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Research article

Factors Influencing Farmer's Choice of Crop Production Response Strategies to Climate Change and Variability in Narok East Sub-county, Kenya

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Abstract

Climate change is considered one of the most serious threats to sustainable development in the world. As a sector, agriculture is very dependent on climatic conditions, which makes it extremely vulnerable to the impacts of climate change and variability. The semi-arid areas of the world are especially more vulnerable to the impacts of climate change and variability. The purpose of this study was to determine how farmers adapt to changing climate in Narok East, and determine the factors that influence their choice of response strategies. Data was collected from 223 household heads using a semi-structured questionnaire. Data was analysed using descriptive statistics to determine how farmers adapt to climate change and variability while Principal Component Analysis and a multivariate probit model were used to assess the factors that influence the choice of response strategies. The results showed that early planting, increased use of manure, use of terraces, increased use of inorganic fertilisers, and planting short season crops were the most widely used strategies while the least used were planting agroforestry trees, crop diversification and irrigation. Results of the multivariate probit model showed that the age of the household head, total household size, level of education of the household head, noticing changes in mean annual rainfall and onset of rains, receiving weather information, and the land tenure system were all significant factors that influence the choice of the response strategy. This study, therefore, recommends boosting more education and climate change awareness for the farmers of Narok East Sub-county.

1. Introduction

Climate change is considered one of the most serious threats to sustainable development in the world [1]. With human activity altering the atmosphere, climate change is now happening at a faster rate than it was in the past when it was mostly driven by natural forces [2]. Some of the recorded changes in global climate include the rise of land and ocean surface temperatures by 0.65 to 1.06 °C between 1880 and 2012, sea level rise, a decrease of the Arctic ice volume and the increase of warm days and nights [3]. In terms of precipitation, there is increased variance all over the world, with research showing that the wet areas have become wetter and arid areas becoming drier [4]. Annual temperature extremes have become more prevalent in the past decade than in any other period in the last century [5]. Extreme weather events such as droughts, storms and floods have also been on the increase [6].

Of all the economic sectors, agriculture is probably the one that is most dependent on climate and therefore also one of the most affected by climate change and variability [7]. As rainfall patterns and temperature values change, growing seasons will change, water will be more scarce and there will be increased incidents of pests and diseases [8]. Droughts and storms are also expected to become more frequent and therefore contribute to lower productivity which may lead to conflicts over scarce resources [9].

Climate change and variability are projected to affect different regions of the world in different ways [7], [8]. Developing countries, and especially those in sub-Saharan Africa, are expected to be more adversely affected by climate change and variability due to overreliance on natural climatic conditions for agricultural production, lack of resources to adapt effectively, poor infrastructure and poor planning and policies [9]–[11]. According to [12], within some African countries, yields from rain-fed crops will have halved by 2020, and the income from such crops will have fallen by 90 %.

In Kenya, climate change and variability is a major concern, since agriculture is the biggest employer (about 82 % of the population), the most significant contributor to the GDP (30 %) and the largest export sector with 70 % of export earnings [13]. Already, climate change and variability have contributed to the increase in the extent of arid and semi-arid land and loss of coastal land due to sea level rise loss. This has further led to declining of important and indigenous species, loss of rangelands, reduction in fresh-water availability, increase in food insecurity, increased prevalence of livestock and human diseases, increase in human-wildlife conflicts, migrations and displacement, loss of fish biomass and hampered energy production [14]. Throughout the country, droughts continue to interrupt rainfall patterns leading to harvest failures, deteriorating pastures, water scarcity and livestock loss [9]. The arid and semi-arid areas in the country, including Narok County, are the most vulnerable, especially about food and livelihood security [15].

In the period between 1950 and 2007, Narok County experienced an overall decline in rainfall amounts and a steady increase in mean temperature [16]. The County has experienced an increase in the frequency and intensity of extreme weather events, especially droughts, and delayed onset of rains [17]. In 2013, Narok County was hit by raging floods that led to 15 fatalities and the displacement of 350 people. The floods also lead to livestock deaths and the damage of more than 80 ha of food crops [17].

