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Original Article

Climate Variability Adaptation Strategies Used by Small-Scale Maize Farmers in Uasin Gishu County, Kenya

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ABSTRACT

The agricultural industry is threatened by climate variability due to its over-reliance on climatic conditions. Maize production faces similar threats due to its sensitivity to climate variations and changes in weather patterns, specifically rainfall and temperature. Increased temperatures, rainfall variability, and heightened frequency of climate extremes, such as long periods of drought, were found to have a significant impact on Kenya's maize production. This study therefore sought to identify climate variability adaptation strategies used by small-scale maize farmers in Uasin Gishu County, Kenya, to curb the effects of climate variability on maize yield. The study adopted a descriptive survey design where questionnaires were administered to 394 household heads. The results show some farmers chose different adaptation strategies to lessen the impact of climate variability on maize yield, while others stuck to their original methods of farming. Changing crop varieties and changing planting dates were the highly opted-for adaptation strategies, while dry planting, irrigation farming, planting drought-tolerant crops and soil moisture conservation techniques were the least opted-for adaptation strategies. Socioeconomic factors such as land size, education level, age, gender and marital status had a strong influence on the choice of utilisation of various adaptation strategies. So as to curb the adverse outcomes of climate variability and empower small-scale maize farmers, the study recommended proper education on diverse adaptation methods, access to accurate climate data for proper adjustment to planting dates, sensitization on different crop varieties as well as access to financial resources to promote practices like irrigation farming.

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INTRODUCTION

Climate change has become a major concern worldwide due to its effects. The changes in precipitation and temperature that contribute to global climate extremes are known as climate variability (Hosen *et al*., 2020; Tang, 2019). Changes in rainfall and temperature are the most distinct effects of climate variability observed over the years (Hosen *et al*., 2020). Effects such as lower seasonal rainfall and variability in rainfall are being felt in the Mediterranean region, where these changes would subsequently impact agricultural systems and viticulture in the region (Barbosa *et al*., 2018). Temperature variability, on the other hand, has been felt globally through surface temperature increasing over time, which has contributed to an increasing drought severity in arid and semi-arid land (ASALs) (Stemn, 2020). In order to reduce these effects on agricultural yield, adaptation strategies are needed. Adaptation has been defined by the Intergovernmental Panel on Climate Change as the process of adjusting to the current or predicted climate and its effects (Phuong *et al*., 2018). Farmers in Vietnam have felt climate variability effects such as changes in rainfall season that influenced crop yield (Thoai *et al*., 2018). To reduce the impact of these effects, farmers in Vietnam adapted by changing their crop varieties, changing their planting dates, practising intercropping, and monitoring weather forecasts (Thoai *et al*., 2018).

Climate variability effects in Africa are characterized by changing rainfall patterns and an increase in temperature in the region (Sidibe *et al*., 2020). Rainfall variability and temperature rise were observed to be persistent in the West African region (Ahokpossi, 2018). Other African countries have experienced changes in planting seasons, increased temperatures, high rainfall variability and increased frequency of climate extremes (drought and rainfall) that have highly influenced agriculture in the region (Zakari *et al*., 2022). To counter these effects, farmers in African countries such as South Benin chose crop-livestock diversification, using improved seed varieties, agroforestry, and application of fertilizers as their main adaptation measures to climate variability effects (Fadina, 2018). Other farmers in South Africa who live in hotter climates opted to employ irrigation and alter their planting dates as adaptation methods (Rankoana, 2022). Farmers in Ghana chose improved seed varieties, tree planting, mixed cropping, land rotation, and planting in rows (Sadiq *et al*., 2019). These adaptation measures that farmers use seek to reduce the effect of climate variability on their yield and livelihood in order to be food secure and maintain their source of livelihood (Assan *et al*., 2020).

Farmers in Sub-Saharan Africa (SSA) rely heavily on rain-fed agriculture for food and a living (Haile *et al*., 2020). The effects of climate variability in SSA have been felt through changes in rainfall and temperature that are being experienced (Serdeczny *et al*., 2017). These changes would eventually have negative implications for food security in the region (Alemayehu, 2016). It is thought that erratic rainfall combined with higher surface temperatures poses a serious threat to agricultural output in the area (Ademe *et al*., 2020; Suryabhagavan, 2017). Due to these effects, adapting to climate variability effects by farmers has become an option for reducing the effects of climate variability shocks on their yield (Akinyi *et al*., 2021; Zougmoré *et al*., 2018). Crop rotation, changing crop varieties, water diversion, and chemical fertilization are some of the measures that farmers in Southern Ethiopia use (Daba, 2018). Other adaptation measures used in SSA

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include mixed farming, mixed cropping, planting drought-resistant crop varieties, changing crop varieties, changing planting dates, water harvesting, irrigation, and diversifying income sources (Daba, 2018). These methods of adaptation are however hindered by factors such as difficulty in accessing climate information, insufficient finances, insufficient skills in adaptation, shortage of labour, and access to land (Thinda *et al*., 2020).

East Africa has witnessed climatic extremes like droughts and flooding, and the trend of increasing maximum and lowest temperatures and high rainfall variability is anticipated to remain in the upcoming years (Gebrechorkos *et al*., 2020). East African farmers chose a variety of adaptation strategies to mitigate the effects of climate variability on rain-fed agriculture (Wens *et al*., 2020). Changing crop varieties, irrigation farming and changing planting dates were the most common adaptation strategies in East Africa (Wens *et al*., 2020). Despite these adaptation strategies being put in place, the effects of long periods of drought are still being felt in the region, influencing food security in the region.

