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# Adoption Intensity of Drought Mitigation Strategies among Households in Tharaka South Sub-County, Kenya

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***Abstract***

*Recent uncertainties in rainfall amount and intensity have increased drought. This situation has prompted the need to assess the intensity of the adoption of the drought mitigation strategy. This study analyzed ten drought mitigation strategies (DMS) among households using the descriptive statistical approach in Tharaka South Sub-County, Kenya. About 397 samples from 18,623 households and 3 key informants were selected as informants. They were selected using cluster random sampling and purposive sampling, respectively. Data collection was done through questionnaires, interviews, and observations. The study revealed that planting drought-tolerant crops (89.7%), crop diversification (84.2%), and rainwater harvesting (78.1%) were among the top three widely adopted DMS for drought mitigation. Community programs (23.2%), irrigation (15.1%), and soil conservation (6.1%) had low adoption among households. The households are more likely to adopt simple strategies. Therefore, policy support is needed for less implemented strategies, such as soil conservation and irrigation.*

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***Abstrak***

*Ketidakpastian terkini dalam jumlah dan intensitas curah hujan telah meningkatkan kekeringan. Situasi ini telah mendorong perlunya menilai intensitas adopsi strategi mitigasi kekeringan. Studi ini menganalisis sepuluh strategi mitigasi kekeringan di antara rumah tangga menggunakan pendekatan statistik deskriptif di Sub-Kabupaten Tharaka Selatan, Kenya. Sekitar 397 sampel dari 18.623 rumah tangga dan 3 informan kunci dipilih sebagai informan. Mereka dipilih menggunakan cluster random sampling dan purposive sampling. Pengumpulan data dilakukan melalui kuesioner, wawancara, dan observasi. Studi ini mengungkapkan bahwa menanam tanaman toleran kekeringan (89,7%), diversifikasi tanaman (84,2%), dan pemanenan air hujan (78,1%) termasuk di antara tiga strategi mitigasi kekeringan teratas yang diadopsi secara luas untuk mitigasi kekeringan. Program masyarakat (23,2%), irigasi (15,1%), dan konservasi tanah (6,1%) memiliki adopsi yang rendah di antara rumah tangga. Rumah tangga di Tharaka Selatan lebih banyak mengadopsi strategi. Oleh karena itu, dibutuhkan dukungan kebijakan untuk strategi yang kurang diterapkan, seperti konservasi tanah dan irigasi.*

## INTRODUCTION

According to the Integrated Drought Management Programme (2022), capacity building and knowledge-sharing are essential to drought mitigation strategies. Investments in the training and capacity development of local communities, extension services, and government agencies are crucial in enhancing their ability to effectively implement drought mitigation strategies. Promotion of knowledge exchange and the sharing of best practices fostered collaborative learning and adaptation (Erbaugh et al., 2021). The results of this study not only raise our knowledge about the drought mitigation measures but also offer insightful information about drought mitigation strategies (DMS) adoption intensity that can guide policy choices.

Diversification and adaptation of livelihood strategies are important to reduce the dependency on rain-fed agriculture and enhance household resilience (Ifejika Speranza, 2010). Effective water management and conservation strategies have been a key focus of drought mitigation efforts. Water harvesting and storage techniques, such as the construction of dams, reservoirs, and rainwater harvesting systems, improve water availability during drought periods (Oweis & Hachum, 2006). The adoption of water-efficient agricultural practices, including the use of drought-resistant crops, drip irrigation, and conservation agriculture, has been promoted to optimize water use and minimize the impacts of drought on food production (Rockström et al., 2009).

Mushore et al. (2013) noted that food aid, food for work, sale of livestock, remittances, and irrigation schemes are drought mitigation strategies people are using in Bikita District in Zimbabwe. Kaua (2021) identified the adaptation strategies to climate change that included engagement in diverse economic activities by pursuing alternatives to farming, such as employment and beekeeping. He also noted that people carry out small scale irrigation along river banks, early planting, use of cover crops, diversification of cropping, cultivation of drought resistant crops, planting fast maturing crops, furrowing, crop rotation, use of zai pits, mulching, planting grass along rivers, migration and reduced meal count. The research investigated the mitigation measures adopted. This research offered an insight into the rate of adoption of these measures.

In his article on climate change detection across all livelihood zones in Tharaka Nithi County by Gioto et al. (2016) urged farmers to embrace climate-smart concepts, technologies, and managerial practices, such as drought-tolerant and quickly maturing varieties, preservation, minimal or no tillage, applying mulch, growing cover crops on farms, and collecting rain water, among others. Extension agents for agriculture and livestock were requested to advise farmers on the best types and varieties of crops to grow. Residents were exhorted to increase rainwater collection from surface runoff and roof catchment, while those who lived upstream of rivers and lakes were counselled to increase soil conservation to lessen the silting up of reservoirs and water pans.