When farmers and pastoralists in affected areas notice the impacts of climate change and variability, they normally respond by adopting various coping mechanisms [18]. These adaptation mechanisms do not aim at preventing all adverse impacts of climate variability or clean-up after a disaster, but to create long-term resilience within concerned communities [19]. In Africa and other developing countries, those farmers take up both traditional and modern adaptation strategies [20]. Most communities in African countries affected usually resort to irrigation, crop diversification, agroforestry practices and changing planting dates [21]. The smallholder farmers in Kenya's dry lands mainly resort to diversifying crops and livestock, diversifying livelihoods, food and animal feed storage, fallowing, irrigation, reforestation and agroforestry practices to cope with the impacts of climate change [16].

In Bangladesh, the significant factors that influence a farmer's choice of adaptation strategies to climate change were the following: farmer's age, education, annual family income, farm size and cooperative involvement [22]. In studies conducted in Ghana and Nigeria's Ekiti State, it was discovered that literacy level of the household head, size of household, access to credit, age of the household head, gender of the household head, years of farming experience, extension services, access to information on climate change and household income were some of the factors that influence the choice of the coping mechanism adopted [19], [20]. According to [21], observing climate change, the level of drought frequency experienced, education level of household head, the primary crop grown and the agro-ecological zone all influenced Tanzanian farmers' adaptation strategies to climate change.

Narok East is a semi-arid area in Kenya. Farmers who practice both crop farming and pastoral activities have perceived climate change and variability, and have been victims to the adverse effects of this phenomenon. They have therefore started taking up various response strategies in order to protect their livelihoods. This research aimed at documenting all the response strategies farmers are using for crop production, and the factors that influence their choice. The results would help improving the existing laws and policies on climate change in the region and also help organizations concerned with climate change tailor their activities to the situation on the ground.

2. Materials and Methods

2.1 Study site

The study was conducted in Narok East Sub-county, Narok County Kenya. Narok County is located between latitudes 34°45'E and 36°00'E, and longitudes 0°45'S and 2°00'S in the Great Rift Valley. Narok East Sub-county has four wards, namely: Mosiro, Keekonyokie, Ildamat and Suswa (**Figure 1**). It has a population of 82,956 and a population density of 47 people per km^2 **[23]**. High human population density is found in the humid, sub-humid and semi-humid zones **[16]**. These are also the areas associated with high agricultural activities, while the remaining portion of the county is occupied by pastoral activities. The main crops grown include wheat, barley, maize, beans, Irish potatoes and horticultural crops while livestock normally include cattle, goats, sheep and donkeys **[24]**. Rainfall increases along a gradient from the dry southwest plains (500 mm/year) to wet northern highlands (2000 mm/year), with higher rainfall amounts in higher altitude areas, including the hills and escarpments. The region has two rainy seasons, the first one between March and May, and the second one between November and December. The driest months are June and July, while the annual temperature range is 12-280 °C **[16]**.

2.2 Sampling Design

A survey research design was used for the study. Narok East Sub-county was selected for the study so as to represent the arid and semi-arid areas of Kenya. The study was conducted in the four wards, with each ward contributing a representative sample through the use of a multi-stage random sampling procedure. All four wards within the Sub-county were purposively selected due to their unique topography and socio-economic conditions of the local communities. A semi-structured questionnaire was used for the research and a total of 223 household heads were interviewed.

2.3 Data Analysis

In order to assess the coping and adaptation strategies being used by the farmers of Narok East, descriptive statistic were used for the analysis. Descriptive statistics, such as frequencies, were used since they allowed for the strategies to be ranked in terms of numbers of farmers using each strategy. Principal Component Analysis was used to group correlated strategies into one group for easier analysis and interpretation of results. The multivariate probit analysis was to determine the factors that influence farmers' choice of response strategies to climate change and variability. The model is as specified below;

