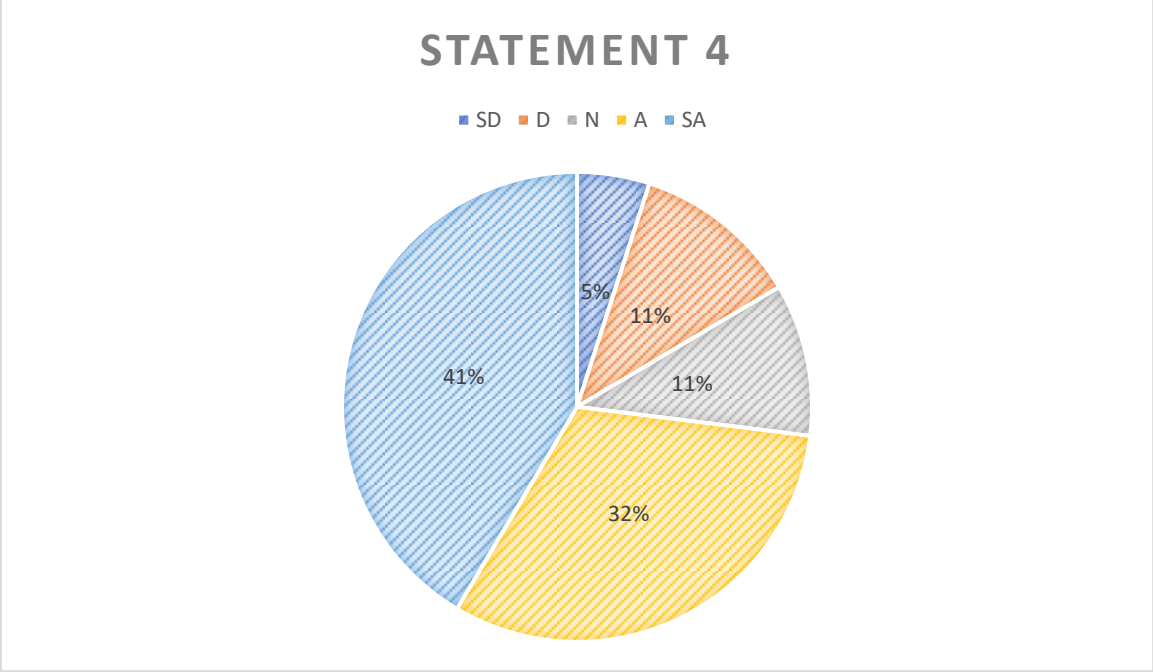



Also, the study findings noted that 240(74.3%) of the respondents agreed that crop diversification is a key strategy they use to increase resilience to climate variability and 35(10.8%) disagreed that crop diversification is a key strategy they use to increase resilience to climate variability. Further, the study results also showed, in terms of mean and standard deviation that the respondents agreed that crop diversification is a key strategy they use to increase resilience to climate variability (Mean=3.89, standard deviation=1.03).