Kenya has felt climate variability effects such as increasing temperatures that have negatively influenced agricultural crops such as maize, which is the staple food of the country (Ochieng *et al*., 2016). The country's rising rainfall variability is anticipated to have an impact on food security, as crops like tea and maize would be severely impacted if the trend continues (Lagat, 2018). Future climate projections backed by the IPCC indicate the continuity of this trend, which would contribute to changing planting seasons, erratic rainfall, and extreme weather events that would negatively influence agricultural yields in the country (Datta *et al*., 2022; del Pozo *et al*., 2019). Farmers in Kenya have chosen adaptation measures to reduce the effects of climate variability on farming (Nyberg *et al*., 2021). Some of the adaptation measures used by farmers in semi-arid Eastern Kenya include planting disease/drought-resistant crops, diversifying crop varieties, irrigation, diversifying sources of income, water harvesting, and soil moisture conservation practices, which are expected to curb the effects of climate variability (Quandt, 2021).

Uasin Gishu County is being affected by climate variability effects (Kimani, 2016). The presence of changing rainfall patterns and amounts is negatively influencing farming in the region, leading to lower quantities of harvest (Ndukwe, 2018). Climate variability, weak agricultural institutions, and inadequate policies contribute to the ongoing reduction in maize production in the region (Kimani, 2016). Farmers must come up with adaptation techniques to combat the effects of climate variability on the region's maize crop (Ndukwe, 2018). This study therefore, aimed to identify climate variability adaptation strategies that small-scale maize farmers in the region use to reduce the effects of climate variability with a view to empower small-scale maize farmers and increase maize output.

METHODOLOGY

Uasin Gishu County covers an area of 3345 km^2 and lies on longitudes of 34°50'E, 35°37'E and latitudes of 0°03'N, 0°55'N. It is generally a highland plateau with altitudes falling gently from 2700m to 1500m above sea level (MoALF, 2017). The County is made up of six sub-counties, namely Ainabkoi, Kapseret, Kesses, Moiben, Soy, and Turbo, as shown in *Figure 1* below:

The study applied a descriptive survey design method of research, which primarily focused on gathering first-hand information from respondents. To obtain the sample size, the study used Yamane's 1967 formula, as cited from Naing (2003), to determine the sample size using the equation: $n = \frac{N}{1+N.e^2}$ Where: n= the sample size, N= the size of the population, e = the error of 5 percentage points

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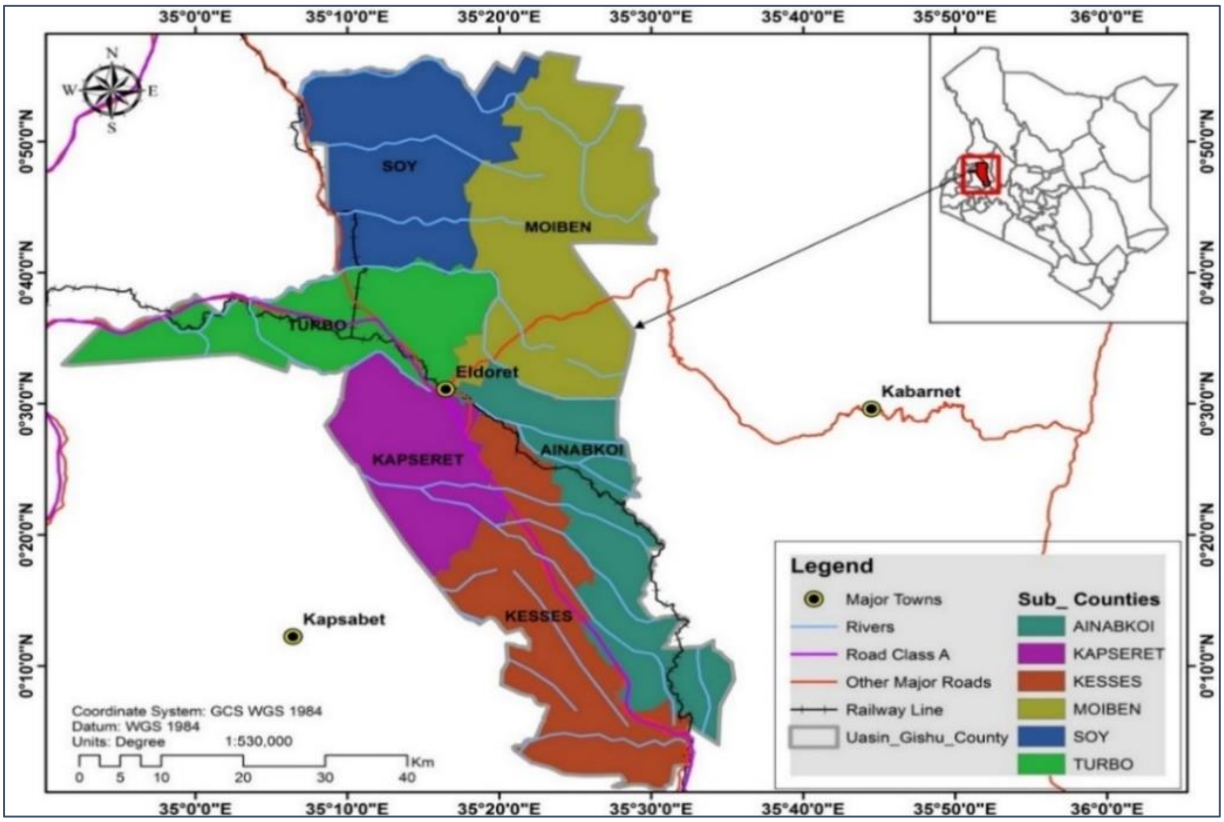
Figure 1: Uasin Gishu County Map



Source**: (**GIS 2019)

A sample of 394 was obtained as the sample size with a 5% error rate, and a 95% level of confidence was obtained. Each of the sub-counties provided samples for collection. The formula used to determine the sample size for each sub-county was $ni = \frac{n}{N} \times 394$.