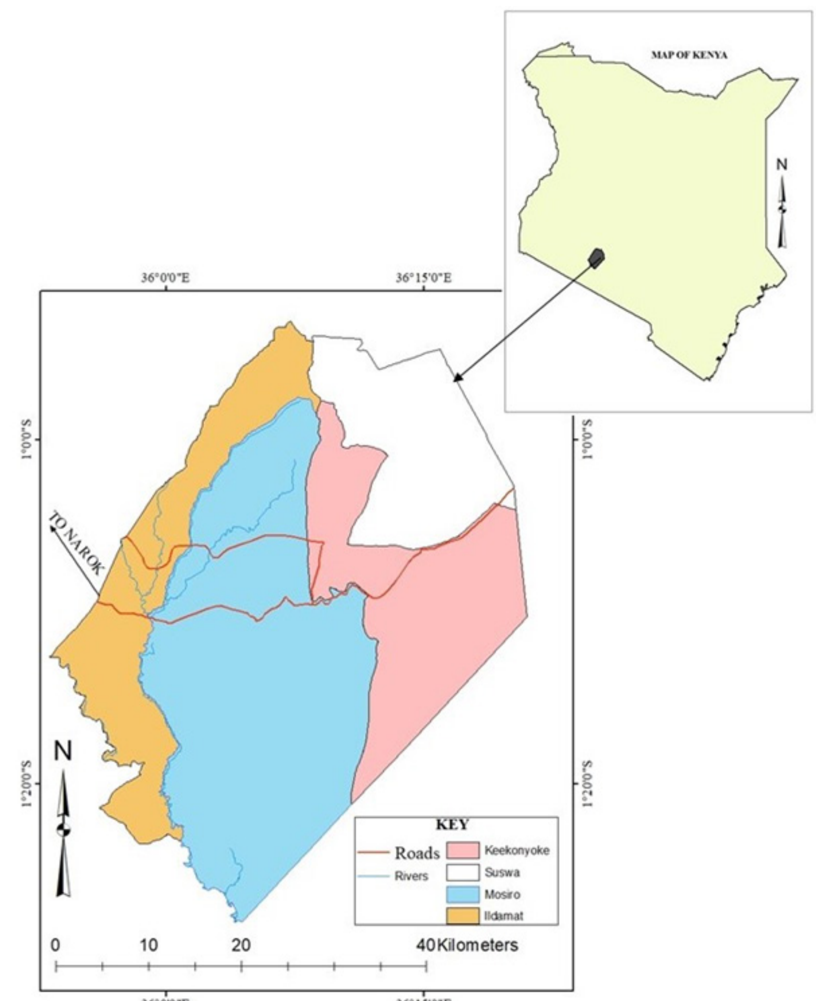

Figure 1: Map of the study site.

Where Y_{im}^* (m = 1,....,k) represents the unobserved latent variable of adaptation strategies adopted by the i^{th} farmer (i = 1,...,n), k is the strategies adopted by the farmer. X_{im} is a 1 × k vector of observed variables that affect the decision-making on the strategy to adopt, the variables include the characteristics of the household head, awareness of climate change and variability, receiving weather information and the land tenure system.

The independent variables for this study were: gender of the household head, the age of the household head, total household size, noticing changes in mean annual rainfall, noticing a change in mean annual temperature, noticing changes in the onset of rains, receiving weather information, level of education of the household head and land tenure system.

3. Results

3.1 Crop Production Strategies Adopted by Farmers

All the coping and adaptation strategies being used by farmers of Narok East Sub-county were documented and descriptive statistics were then used to determine which of those strategies are the most widely adopted. A total of 12 response strategies were identified. Five of the crop production response strategies were found to be used by more than 50 % of the respondents. These were, in descending order: early planting, increased use of manure, use of terraces, increased use of inorganic fertiliser, and planting short season crops. The least adopted crop production strategies were: planting agroforestry trees, crop diversification and irrigation, in that order (**Figure 2**).

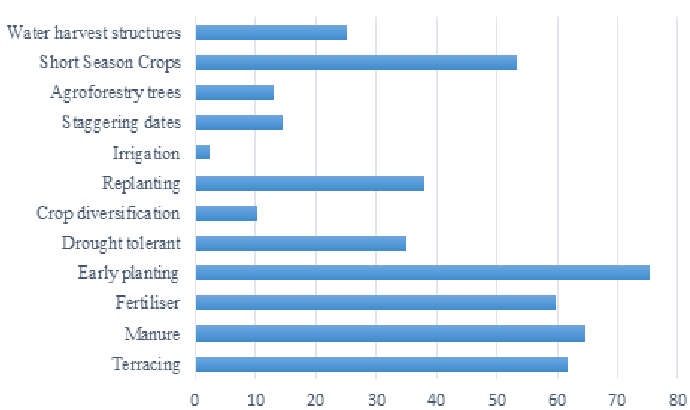

Figure 2: Percentage of farmers using each response strategy.