In the agricultural and rearing of animals setups, several of the present crop-related methods for adapting to climate-related risks comprise small-scale collection of rainwater, the use of good agricultural practices, sustainable farming, growing drought-resistant varieties that mature quickly, handling after harvesting, and incorporating trees into farming practices. Crops can adapt to climate change over a longer period by improving water gathering, developing irrigation systems, expanding conservation agriculture, and improving irrigation (United Nations Development Programme, 2013). The United Nations Development Programme analyzed the mitigation measures adopted, while this study analyzed the intensity of their adoption.

Recha et al. (2015), in their study on socio-economic determinants of adoption of rainwater harvesting and conservation techniques in semi-arid Tharaka Sub-County, noted that the majority of farmers were practicing 1-6 rainwater harvesting and conservation techniques, which indicated awareness of their benefits. In-situ technologies were more frequently practiced than micro-catchment and macro-catchment technologies. The number of techniques practiced was influenced by years of schooling, arable land size, labor availability, and the number of livelihood options. The choice of rainwater techniques is primarily informed by a desire to harvest and conserve soil moisture rather than to improve soil quality. This study not only investigates rainwater harvesting methods, but also examines the intensity of adoption.

The results of the study on the adoption of rainwater harvesting technologies by the community in Kilifi County by Nabwire (2020) revealed that 92.6% of households in Kilifi County engaged in rooftop water harvesting technologies, while 3.5% utilized water pans/ponds. Furthermore, the majority of people (93.5%) in Kilifi County expressed a strong desire to organize and harvest more surface water runoff effectively. The study found that most households are aware of rainwater harvesting technologies but face challenges in adoption due to factors such as training gaps on the installation of the technologies and socio-economic factors, including capital and education. Nabwire investigated the rainwater harvesting technologies, while this study investigated the adoption of rainwater harvesting as a DMS.

## METHOD

### Study Location

Tharaka Nithi County is among the 47 counties in Kenya. It is located between latitudes 00°02’S and 00°17’S and between longitudes 37°29’E and 38°00’E (Figure 1). The county is situated in the eastern part of Kenya, bordered by Meru County to the north and east, Kitui County to the south, and Embu County to the west. Tharaka’s administrative subdivisions are sub-counties, constituencies, and wards to facilitate governance and service delivery. Some of the sub-counties include Tharaka North, Tharaka South, Chuka, and Maara (Government of Kenya, 2019).

Tharaka-South Sub-County is situated within Kenya's Arid and Semi-Arid Lands (ASALs). The region experiences a bimodal rainfall pattern, with annual precipitation ranging from 500 to 800 mm, while temperatures fluctuate between 24 °C and 37 °C, occasionally reaching up to 40 °C (National Drought Management Authority, 2014). Tharaka Sub-County includes four agroecological zones: Lower Midland 4 (LM4), Lower Midland 5 (LM5), Intermediate Lowland 5 (IL5), and Intermediate Lowland 6 (IL6), as identified by Recha et al. (2017).

The river Tana's main tributaries traverse the region. These tributaries are Mutonga, Kathita, Kithino, and Thingithu. The majority of the soils are humic Nitisols, which are deep, well-weathered, and naturally fertile to high productivity. However, owing to extensive agriculture without proper nutrient replenishment, the soil's fertility has decreased. Cassava, millet, green grams, pigeon peas, cowpeas, and maize are the principal crops farmed in Tharaka South. There is also livestock rearing like cattle, goats, sheep, and poultry (Kaua, 2019).