Where: *ni* = the sample size in the sub-county, *n*= population of small-scale maize farmers in the stratum, *N*= total number of small-scale farmers in the County

Table 1 below shows the distribution of respondents per sub-county:

Table 1: Sample size per sub-county

Sub-County	Population of maize farmers	Representative fraction
Ainabkoi	3,395	47
Kapseret	4,875	67
Kesses	3,670	52
Moiben	4,410	61
Soy	5,650	78
Turbo	6,540	90
Total	28,540	394

Small-scale maize farmer household heads were administered questionnaires in order to gather primary data. Questionnaires were administered at random in the corresponding sub-counties. Using the relevant statistical software, such as SPSS and Excel, qualitative data was coded and subjected to measures of central tendency and dispersion analysis. The preferred adaptation strategies for the responses were noted and presented in frequencies and percentages. A multivariate linear regression model was used to determine the relationship between socioeconomic factors (independent variables) and the choice of adaption strategies (dependent

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variables). The approach of inferential data analysis was appropriate given that there were numerous dependent variables (adaptation techniques) being compared with independent variables (socioeconomic factors) that were assessed using the p values.

The equation of the model used was: Y = a + b1x1 + b2x2 + b3x3 + …+bnxn

Where: Y = choice of adaptation strategies, a = Constant, b = is the rise or falls with changes in X, x1 = Gender, x2 = Age, x3 = Education level, x4 = Marital status, x5 = Income level, x6 = land size

The results were thereafter presented in tables, and the p values ($p \leq 0.05$) of socioeconomic factors that had an influence on adaptation strategies were highlighted

RESULTS AND DISCUSSION

Response Rate of the Questionnaire

A descriptive survey design was used in this study. In order to generate conclusions and recommendations appropriate for the study location, the design emphasized the gathering of first-hand information from respondents. 394 questionnaires were distributed as per the sample size per Sub-county highlighted in *Table 1* above. 394 questionnaires were filled, with a majority of the respondents being male household heads at 82.33%, while the female respondents were 17.77%.

Response Rate of Adaptation

A majority of small-scale farmers (63%) made the decision to adjust to the effects of climatic variability by adopting one or more adaptation strategies, whereas a minority (37%) did not and kept up with their usual farming practices. The gender of the household head had more male respondents (82.33%), which can be attributed to the African culture where the male is the household head. Despite this, 42 (10.66%) out of the total female household heads (n=70, 17.77%) chose to adapt to climate variability. Respondents who chose to adapt were between the age of 29-58, with the highest being respondents in the 39-48 age group. The age groups of 19-28 and 59-68 had the least number of respondents who picked up adaptation measures. Older generation farmers with more years of agricultural experience made up the 59–68 age group of respondents, yet 3% of them made the decision to adapt. This can be ascribed to the age group's conservatism, as demonstrated by a study by Muzamhindo (2015), which found that older farmers were less willing to adopt adaptation methods than younger farmers, who were more receptive to novel concepts and adaptation technologies. Respondents who had attended formal education were the majority of respondents who chose to adapt (62.94%), whereas respondents who took up adaptation measures and had no formal education stood at 0.25%. These results agree with Zougmoré's *(*2018) study findings that highlighted that those with formal education had the ability to adapt. The level of education is an aspect that affects awareness, knowledge and adoption of adaptation methods, which in turn affects the adaptive capacity of an individual (Zougmoré *et al*., 2018). The distribution of response rate is shown in *Table 2* below:

It is clear in *Table 2* that the majority of respondents had attended formal schooling. Respondents with secondary education were the highest respondents who used changing crop varieties as an adaptation measure, while the lowest respondents (0.3%) had not gone through the country's formal education system. The household size that stood out with the highest number had 4-6 members, with 17% of the respondents, while the least was 10 and above, with 2.8%. The results on education agree with Thoai's (2018*)* study findings that highlighted changing crop variety as a preferred adaptation measure for educated farmers. The results of Thoai's (2018) study underlined the significance of education in maize variety knowledge that would be helpful in coping with the effects of climate variability. Therefore, for farmers to raise their adaptive capacity, the level of education and understanding of maize seed varieties should be considered.