3.2. Factors Affecting Farmers' Choice of Response Strategies

Results of the PCA showed that a total of four components should be retained for the analysis, using Kaiser's criterion which suggests that all components with an eigenvalue of >1 should be retained for analysis **[25]**. Each component was given a name representing the strategies under it (**Table 1**).

Table 1: A breakdown of the variables under each component from PCA.

Component	Variables in component
Comp1-Loss reduction	· Terraces · Staggering planting dates
Comp2- Soil fertilisation and drought avoidance	· Increased use of manure · Increased use of organic fertiliser · Planting drought tolerant crops · Planting short season crops
Comp3-Crop diversification	· Water harvesting structures · Crop diversification · Planting agroforestry trees
Comp4-Adjusting planting dates	· Early planting · Replanting · Irrigation

Results of the multivariate probit analysis show that the following factors significantly influence a farmer's decision of crop production strategies: age of the household head, total household size, perceiving changes climate patterns, receiving weather information, level of education of the household head and land tenure system (**Table 2**). The gender of the household head was the only factor that was not significant.

3.2.1. Household Characteristics

The age of the household head was found to be a significant factor that influenced a farmer's decision to take up crop diversification strategies. The older the farmer was, the less likely they were to take up water harvesting, crop diversification or to plant agroforestry trees at 1 % significance level (**Table 2**). However, the age of the household head was not significant for the other three components.

The total household size was also found to be a significant explanatory variable for two of the components. Nonetheless, the relationship was positive for one of the components, but negative for the other one. Households with more household members were less likely to take up loss reduction strategies (terraces and staggering planting dates) at 1 % significance level. On the other hand, a household with more members was found to be more likely to engage in crop diversification, planting agroforestry trees and having water harvest structures at 10 % level.

The level of education was found to be a significant explanatory variable for three of the dependent variable components. The only component for which the level of education was not found to be significant was the loss of reduction component (terraces and staggering planting dates). Household heads who had gone up to either primary school, secondary school or to tertiary institutions of learning were more likely to use soil and drought avoidance strategies at 5 % level each compared to those who had no formal education. Farmers who had completed secondary and tertiary education were more likely to do water harvesting, diversify crops and plant agroforestry trees at 1 % significance level compared to those who had informal education. Farmers who had gone up to primary school

Table 2: Factors affecting farmers' choice of response strategy.

	Loss reduction		Soil fertilisation and drought avoidance		Crop diversification		Adjusting planting dates & irrigation	
Independent Variable	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**	**Coef.**	**Std. Err**
Gender	0.561	0.428	-0.324	0.582	-0.130	0.529	-0.509	0.535
Age	0.009	0.009	-0.008	0.01	-0.034	0.01***	0.003	0.009
Household size	-0.075	0.019***	0.002	0.015	0.031	0.015*	0.008	0.014
Mean annual rain change	-0.656	0.664	0.005	.597	0.241	0.665	1.490	0.519***
Rain onset change	2.086	0.545***	1.537	0.411***	-0.549	0.411	1.179	0.372***
Weather info	0.772	0.273***	0.521	0.248**	-0.130	0.339	0.408	0.236*
Primary education	-0.060	0.278	0.575	0.276**	-0.251	0.314	0.460	0.266*
Secondary education	0.173	0.270	0.668	0.3**	1.463	0.293***	0.838	0.285***
Tertiary education	-0.044	0.318	1.148	0.389**	2.319	0.439***	0.624	0.315*
No title deed	0.552	0.218**	0.117	0.224	1.202	0.242***	0.290	0.223
Family land	-0.533	0.489	1.941	4.454	-0.349	0.503	0.440	0.627
Communal land	-4.688	109.469	-0.828	0.385**	-0.946	0.654	-.674	0.340*
_cons	-2.284	0.995**	-0.959	1.009	0.622	-1.010	-2.413	0.999**

Observations: 223; Log Likelihood: -349.694; Wald χ 2: 163.55; Prob > χ 2: 0.0000; *, **, *** = significant at 10 %, 5 % and 1 % significance level respectively.

were more likely to adjust planting dates and do irrigation compared to illiterate farmers at 10 % significance level, those who had gone up to secondary school were more likely to use the same strategies at 1 % significance level, while those who completed tertiary education were more likely to use those strategies at 10 % level compared to illiterate farmers.