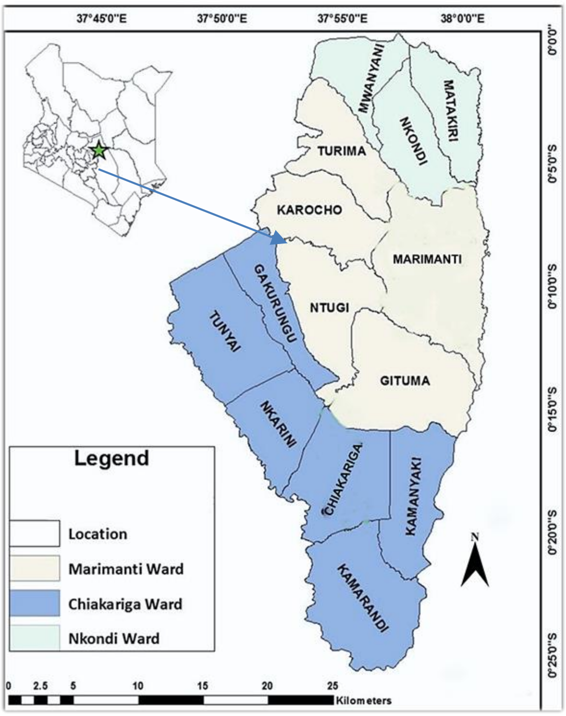


**Figure 1.** Map of Tharaka South Sub-County

## Research Design

The study used a descriptive study design. A sample of 397 respondents was chosen from a target population of 18,623 households; three key informants that including: Director of the Department of Agriculture, Livestock and Fisheries, Director, County Drought Management Authority, and Director, Grassroot Development Initiatives Foundation- Kenya (GRADIF), making a total of 400 respondents. Cluster random sampling was used to select households, while purposeful sampling was used to select key informants. The study used questionnaires, interviews, and direct observation to collect data. The descriptive statistics, frequencies, and percentages were used to analyze data. The data was then presented using graphs and tables.

## Sampling Procedures

This research used cluster sampling to choose the respondents. A total of 397 respondents were selected from a population of 18,623 households using the Krejcie & Morgan (1970) formula. The formula used is presented in equation 1 below.

$$n = \frac{x^2\ Np\ (1-p)}{e^2\ (N-1) +\ x^2\ p(1-p)} \qquad (1)$$

where $n$ is sample size, $N$ is population size, $e$ is acceptable sampling error, $x^2$ is chi-square of degree of freedom 1 and confidence 95% = 3.841, and $p$ is proportion of population (if unknow, 0.5).

Three key informants were chosen using purposive sampling. The sample population was selected from three wards, which formed the 3 clusters. These clusters included Chiakariga, Marimanti, and Nkondi. Proportionate sampling was carried out to arrive at the sample size from the three clusters.

## Sample Size

A sample size was determined from a population of 18,623 using the Krejcie & Morgan (1970) formula. By applying this formula to the given population size, the required sample size was calculated to be 397 respondents. To allocate the sample across different clusters, proportionate stratified sampling was employed using Formula 2 below. The distribution of the sample size across clusters is presented in Table 1.

$$n_i = \frac{N_i}{N} \times n \qquad (2)$$

where $n_i$ is the number of samples from the i-th cluster, $N_i$ is the population size in the i-th cluster, $N$ is the total population (18,623), and $n$ is the total samples that have been calculated previously (397). The study therefore used a sample size of 397 households and 3 key informants, thus a total of 400 respondents.

**Table 1.** Proportionate Sample Size by Wards

| Ward | Ward Households | Sample Size |
|---|---|---|
| Chiakariga | 9,713 | 207 |
| Marimanti | 5,187 | 111 |
| Nkondi | 3,723 | 79 |
| **Total** | **18,623** | **397** |

Source: Kenya National Bureau of Statistics Report, 2022.

## Research Instruments

Instruments used in this study were household head questionnaires, interview schedules, and observation schedules. The study used questionnaires to collect data from households. The semi-structured questionnaires with both open-ended and closed questions were used to obtain data on the intensity of adoption of DMS. This type of questionnaire was considered appropriate for the study because it allows for the collection of quantifiable data on adoption intensity while also capturing detailed insights into the respondents' experiences and perceptions of DMS.

The study used interview schedules to obtain data from the key informants on the DMS adopted. Interviews were appropriate as the researcher engaged the respondent on one, hence getting first-hand information which was more reliable. Interviews also provided in-depth data since the unclear questions were clarified. The information obtained from key informants was used to clarify data from the household heads.

In the study, direct field observations, following a structured observation schedule, were utilized to enhance the information gathered from the questionnaires. This schedule was specifically created to aid in the collection of data regarding the adoption of DMS, including rainwater harvesting, planting drought-tolerant crops, crop diversification, agroforestry, water-saving irrigation, and soil water conservation.

### Reliability

Rigorous data collection methods, including household questionnaires, key informants' interviews, and field observations, were used. The test-retest method was used to ensure the reliability of this questionnaire, and a correlation coefficient was calculated. A correlation coefficient of 0.8 was obtained; therefore, the questionnaire was considered reliable for this study, as noted by Mugenda & Mugenda (2003) and Fraenkeal & Wallen (2002) that a correlation above 0.7 is reliable for a study.