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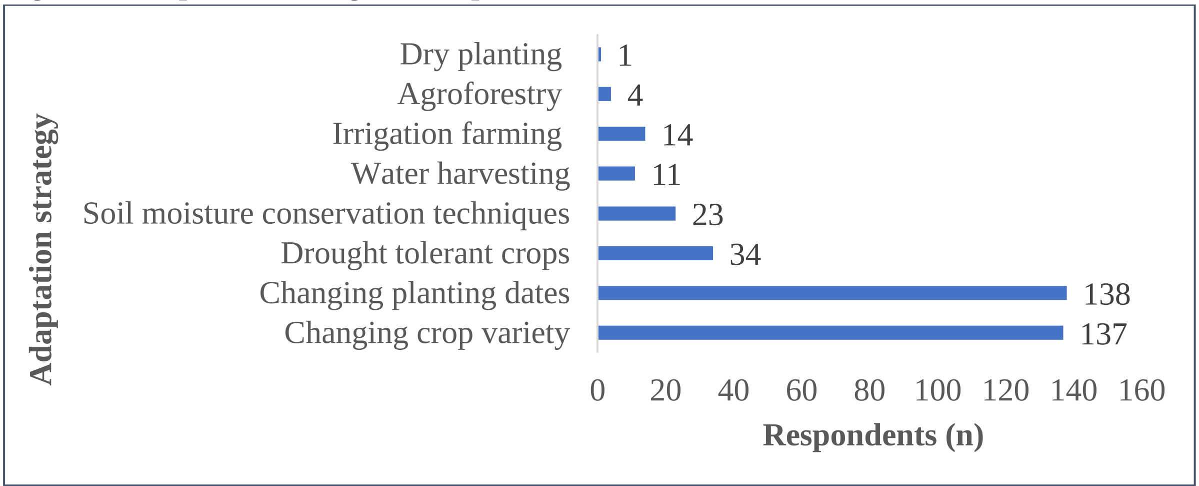
Table 2: Adaptation per demographic characteristics of respondents

Parameter		Adopters		Non-adopters		Total
		f (n)	%	f (n)	%	
Gender	Male	206	52.28	118	29.95	324
	Female	42	10.66	28	7.11	70
	Total	248	62.94	146	37.05	394
Age	19-28	13	3.30	7	1.78	20
	29-38	67	17.01	39	9.90	106
	39-48	97	24.62	64	16.24	161
	49-58	57	14.47	30	7.61	87
	59-68	14	3.55	6	1.52	20
	Total	248	62.94	146	37.05	394
Education	No formal education	1	0.25	5	1.27	6
	Primary	74	18.78	53	13.45	127
	Secondary	119	30.20	65	16.50	184
	Tertiary	54	13.71	23	5.84	77
	Total	248	62.94	146	37.06	394
Marital Status	Single	36	9.14	34	8.63	70
	Married	212	53.81	112	28.43	324
	Total	248	62.94	146	37.06	394
Household Size	1- 3	35	8.88	16	4.06	51
	4-6	133	33.76	86	21.83	219
	7-9	65	16.50	35	8.88	100
	10 and above	15	3.81	9	2.28	24
	Total	248	62.94	146	37.05	394

Adaptation Strategies Used for Maize Production in Uasin Gishu County

Respondents selected a range of adaptation strategies, including shifting crop varieties, changing planting dates, planting drought-tolerant crops, conserving soil moisture, water harvesting, irrigation farming, agroforestry, and dry planting. *Figure 2* demonstrates that the majority of respondents' choice for their maize adaptation approach was to change the crop variety and planting dates:

Figure 2: Adaptation strategies of respondents



With 138 respondents, it is clear that the choice made by the majority of farmers to adjust to the effects of climate variability is changing planting dates. The altering of maize crop variety came in second, with 137 respondents using it to adjust to the changing trends in temperature and rainfall. These findings are consistent with the Thoai *et al.* (2018) study, which found that farmers most

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frequently choose to change their crop varieties and planting dates when adjusting to the effects of climate variability. Dry planting, which involved planting maize before the rainy season began and then waiting for it to begin, was the adaptation strategy that received the least support (0.25%). The adaptation strategies chosen are in line with a study by Daba (2018) that highlighted the use of irrigation farming and water harvesting, as well as using crop varieties that can withstand drought and changing planting dates. Implementing adaptation strategies improves farmers' ability to adjust by lowering their sensitivity to the effects of climatic variability, maintaining their predicted yield per acre.

Table 3: Changing crop variety distribution

Parameter		Adopters		Non-adopters		Total
		f (n)	%	f (n)	%	
Gender	Male	109	27.66	215	54.57	324
	Female	28	7.11	42	10.66	70
	Total	137	34.77	257	65.23	394
Age	19-28	7	1.78	13	3.30	20
	29-38	33	8.38	73	18.53	106
	39-48	47	11.93	114	28.93	161
	49-58	41	10.41	46	11.68	87
	59-68	9	2.28	11	2.79	20
	Total	137	34.77	257	65.23	394
Education	No formal education	1	0.25	5	1.27	6
	Primary	48	12.18	79	20.05	127
	Secondary	70	17.77	114	28.93	184
	Tertiary	18	4.57	59	14.97	77
	Total	137	34.77	257	65.22	394
Marital Status	Single	27	6.85	43	10.91	70
	Married	110	27.92	214	54.31	324
	Total	137	34.77	257	65.22	394
Household Size	1-3	17	4.31	34	8.63	51
	4-6	69	17.51	150	38.07	219
	7-9	40	10.15	60	15.23	100
	10 and above	11	2.79	13	3.30	24
	Total	137	34.77	257	65.23	394

Respondents chose to change their crop varieties and used alternative maize varieties that seemed to be better suited to provide the expected yield per acre despite the climate stresses caused by climate variability. Both male and female respondents chose to use this method, with a majority being male household heads at 28%, while female respondents were 7%. Respondents who chose to use this adaptation technique had a majority within the age brackets of 39-48 and 49-58, with 12% and 10% of the respondents, respectively. This can be attributed to more years of farming experience that have exposed these farmers to different maize varieties, thereby making them able to distinguish which variety is most suitable for their individual farms. These results agree with Dang's (2019) study that highlighted the years of farming experience as an advantage to the adaptation method.