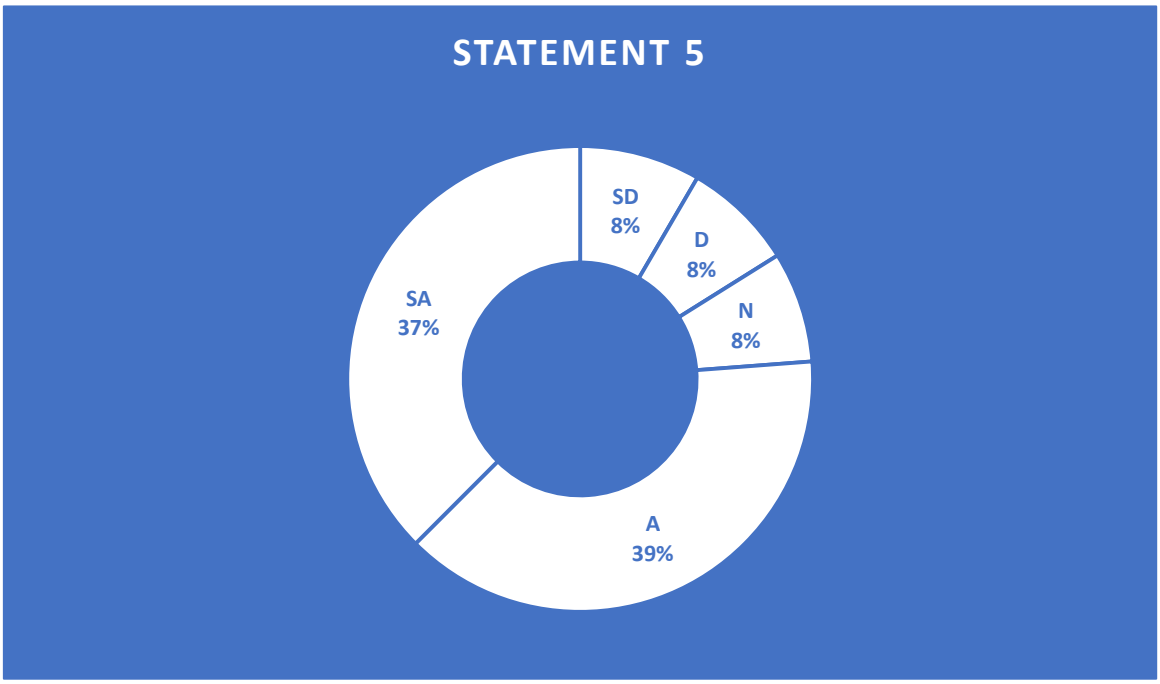
The study further revealed that, 232(71.8%) of the participants agreed that they have integrated agroforestry practices (e.g., trees interplanted with crops) on their farm. On contrary to that, 41(15.8%) of the respondents disagreed that they have integrated agroforestry practices (e.g., trees interplanted with crops) on their farm. Further, the study results also showed, in terms of mean and standard deviation that the respondents agreed that they have integrated agroforestry practices (e.g., trees interplanted with crops) on their farm (Mean=3.91, standard deviation=1.17).



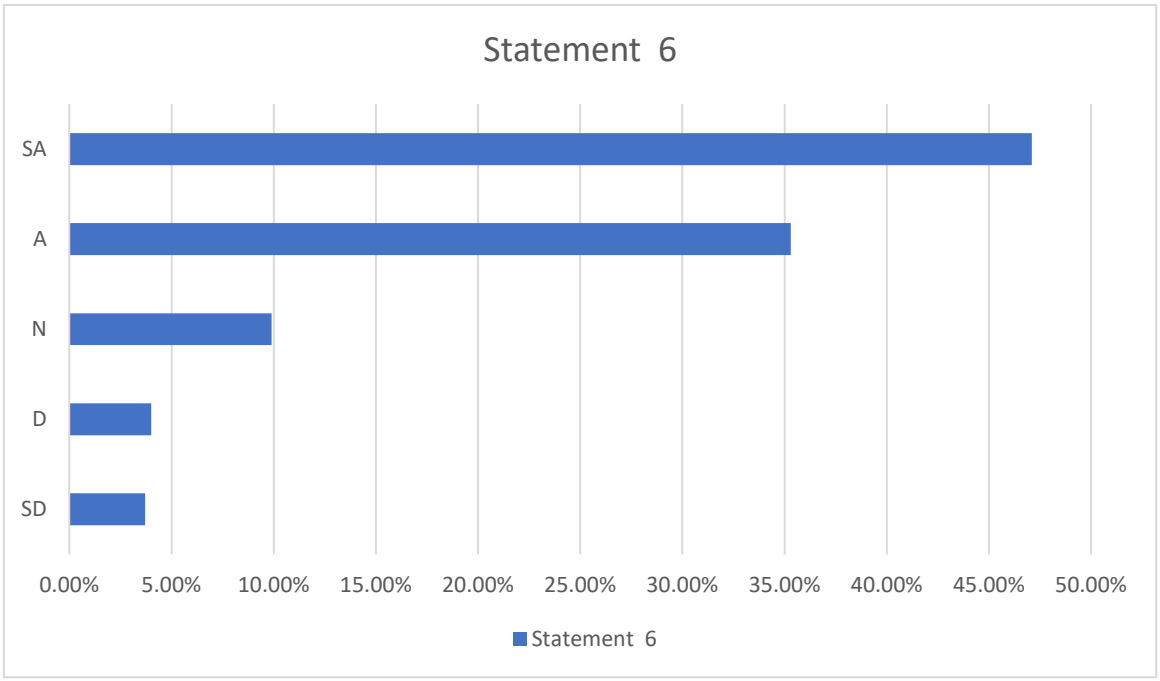
The study also showed that 236(73.1%) of the participants agreed that water management strategies such as rainwater harvesting or irrigation are in place. On contrary to those findings, 53(16.5%) of the respondents disagreed that water management strategies such as rainwater harvesting or irrigation are in place. Further, the study results also showed, in terms of mean and standard deviation that the respondents agreed with the statement that water management strategies such as rainwater harvesting or irrigation are in place (Mean=3.93, standard deviation=1.19).