3.2.2 Perceiving changes in climatic patterns

Farmers who perceived changes in mean annual rainfall were more likely to engage in early planting, replanting and irrigation at 1 % significance level. However, noticing changes in mean annual rainfall was not a significant factor for the three other components. Those who perceived changes in the onset of rainfall were also more likely to engage in three out of four of the components (loss reduction, soil and drought avoidance and adjust planting dates) at 1 % significance level.

3.2.3 Receiving weather information

Farmers who received weather information were more likely to stagger planting dates and use terraces at 1 % level. They were also more likely to use soil and drought avoidance strategies at 1 % significance level. At 10 % significance level, the same farmers were more likely to adjust planting dates and do some irrigation.

3.2.4. Land tenure system

Although many households had secured title deeds for their land, another significant portion was yet to secure theirs, and some were still using communal land. This study found that farmers who were using land without having the title deed were more likely to use terraces or stagger planting dates at 5 % significance level compared to those who had title deeds. At 1 % significance level, farmers who did not have title deeds were also more likely to do crop diversification and water harvesting compared to those who had title deeds. On the other hand, farmers who still used communal land were less likely to use soil and drought avoidance strategies at 5 % significance level compared to those who had title deeds. The same farmers were also less likely to engage in irrigation or adjust planting dates at 1 % level compared to those who had title deeds. These results are to be expected as using communal land denies a farmer certain rights, which means that they cannot use their preferred strategies.

4. Discussion

4.1 Farmers' Response Strategies to Climate Change and Variability

Farmers is Narok East engage more in early planting, use of manure and fertiliser, terracing and planting short season crops. This is similar to the findings of **[26]**, who also reported that changing planting dates and changing fertilisers were among the most adopted strategies in Pakistan. The reason why these strategies are more preferred is because they are effective and they also require little or no extra financial investment. Terraces are preferred because they are inexpensive, and they perform many functions such as helping to retain soil moisture and minimising damage from rain runoff. Short season crops such as vegetables are also gaining popularity because they can provide sustenance for the families in the short term, while they wait for the main harvests. The study by **[26]** also associated the higher rate of adoption of those strategies with low costs and ease of accessing them.

In Narok East, planting agroforestry trees, crop diversification and irrigation were among the least utilised strategies. Some of these findings are echoed by **[26]**, who reported that irrigation, soil conservation, crop diversification and migration to urban areas were among the least utilised strategies. Others have also reported irrigation to be among the least utilised strategies despite its potential for alleviating the impacts of climate change and variability in most areas, especially the semi-arid areas **[27]**, **[28]**. Since Narok East is a semi-arid area with limited access to piped water, the limited use of irrigation as a response strategy is to be expected. Buying and setting up irrigation infrastructure is also expensive and many farmers cannot afford it. Nevertheless, farmers have started using water harvest structures on their farms such as retention ditches and planting pits in an attempt to retain soil moisture.

The low rate of agroforestry adoption may be associated with the fact that its benefits take longer to be fulfilled, while farmers prefer the short term coping strategies. Crop diversification is adopted at a lower rate because the farmers lack exposure or knowledge of other crops that can do well in the region, preferring to stick with the tried and tested crops. As noted by **[29]**, farmers in developing countries are less likely to choose response strategies that have high input expenses or strategies that they lack the knowledge and skills to implement properly.

4.2 Factors affecting farmers' choice of response strategies

4.2.1 Household Characteristics

Although gender was found not to be a significant factor for crop production strategies, other studies have reported it to be a significant factor **[30]**. In Northern Ghana, it was observed that female-led households were more likely to change crop varieties than male-led households, since female farmers are more willing to accept innovations **[30]**.

However, there are some studies that have also found the gender of a household head to be insignificant in influencing farmers' choice of climate change adaptation strategies. One of those studies was conducted in Swaziland and reported that the gender of the household head had no significant influence on the farmers' choice of adaptation strategies **[31]**. Another study conducted in Ethiopia also reported that there was no significant difference in the response strategies adopted by male and female-headed households **[32]**.