Changing Planting Dates

Changing planting dates was the most commonly practised adaptation measure, with a total of 138 (35.03%) respondents. Respondents chose this method due to rainfall variability that caused a change in rainfall patterns, thus forcing them to change planting dates. A majority of the male respondents chose this method as an adaptation strategy with 29%, while 5% of female household heads chose it. Respondents between the age brackets of 39–48 recorded the highest percentage at 15%, while the lowest age group, 1.8% of

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respondents, is the age bracket of 19–28 (1.78%) and 59–68 (1.78%). Respondents with a secondary level of education were the highest, with 16% of the respondents, while the least had primary and tertiary education, with 9% each, as shown in *Table 4* below:

Table 4: Changing planting dates

Parameter		**Adopters**		**Non-adopters**		**Total**
		f (n)	**%**	**f (n)**	**%**	
Gender	Male	116	29.44	208	52.79	324
	Female	22	5.58	48	12.18	70
	Total	138	35.02	256	64.97	394
Age	19-28	7	1.78	13	3.30	20
	29-38	40	10.15	66	16.75	106
	39-48	59	14.97	102	25.89	161
	49-58	25	6.34	62	15.73	87
	59-68	7	1.78	13	3.30	20
	Total	138	35.02	256	64.97	394
Education	No formal education	0	0	6	1.52	6
	Primary	36	9.14	91	23.10	127
	Secondary	65	16.50	119	30.20	184
	Tertiary	37	9.39	40	10.15	77
	Total	138	35.03	256	64.97	394
Marital Status	Single	18	4.57	52	13.20	70
	Married	120	30.46	204	51.78	324
	Total	138	35.03	256	64.98	394
Household Size	1-3	25	6.35	26	6.60	51
	4-6	75	19.03	144	36.55	219
	7-9	33	8.38	67	17.01	100
	10 and above	5	1.27	19	4.82	24
	Total	138	35.03	256	64.98	394

Changing planting dates is an adaptation measure that needs knowledge of rainfall trends that is achieved through monitoring and observing weather patterns and years of farming experience (Thoai *et al*., 2018). Years of farming experience is an added advantage to farmers since they have had first-hand experience with rainfall and temperature trends, thereby giving them an upper hand in using changing planting dates as a method of adaptation (Peng *et al*., 2020). Respondents over the age of 39 years are the majority of respondents who picked up changing planting dates as an adaptation technique, which can be attributed to study findings by Peng (2020) that showed the years of farming experience being a factor in adaptation.

Planting Drought-Tolerant Crops

A total of 34 (8.63%) respondents chose to plant drought-tolerant crops as a method of adaptation. A majority of the respondents were male household heads at 5%, while female household heads were the least at 3%. The age bracket with the highest number of respondents was 49-58 with 3%, while the lowest age group was 19-28 with 0.5% of the respondents. According to *Table 5* below, those in secondary education had the greatest rate at 4.8%, whereas those in the tertiary category had the lowest rate at 1.8%.

The adaptation strategy chosen by respondents to lessen the effects of shifting rainfall patterns and amounts was planting drought-tolerant crops. For the adaptation method to be effective, a farmer must be knowledgeable about temperature and rainfall trends as well as the several suitable maize crop varieties (Sadiq et al., 2019). In order to reduce the impacts of climate stress on maize yield, farmers must increase their adaptive capacity and gain a better understanding of maize varieties.

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Table 5: Drought-tolerant crops

Parameter		Adopters		Non-adopters		Total
		f (n)	%	f (n)	%	
Gender	Male	21	5.33	303	76.90	324
	Female	13	3.30	57	14.47	70
	Total	34	8.63	360	91.37	394
Age	19-28	2	0.51	18	4.57	20
	29-38	4	1.02	102	25.89	106
	39-48	9	2.28	152	38.58	161
	49-58	15	3.81	72	18.27	87
	59-68	4	1.02	16	4.06	20
	Total	34	8.63	360	91.37	394
Education	No formal education	0	0	6	1.52	6
	Primary	8	12.18	119	30.20	127
	Secondary	19	17.77	165	41.88	184
	Tertiary	7	4.57	70	17.77	77
	Total	34	8.63	360	91.37	394
Marital Status	Single	11	6.85	59	14.97	70
	Married	23	27.92	301	76.40	324
	Total	34	8.63	360	91.37	394
Household Size	1-3	4	1.02	47	11.93	51
	4-6	17	4.31	202	51.27	219
	7-9	10	2.54	90	22.84	100
	10 and above	3	0.76	21	5.33	24
	Total	34	8.63	360	91.37	394

Soil Moisture Conservation Techniques

Only 5.84% of the respondents chose to use soil moisture conservation techniques. This method entails the use of cover crops to prevent high evaporation of moisture. Majority of the respondents were male household heads (4%), while female respondents made up 1% of the respondents. The age group of 39-48 had the highest number of respondents with 10 respondents (2.54%), while the minimum was 1 (0.25%) that was in the age bracket of 59-68. Respondents with secondary education were the highest, while those with primary education had the least number of respondents, at 3.6% and 1%, respectively. Respondents who were married had a higher response as compared to single respondents with 5.6% and 0.3%, respectively. The household size of 4 to 6 members had the highest number of respondents at 2.5%, while the least number of respondents was 0.8%, as shown in *Table 6* below:

Respondents who selected dry planting as an adaptation strategy would benefit from soil moisture conservation strategies as well. Conserving soil moisture is crucial for lessening the effect of increasing temperatures on soils. Four percent of respondents who utilized this strategy were educated, which suggests that understanding the techniques is necessary before execution. These findings are consistent with study by Menghistu (2020) that highlighted education level as a factor influencing comprehension of adaptation strategies. Therefore, it is important to raise awareness of soil moisture conservation as an adaptation approach in order to urge farmers to employ it.