### Piloting

A pilot study was conducted in Tharaka North to enhance the reliability of the research. In conformity with the advice of Mugenda & Mugenda (2003), questionnaires were administered to 40 households (10% of the sample size) in Tharaka North since Tharaka South, which is the study area, and Tharaka North have similar climatic conditions and share similar economic activities. A pilot study was important since it showed the likely responses from the respondents, and necessary adjustments were made before the actual research was conducted.

### Data Analysis

The intensity of the adoption of DMS was analysed using percentages, mean, and mode. To compute the percentage, the number of respondents who had employed a given DMS was divided by the sample size of 400 and then multiplied by 100%. The intensity of adoption was based on the percentage of adoption. The data was then presented by the use of tables showing the various drought mitigations and the percentage of adoption. Also, the number of DMS adopted per household was computed and presented using a pie chart.

## RESULTS AND DISCUSSION

### Status of Adoption of Drought Mitigation Strategies among Households

We group the DMS adoption status into percentages to facilitate further analysis. The study sought information on the status of adoption of DMS among farming households, and the results are presented in Figure 2 below.

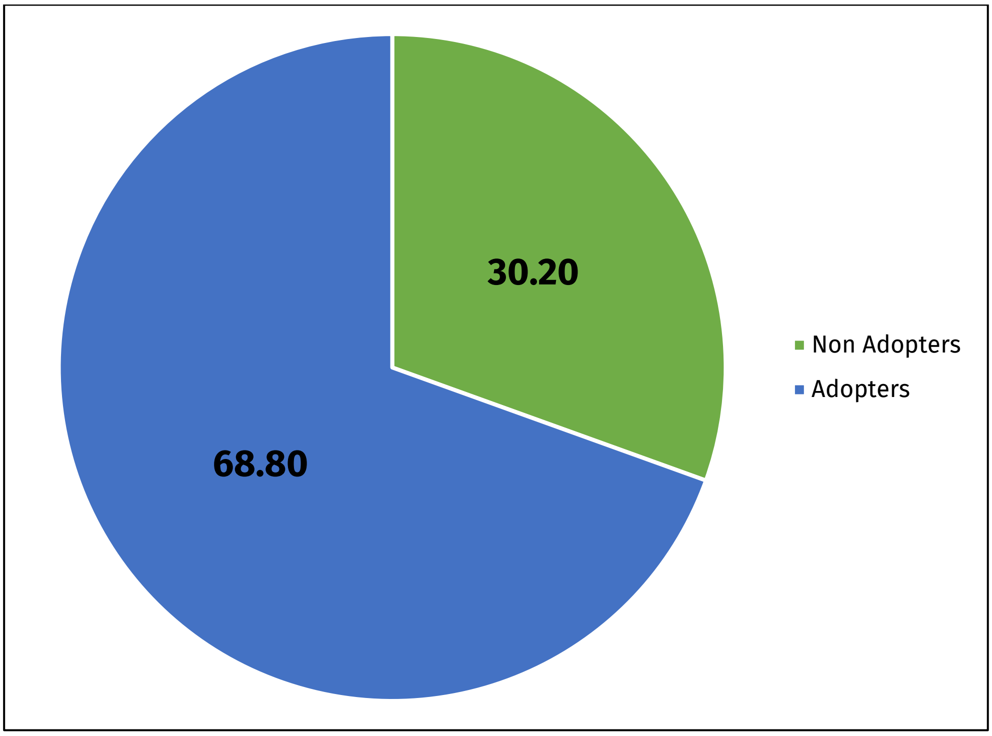


**Figure 2.** Status of Adoption of Drought Mitigation Strategies by Households in Percentage

Information on Figure 2 shows that more than two-thirds (69.8%) of the farming households in Tharaka South Sub County had adopted one or more DMS, whereas about a third (30.2%) of the households had not adopted. The proportion of the non-adopters included those who had either used a strategy once and abandoned it or had never adopted any strategy at all. Most households adopting the DMS indicate that most households are taking steps to prepare for or reduce the impacts of droughts. This high adoption of DMS could be motivated by the households' need to protect their source of livelihood. Some of the sources of livelihoods in Tharaka South are agriculture-based, and others are off-farm businesses. In addition to water being a basic human need, these Agri-based ventures largely depend on a constant water supply.

Additionally, people who had experienced droughts in the past may be more likely to adopt mitigation strategies to avoid the negative consequences of future droughts. There are a variety of DMS that can be adopted, depending on the specific circumstances. Some common strategies used included changes in land use practices, such as planting drought-tolerant crops, crop diversification, agroforestry, rearing indigenous animals, and rainwater harvesting. The adoption of DMS is an important step in preparing for and reducing the impacts of droughts, such as low crop and animal yields. By taking steps to conserve water and develop new water sources, communities become more resilient to drought conditions.