Furthermore 246(76.2%) agreed that they implement cover cropping or mulching to improve soil moisture retention while 52(16.1%) disagreed that they implement cover cropping or mulching to improve soil moisture retention. In terms of mean and standard deviations the respondents agreed that they implement cover cropping or mulching to improve soil moisture retention (mean=3.89, standard deviation=1.23).

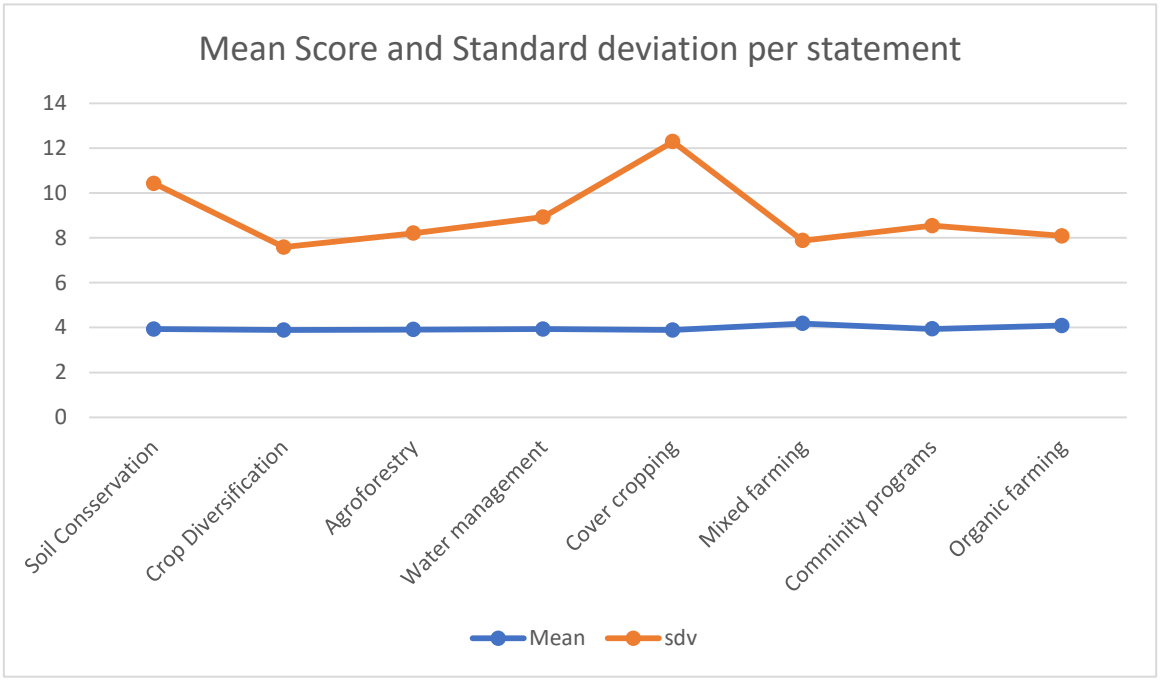


Further, 266(82.4%) of the respondents agreed that their farm benefits from mixed farming, combining crops and livestock as part of EbA and those who disagreed 24(7.7%) that their farm benefits from mixed farming, combining crops and livestock as part of EbA. Furthermore, the study's findings revealed that participants agreed (mean=4.18, standard deviation=1.02) that their farm benefits from mixed farming, combining crops and livestock as part of EbA.




The study further revealed that 240(74.3%) of the respondents agreed that they actively participate in community programs promoting soil and water conservation. However, 35(10.8%) of the respondents disagreed that they actively participate in community programs promoting soil and water conservation. Additionally, the study results on mean and standard deviation revealed that the respondents agreed that they actively participate in community programs promoting soil and water conservation (Mean=3.94, standard deviation=1.08).


Finally, 253(78.3%) agreed that the use of organic farming practices is part of their overall strategy to adapt to climate change. However, 33(10.2%) of the respondents disagreed that the use of organic farming practices is part of their overall strategy to adapt to climate change. Further, the study results also showed, in terms of mean and standard deviation that the respondents agreed that the use of organic farming practices is part of their overall strategy to adapt to climate change (Mean=4.09, standard deviation=1.08).




### 3.2. Inferential Analysis

Inferential analysis used in this section was correlation and multiple regression models. Correlation and multiple regression analysis showed the relationship between independent variables and the dependent variable.

### 3.1 Correlation Analysis

Correlation analysis was done to achieve the direction and strength of the correlation between the study variables. The findings are presented in Table 2.

**Table 2 Correlation Analysis**

| | | Climate Change Vulnerabilities | EbA strategies implemented |