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Table 6: Soil moisture conservation techniques

Parameter		Adopters		Non-adopters		Total
		f (n)	**%**	**f (n)**	**%**	
Gender	Male	18	4.57	306	77.66	324
	Female	5	1.27	65	16.50	70
	Total	23	5.84	371	94.16	394
Age	19-28	3	0.76	17	4.31	20
	29-38	3	0.76	103	26.14	106
	39-48	10	2.54	151	38.32	161
	49-58	6	1.52	81	20.56	87
	59-68	1	0.25	19	4.82	20
	Total	23	5.83	371	94.15	394
Education	No formal education	0	0	6	1.52	6
	Primary	4	1.02	123	31.22	127
	Secondary	14	3.55	170	43.15	184
	Tertiary	5	1.27	70	18.27	77
	Total	23	5.84	371	94.16	394
Marital Status	Single	1	0.25	69	17.51	70
	Married	22	5.58	302	76.65	324
	Total	23	5.83	371	94.16	394
Household Size	1-3	3	0.76	48	12.18	51
	4-6	10	2.54	209	53.05	219
	7-9	10	2.54	90	22.84	100
	10 and above	0	0	24	6.09	24
	Total	23	5.84	371	94.16	394

Water Harvesting

The total number of respondents who chose to use water harvesting was 11 (2.79%) respondents. Male respondents were higher than female respondents, with 10 (2.5%) and 1 (0.3%) respondents, respectively. The age group of 39-48 had the highest respondents at 1.5%, while the least respondents were in the 19-28 age group at 0.3%. Tertiary education level had the highest percentage of respondents who chose water harvesting at 1.7%, while the least was secondary school at 1%, as seen in *Table 7* below:

Water harvesting was not an adaptation method that was widely used by respondents. These results do not agree with Mugi-Ngenga (2016) study findings that highlighted water harvesting as a major adaptation method. The household size of 4-6 members had the highest respondents who took up adaptation measures, while the least had over 10 members, with 1.78% and 0.25%, respectively. Water harvesting is an adaptation measure that would be useful during delayed or shortages of rainfall caused by climate variability, ensuring the farmers get the expected number of bags per acre. This adaptation technique was not highly used due to insufficient technology, material and financial resources for purchasing and implementation.

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Table 7: Water harvesting

Parameter		Adopters		Non-adopters		Total
		f (n)	%	f (n)	%	
Gender	Male	10	2.54	314	79.70	324
	Female	1	0.25	69	17.51	70
	Total	11	2.79	383	97.21	394
Age	19-28	1	0.25	19	4.82	20
	29-38	2	0.50	104	26.40	106
	39-48	6	1.52	151	39.34	161
	49-58	2	0.51	81	21.57	87
	59-68	0	0	20	5.08	20
	Total	11	2.78	383	97.21	394
Education	No formal education	0	0	6	1.52	6
	Primary	0	0	127	32.23	127
	Secondary	4	1.01	170	45.69	184
	Tertiary	7	1.78	70	17.77	77
	Total	11	2.79	383	97.21	394
Marital Status	Single	4	1.02	66	16.75	70
	Married	7	1.78	317	80.46	324
	Total	11	2.80	383	97.21	394
Household Size	1-3	0	0	51	12.94	51
	4-6	7	1.78	212	53.81	219
	7-9	3	0.76	97	24.62	100
	10 and above	1	0.25	23	5.84	24
	Total	11	2.79	383	97.21	394

Irrigation Farming

There was a total of 14 (3.55%) respondents who chose irrigation farming, with 2% male and 1% female respondents, respectively. Secondary and tertiary education had the highest respondents, with 7 (1.78%) respondents each. Married respondents had the highest under marital status category with a total of 11 (2.80%) respondents, while single respondents had the least with a total of 3 (0.76%), as shown in *Table 8* below:

Irrigation farming as an adaptation strategy was not implemented by respondents. These results do not agree with Destaw (2021) study that highlighted irrigation farming as an adaptation for farmers highly picked. The study, however, highlighted financial constraints as a barrier to implementing irrigation farming due to the inability to purchase irrigation equipment. This adaptation measure would be beneficial to curb the effects of rainfall variability such as erratic rainfall and delayed rainfall, which would prevent the loss of maize yield. In order to raise the adaptive capacity, irrigation farming as an adaptation measure should be encouraged to reduce the effect of changing rainfall patterns on maize farming.