The possible explanation for this situation in the study site is that the Maasai community is traditionally nomadic pastoralists who did little or nothing in crop farming. However, nowadays an increasing number of said pastoralists are turning to it. The reason why gender might not influence their decision is that both the male and female farmers are equally inexperienced and ignorant in crop farming and therefore, they simply copy what others in the community and neighbouring areas are practising.

This study found that the age of a household head was a significant factor that influenced their decision to take up various crop production strategies, with older farmers being less likely to take up specific strategies. These results agree with several studies conducted in other parts of the world which reported the age of household head to be a significant factor with a negative influence on the decision to use certain strategies **[19]**, **[22]**, **[28]**–**[30]**, **[33]**, **[34]**. More specifically **[19]**, found that with increasing age, farmers were less likely to use improved varieties, engage in mixed farming, adjust planting period and diversify into non-farm activities. In Ethiopia, **[34]** reported that an older farmer was less likely to use soil and water conservation. A study conducted in several Southern African countries on factors affecting adoption of agroforestry practices found that farmers between 20-40 years old contributed the largest group of adopters of agroforestry **[29]**. Younger farmers in Northern Ghana were found to be more likely to use improved crop varieties **[30]**.

This situation is to be expected, as older farmers are more conservative when following traditions and may be unwilling to experiment with new crops or new farming techniques **[22]**, **[28]**, **[33]** Younger farmers are also more likely to take up various adaptation strategies because they are more energetic and can therefore use more arduous strategies and they also take more risks compared to older farmers **[29]**. Older farmers are also less educated than younger farmers and therefore lack the knowledge or skills to adopt and use new technologies. Nevertheless, some studies have found a positive correlation between the age of household head and climate change and variability adaptation **[34]**. The reason for this is that increasing age means more experience which enables older farmers to better anticipate climatic changes and plan for them.

According to the literature reviewed, total household size, when significant, can either have a positive or a negative impact on climate change and variability adaptation. Some studies have reported that with increasing household size, farmers are more likely to take up certain adaptation and coping strategies **[20]**, **[26]**, **[33]**, **[34]**. Larger families were more likely to use trees and cover crops as a response to drought **[20]**. In Narok East, availability of cheap family labour means that farmers can comfortably construct water harvest structures and plant agroforestry trees. The need to provide food for a larger family may also imply that households have to look for more crops that provide both quality and quantity harvests thereby, which explains why more family members means a higher probability to diversify crops. But, on the other hand, other studies reported a negative relationship between an increasing household size and adapting to climate change **[22]**, **[28]**, **[30]**, **[35]**. One study found that with increasing family size, the probability of a farmer taking up any adaptation strategy decreases **[22]**. Another study conducted in Northern Ghana reported that families with large household sizes had low probabilities of shifting the cropping calendar **[30]**. Ironically, availability of cheap family labour can also be used to explain why households with more family members in the study site are less likely to stagger planting dates or use terraces. With more family members, farmers can use planting pits instead of terraces, and they can all finish the planting in one or two days rather than doing it in phases.

Other studies have also reported this scenario whereby household size affects two different strategies in opposite directions **[19]**, **[36]**. According to **[19]**, with increasing household size, households can increase the use of soil and water conservation strategies, but reduce the probability of farmers adjusting their planting period or diversifying into non-farm activities.

The results of this study on the influence of the level of education on climate change adaptation are echoed by many other studies that found the level of education (literacy level) to be positively related to adaptation to climate change and variability **[18]**–**[20]**, **[22]**, **[26]**, **[30]**, **[37]**, **[38]**. This is because more educated farmers are more knowledgeable on climate change and on better agricultural production methods which they adopt to minimise loss and improve productivity in the face of changing climate and weather extremes.

4.2.2. Perceiving changes in climatic patterns

Logically speaking, a farmer cannot consciously adopt response strategies for a phenomenon they have not perceived. It therefore holds that perceiving climate change and variability is one of the most important factors that influence adaptation. Thus, this argument supports the findings of this study that perceiving changes in mean annual rainfall and onset of rains positively influences the decision to take up most of the crop production response strategies. The result is also consistent with the finding of **[21]**, who reported that observing climate change and experiencing drought influenced the farmers' coping strategies to climate change in Tanzania. In Ethiopia, farmers who had perceived increasing temperature were found to be more likely to adapt to climate change and variability compared to those who had not **[34]**. In Northern Ghana, farmers who had perceived changes in temperature were more likely to plant trees on their farm **[30]**. When farmers in Swaziland perceive a change in climate, they are more likely to adapt to it by planting drought-tolerant crops and changing planting time **[31]**.