|---|---|---|---|
| Climate Change Vulnerabilities | Pearson Correlation | 1 | |
| | Sig. (2-tailed) | | |
| EbA strategies implemented | Pearson Correlation | .736** | |
| | Sig. (2-tailed) | .000 | |
| | Sig. (2-tailed) | .000 | .000 |
| | N | 323 | 323 |

The Table 2 showed that ecosystem-based adaptation strategies implemented was positively and statistically significant correlated to Climate Change Vulnerabilities ($r=0.736$, $p<0.01$).

### 3.2 Regression Analysis Results

Multiple regression analysis was utilized to look at how each variable in the study related to the others. Tables summarizing the findings are provided below.

### 3.3 Model Summary

The correlation coefficient (R) and the coefficient of determination (R2) illustrated the extent to which the independent variable explained the variance in the dependent variable, while the coefficient of determination ($R^2$) demonstrated the strength of the relationship between the dependent and independent variables. Table 3 presented regression model summary findings.

**Table 3 Regression Model Summary**

| R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|
| .825[a] | .680 | .677 | .58380 |

Table 3 shows that the R value is 0.825, the R square is 0.680, and the adjusted R square is 0.590. In addition, the results demonstrated that ecosystem-based adaptation strategies implemented, rate of adoption of the ecosystem-based adaptation strategies and effectiveness of ecosystem-based adaptation strategies account for 68.0 percent of the variation in climate change vulnerabilities.

### 3.4 Model Fitness

Table 4 displays the findings of an analysis of variance performed to assess the model fitness.

**Table 4 Results of Model Fitness**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 230.861 | 3 | 76.954 | 225.791 | .000b |
| Residual | 108.721 | 319 | .341 | | |
| Total | 339.582 | 322 | | | |

**Source: Field Data (2025)**

The study findings revealed that there was a statistical significance between the independent variables and the dependent variable ($F=225.791$; $p = 0.000 < 0.05$), as shown in Table 4. Since the multiple regression models fit the data well, this means that it was chosen. Ecosystem-based adaptation strategies implemented, rate of adoption of the ecosystem-based adaptation strategies and effectiveness of ecosystem-based adaptation strategies all play a role in climate change vulnerabilities.