Agroforestry

Agroforestry is one of the methods that can be an alternative source of income for maize farmers in the region. However, a small percentage (1%) of the respondents chose to use it as an adaptation technique. The respondents would use the term "planting trees around the farm" to refer to agroforestry. All the respondents who took up agroforestry were male, with two respondents (0.51%) under the age group of 39-48, while the 29-38 and 49-58 age groups had one respondent each (0.25%). All of the respondents had tertiary education, with a household size of 8 members or below, as seen in *Table 9* below:

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Table 8: Irrigation farming

Parameter		Adopters		Non-adopters		Total
		f (n)	**%**	**f (n)**	**%**	
Gender	Male	9	2.28	315	79.95	324
	Female	5	1.27	65	16.50	70
	Total	14	3.55	380	96.45	394
Age	19-28	0	0	20	5.08	20
	29-38	2	0.51	104	26.40	106
	39-48	8	2.03	153	38.83	161
	49-58	4	1.02	83	21.07	87
	59-68	0	0	20	5.08	20
	Total	14	3.56	380	96.46	394
Education	No formal education	0	0	6	1.52	6
	Primary	0	0	127	32.23	127
	Secondary	7	1.78	170	44.92	184
	Tertiary	7	1.78	70	17.77	77
	Total	14	3.56	380	96.44	394
Marital Status	Single	3	0.76	67	17.00	70
	Married	11	2.80	313	79.44	324
	Total	14	3.56	380	96.44	394
Household Size	1-3	0	0	51	12.94	51
	4-6	12	3.05	212	52.54	219
	7-9	2	0.51	98	24.87	100
	10 and above	0	0	24	6.09	24
	Total	14	3.56	380	96.44	394

Table 9: Agroforestry

Parameter		Adopters		Non-adopters		Total
		f (n)	**%**	**f (n)**	**%**	
Gender	Male	4	1.02	320	81.21	324
	Female	0	0	70	17.77	70
	Total	4	1.02	390	98.98	394
Age	19-28	0	0	20	5.08	20
	29-38	1	0.25	105	26.65	106
	39-48	2	0.51	151	40.36	161
	49-58	1	0.25	86	21.83	87
	59-68	0	0	20	5.08	20
	Total	4	1.01	390	99.00	394
Education	No formal education	0	0	6	1.52	6
	Primary	0	0	127	32.23	127
	Secondary	0	0	184	46.70	184
	Tertiary	4	1.02	73	18.53	77
	Total	4	1.02	390	98.98	394
Marital Status	Single	0	0	70	17.77	70
	Married	4	1.02	320	81.22	324
	Total	4	1.02	390	98.99	394
Household Size	1-3	1	0.25	50	12.69	51
	4-6	2	0.51	217	55.08	219
	7-9	1	0.25	99	25.13	100
	10 and above	0	0	24	6.10	24
	Total	4	1.01	390	99.00	394

Agroforestry as an adaptation strategy was not highly sought, most likely due to a lack of knowledge about the technique or the perception that trees require more land, which maize farmers

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may be reluctant to embrace because maize and shade are incompatible. It is noticeable that respondents who picked this adaptation strategy had tertiary education, thereby making them more knowledgeable of the technique. These results do not agree with Fadina (2018) study that highlighted agroforestry as an adaptation method that farmers highly practice. Factors such as education level have been found to have an influence on adaptation as fronted by Muthelo *(*2019). Awareness and knowledge of adaptation strategies would be beneficial to farmers to reduce the effects of climate variability on maize yield, thereby raising their adaptive capacity to climate variability effects (Talanow *et al*., 2021).

Dry Planting

One respondent picked dry planting as an adaptation strategy. The respondent was male between the age groups of 29 and 38, as shown in *table 10* below:

Table 10: Dry planting

Parameter		Adopters		Non-adopters		Total
		f (n)	**%**	**f (n)**	**%**	
Gender	Male	1	0.25	323	81.98	324
	Female	0	0	70	17.77	70
	Total	1	0.25	393	99.75	394
Age	19-28	0	0	20	5.08	20
	29-38	1	0.25	105	26.65	106
	39-48	0	0	161	40.86	161
	49-58	0	0	87	22.08	87
	59-68	0	0	20	5.08	20
	Total	1	0.25	393	99.75	394
Education	No formal education	0	0	6	1.52	6
	Primary	0	0	127	32.23	127
	Secondary	1	0.25	183	46.45	184
	Tertiary	0	0	77	19.54	77
	Total	1	0.25	393	99.74	394
Marital Status	Single	0	0	70	17.77	70
	Married	1	0.25	323	81.98	324
	Total	1	0.25	393	99.75	394
Household Size	1-3	0	0	51	12.94	51
	4-6	1	0.25	218	55.34	219
	7-9	0	0	100	25.38	100
	10 and above	0	0	24	6.09	24
	Total	1	0.25	393	99.75	394

This method of adaptation involved planting before the beginning of the rainy season to ensure that the rains would start while the seed had already been planted. The adaptation method, however, had its own challenges in the event of delayed rainfall caused by rainfall variability, which would lead to the seeds not germinating, causing a loss to the farmer. Knowledge of adaptation is paramount in choosing and implementing adaptation strategies (Marie *et al*., 2020).

Inferential Statistics Results

The multivariate linear regression analysis was used to identify the socioeconomic aspects that are essential to the choice of adaptation strategy. The significance of the dependent variable (adaptation strategies) and independent variable (social economic factors) was assessed using the p values. The null hypothesis argued that there is no significant relationship between socioeconomic factors and the choice of adaptation strategies to climate variability.

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Socioeconomic factors that influence the choice of adaptation strategies to climate variability

It was established that land size (p = 0.010) had a significant relationship to changing crop variety, as opposed to age, gender, education level, marital status, household size, and income level.