4.2.3. Receiving weather information

Farmers who have a better understanding of what climate change and variability are, as well as their causes and impacts, are more likely to adapt better to them **[19]**, **[29]**. Furthermore, as noted by **[29]**, a better understanding of the relationship between climate change and land degradation is one of the factors that can enhance the adoption of agroforestry technologies. For the current study, 'receiving weather information' was a term used to mean getting reliable and accurate weather forecast and also being more informed about climate change and variability. The results were as expected, as farmers who received weather information were more likely to use most of the strategies. Other studies also reported similar results. For example, in Pakistan, receiving weather forecast information positively influenced a farmer's decision to change crop types, change planting dates, plant shade trees, engage in soil conservation, change fertiliser, irrigate and diversify crops **[26]**. Similar findings by **[19]** reported that farmers who had received climate change information were more likely to use improved varieties, adjust planting dates, and diversify into non-farm activities. Also, the access to weather information positively affects the farmers' decision to fertilise and plant trees in their farms **[30]**.

4.2.4 Land tenure system

Land tenure systems and policies have a major influence on the nature of agriculture conducted on a farm, and indeed other land use practices **[39]**. The issue of land ownership is very sensitive in the study area, with a lot of previously communal land being privatised **[16]**. Before undertaking the study, it was expected that people with title deeds would be more likely to use various strategies compared to those who had no title deeds. However, this was not the case.

Similar findings were reported in Punjab Province of Pakistan by **[26]**, who found that tenant farmers were more likely take up various adaptation strategies compared to owner farmers. More specifically, they reported that farmers who owned their land were less likely to change crop type, change planting dates or change fertilisers and these findings were similar to the ones of the current study. They associated this finding with the fact that a tenant farmer had more expenses, including the rent of the land and therefore did more to be more profitable **[26]**.

Part of this argument can be applied to Narok East, as farmers do not have title deeds and would want to get maximum benefits from the land. An even better explanation can be deduced from what **[39]** noted: increased privatisation of land in the pastoral areas had led to an increase in absentee landlords, those who hold onto land for accumulation and speculation purpose. Therefore, this observation may mean that farmers who have title deeds may be doing the bare minimum on their land as they wait for it to appreciate in value. On the other hand, those without title deeds may be maximising the use of their land since it may be their only source of livelihood.

The finding that farmers who use communal land are less likely to use soil and drought avoidance strategies and are also less likely to use irrigation or adjust planting dates is to be expected. This is because without complete freedom on how to use the land, farmers are restricted to using practices that would be acceptable to other community members.

5. Conclusion and Recommendations

The results of this study show that the farmers of Narok East Sub-county have adopted various response strategies to climate change and variability. The most widely adopted strategies were early planting, increased use of manure, use of terraces, increased use of inorganic fertilisers and planting short season crops while planting agroforestry trees, crop diversification and irrigation were the least adopted. The age of the household head, total household size, level of education of the household head, noticing changes in mean annual rainfall and onset of rains, receiving weather information and the land tenure system were all significant factors that influence choice of response strategy. However, the gender of the household head was not a significant factor. More educated farmers were more likely to take up specific response strategies compared to less educated farmers. Similarly, those who notice changes in climatic conditions were also more likely to take up certain adaptation strategies. Farmers who received weather information were also more likely to choose certain strategies compared to those who were less informed. Older farmers were found to be less likely to use certain strategies compared to younger farmers. Farmers without title deeds for their land were found to be more likely to adopt specific strategies than farmers with title deeds.

Therefore, this study recommends providing more education and climate change awareness sensitisation to the farmers of Narok East Sub-county. Farmers should be trained and educated on the more effective response strategies such as greenhouses and irrigation. Financial incentives should also be provided to the farmers to enable them to use the more effective strategies. Farmers should be provided with accurate and timely weather forecasts in order to enable them to plan effectively and protect themselves.

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