### 3.5 Regression Coefficients

The study primary objective was to determine the study variables respective coefficients. The study findings are presented in Table 5.

**Table 5 Regression Analysis Coefficient**

| **Model** | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| (Constant) | .676 | .106 | | 6.396 | .000 |
| EbA strategies implemented | .227 | .051 | .240 | 4.424 | .000 |

a. Dependent Variable: climate change vulnerabilities

The resultant equation becomes:

**$Y=0.676 + 0.227X_1$ ……Equation 1**

Where;

**Y** represents climate change vulnerabilities which is the independent variable,

**$X_1$** EbA strategies implemented

Table 5 presents the regression coefficient results, which revealed a positive and statistically significant relationship between ecosystem-based adaptation strategies implemented and climate change vulnerabilities ($\beta_1$=.227, p=.001).

## Discussion

The respondents were asked about the existing ecosystem-based adaptation strategies implemented among smallholder maize farmers in Moiben Sub-County. The study findings indicates that majority of the respondents agreed that they practice soil conservation techniques (e.g., terracing, contour farming) on their farm and also, they agreed that crop diversification is a key strategy they use to increase resilience to climate variability. Study findings agreed with Telles et al., (2022) found that most farmers in the study do not have enough knowledge of the pillars of CA. As a result, there is little diversification in crop rotation, and the soil is continually disturbed with chiselling.

Additionally, they also agreed that they have integrated agroforestry practices (e.g., trees interplanted with crops) on their farm, they also agreed that water management strategies such as rainwater harvesting or irrigation are in place and also, they agreed that they implement cover cropping or mulching to improve soil moisture retention. Further, they also agreed that their farm benefits from mixed farming, combining crops and livestock as part of EbA and also, they agreed that they actively participate in community programs promoting soil and water conservation and finally majority of the respondent agreed that the use of organic farming practices is part of my overall strategy to adapt to climate change. These findings are consistent with the study done by Vernooy, (2022) reveal ample evidence of positive outcomes, including increased yields and household incomes, improved nutrition and food security, new marketing opportunities, reduced poverty, and strengthened adaptive and innovative capacity.

These findings are consistent with the study done by Velasco-Muñoz, Aznar-Sánchez, Batlles-delaFuente and Fidelibus, (2019) reveal that this line of research is becoming increasingly important within research on irrigation. Environmental sciences and agricultural and biological sciences are the most relevant subject areas. The study findings agreed with Demo and Asefa Bogale, (2024) noted that mulching has several advantages for dryland agriculture, such as reducing soil water loss, soil erosion, weed growth, water droplet kinetic energy, and competition for nutrients and water with nearby fields. The study results agreed with Fadina and Barjolle, (2018) results show that farmers have a developed perception of climate change. These changes are translated by

rainfall disturbances (rainfall delays, early cessation, bad rainfall distribution etc.), shortening of the small dry season, increasing of temperature and sometimes, violent winds.

## Conclusion

Based on the study findings, it can be concluded that smallholder maize farmers in Moiben Sub-County are already in process of implementing a several ecosystem-based adaptation (EbA) strategies. The strategies includes soil conservation like terracing and contour farming, crop diversity, agroforestry, rainwater harvesting, cover cropping and organic farming. The popularity of these strategies indicates that people have a good understanding of the consequences of climate change and start to take initiative to improve agricultural sustainability by resorting to the so-called nature-based solutions.

### Recommendations

The study findings recommends that the county agricultural departments and stakeholders to strengthen the adoption and promotion of ecosystem-based adaptation (EbA) strategies to smallholder farmers growing maize. It can be done by reinforcing agricultural extension service to offer frequent training classes and a sample plot that demonstrated the practical usefulness of EbA practices like agroforestry, mulching, and soil conservation. These contributed towards the improvement of technical skills in the farmers and also towards their confidence in implementing and maintaining the strategies.

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