Among the seven independent factors, education level stood out, showing a significant link with changing planting dates (p = 0.050). This finding supports the studies done by Oduniyi (2022) and Harvey (2018) which suggest that the level of education affects the awareness and knowledge of adaptation strategies.

There was a strong positive significance between planting drought-tolerant crops and land size (p=0.002), age (p=.006) and gender (p=.036). In regards to age, a majority of the respondents who picked up this adaptation method were in the age group of 49-58 yrs. Gender had a significant relationship on planting drought tolerant crops where the minority of respondents were females. These results do not agree with Ngigi (2017) study that concluded that female respondents take up more conservative techniques since female household heads chose similar adaptation strategies to male household heads in this case planting drought tolerant crops. Other socioeconomic characteristics like education, marital status, and family size had no discernible link.

The study also revealed that a significant link existed between gender (p= 0.03), land size (p= 0.029) and marital status (p=0.002) and soil moisture conservation methods. ***Water Harvesting*** as an adaptation strategy was not highly considered as a choice of adaptation strategy by respondents. However, the analysis demonstrates that gender (p=0.001), education level (p=0.000), and marital status (p=0.002) all significantly influenced water harvesting. Notably, water harvesting as an adaptation method was demonstrated to have a strong and substantial link with education level.

Majority of the respondents who selected this adaptation strategy had a tertiary education. These results are consistent with Khanal (2018) study that noted education level as a factor affecting adaption strategies. Only marital status and gender had a significant association to irrigation farming (p=0.001) and (p= 0.041) respectively but age, education, income, and family size did not show any significant relationship. A variety of obstacles to the adoption of irrigation farming were noted by the respondents, including a lack of financial resources, subpar irrigation sources, and insufficient irrigation knowledge. Gender (p=0.015), age (p=0.025) and marital status (p=0.008) were shown to have significance to agroforestry while other socioeconomic factors have no significant relationship.

The gender difference is significant because all of the respondents who chose agroforestry were married male respondents. Because of their education level, respondents who adopted this method did so with a high level of understanding. As per the findings, the null hypothesis argued that there is no significant relationship between socioeconomic factors and the choice of adaptation strategies to climate variability was rejected.

CONCLUSION

Due to the African culture, men presided over households rather than women. A few respondents stuck to their traditional farming practices, while the majority chose to adapt to the effects of climatic variability. The middle-aged respondents were the most likely to choose adaptation as opposed to the elder generation. This is consistent with a study on age group conservatism by Muzamhindo (2015), which revealed that younger farmers were more open to novel ideas and adaptation technologies and were more inclined to accept adaptation strategies than older farmers.

We deduce from the analysis that education level is a factor that influences awareness, understanding, and adoption of adaptation strategies, which in turn influences an individual's potential for adaption. This is demonstrated by the fact that respondents with formal education used

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adaption measures more frequently than respondents without formal education.

The results of the survey confirmed that changing planting dates and maize crop varieties were the two most popular strategies for coping with the effects of climate variability. Older small-scale farmers were the ones that favoured this the most. This suggests that having a long history of farming gives farmers an advantage since they have first-hand knowledge of rainfall and temperature trends, giving them a leg up when adopting shifting planting dates as a strategy for adaptation (Peng *et al*., 2020). In a similar vein, dry planting was the least popular method used by small-scale farmers.

All respondents (male and female) favoured using crop varieties as well as alternative maize varieties to deliver the anticipated yield per acre despite the environmental constraints brought on by climatic variability. In addition, respondents who used this adaptation strategy were older in age since they had been farming for longer and had been exposed to a wider variety of maize types, allowing them to determine which kind would work best on their particular farms.

Few respondents, regardless of gender, age group or level of education, decided to grow drought-tolerant crops. The respondents did not frequently use planting drought-tolerant crops as an adaptation strategy to mitigate the effects of shifting rainfall patterns and volumes. According to Sadiq (2019), farmers must be familiar with the patterns of temperature and rainfall as well as the range of crops that are acceptable for the adaptation measure before planting drought-tolerant crops.

Soil moisture conservation techniques, water harvesting, irrigation, agroforestry and dry planting were the least preferred adaptation strategies by the farmers. In regards to inferential statistics we conclude that all socioeconomic factors utilized in the study play a role in influencing different adaptation strategies.

Recommendations

Farmers would benefit from adaptation methods on the basis of the sensitization of all adaptation techniques because it expands their options for adaptation strategies and increases their ability for adaptation. For instance; Land size should be considered as an independent variable when recommending adaptation strategies to farmers in order to increase their adaptive capacity. The findings concur with the Myeni (2020) study, which highlighted the importance of land size in influencing the selection of adaptation options, in this case, changing crop varieties.

There is a need for farmers to be educated as well as have access to information on rainfall patterns for them to be able to adequately change planting dates, thereby raising their adaptive capacity to climate variability effects. In order to mitigate the consequences of climate change on maize yield, farmers must increase their adaptive capacity by becoming more familiar with maize varieties and drought-tolerant crops.

Strategies for conserving soil moisture should be inclusive of all small-scale farmers who are impacted by the effects of climate variability, regardless of gender. Irrigation farming should be promoted and challenges such as insufficient financial resources, subpar irrigation sources as well as lack of knowledge on the same be addressed to reduce the impact of rainfall variability on maize productivity and boost farmer adaptation. Finally, agroforestry as a technique for adaptation and as source of income should be upheld to farmers in order to boost their capacity for adaptation and broaden their source of livelihood.

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