The study compared the intensity of adoption of different DMS in the three wards (Chiakariga, Marimanti, and Nkondi) in Tharaka South Sub-County, and the results are presented in Table 2 below.

**Table 2.** Intensity of Adoption of Drought Mitigation Strategies by Ward in Percentage

| Drought Mitigation Strategies | Chiakariga | Marimanti | Nkondi | Average Rate | Intensity |
|---|---|---|---|---|---|
| Drought-Tolerant Crops | 85.1 | 93 | 91.1 | 89.7 | High |
| Crop Diversification | 91.2 | 82 | 79.5 | 84.2 | High |
| Rainwater Harvesting | 97.1 | 64.8 | 72.3 | 78.1 | High |
| Rearing of indigenous animals | 74.1 | 78.2 | 76 | 76.1 | High |
| Agroforestry | 68.4 | 61.7 | 57.2 | 62.4 | Medium |
| Livelihood Diversification | 14.3 | 33.1 | 30.7 | 26 | Low |
| Community-Based Organization Membership | 27.6 | 19 | 23 | 23.2 | Low |
| Irrigation | 20.7 | 11.4 | 13.2 | 15.1 | Low |
| Early Warning Systems on Weather Conditions | 10.1 | 12.6 | 9.7 | 10.8 | Low |
| Soil Water Conservation | 6.4 | 6.3 | 5.7 | 6.1 | Low |

The information in Table 2 shows that four adoption of DMS was common across the three wards in the sub-county. The adoption of these strategies that had a high intensity of adoption varied across the wards, with different strategies topping the list in different wards being adopted by more than three-quarters of the households. In Chiakariga ward, rainwater harvesting tops the list with a 97.1% rate of adoption among the households, while in Marimanti and Nkondi wards, adoption of drought-tolerant crops topped their list with an adoption rate of 93% and 91.1% respectively among households. These findings are in line with the findings of Nabwire (2020), who reported a high adoption rate of rainwater harvesting in Kilifi County. The findings on the adoption of drought-tolerant crops agree with the findings of Kaua (2020), who reported high adoption of drought-tolerant crops in Tharaka South as an adaptive strategy to climate change.

Planting drought-tolerant crops had high intensity across the three wards, being adopted by more than three-quarters of the households, with an adoption rate of 85.1% in Chiakariga ward, 93% in Marimanti ward, and 91.1% in Nkondi ward. This high intensity adoption of drought-tolerant crops across the wards indicates the important role of the strategy in mitigating drought. These crops have low water requirements and therefore could grow well in Tharaka South with low rainfall amounts.

Crop diversification was also highly adopted among the three wards, with Chiakariga topping the list with a household adoption rate of 91.2%, followed by Marimanti with an 82% household adoption rate, and Nkondi ward with an adoption rate of 79.5% among households.

According to the study, Chiakariga recorded a high intensity of rainwater harvesting being adopted by more than three-quarters of the households, with an adoption rate of 97.1%. This high adoption of rainwater harvesting in Chiakariga ward is an indicator of its important role in drought mitigation in the ward. In Marimanti, rainwater harvesting was adopted by slightly below three-quarters (64.8%) of the households, and Nkondi recorded a slightly below three-quarters (72.3%) adoption rate of rainwater harvesting among households.

Agroforestry as DMS was highly reported in Chiakariga with a slightly below three-quarters (68.4%) adoption rate, followed by Marimanti ward, which reported a 61.7% adoption rate of agroforestry, and the least was Nkondi, which reported 57.2% adoption by households. According to the study, rearing of indigenous animals was most popular in Marimanti ward with 78.2%, followed by Nkondi ward with 76% adoption rate, and Chiakariga with 74.1% rate of adoption by households. The study recorded low levels of adoption intensity of five DMS, that is, livelihood diversification, membership to a Community-Based Organization (CBO), irrigation, early warning systems, and soil water conservation, across the three wards.

The findings of this study noted that, in all three wards, half of the evaluated DMS were widely accepted and adopted by more than half of the households. These strategies were planting drought-tolerant crops, crop diversification, rainwater harvesting, rearing of indigenous animals, and agroforestry. These findings agree with observations by Kaua (2020), who reported the popularity of the strategies. This implies that these approaches are widely adopted by households and may be instrumental in mitigating the effects of drought in the county, as noted by Esikuri (2005).

On average in the three wards, four mitigation strategies had a high intensity of adoption in Tharaka South, being adopted by about three-quarters of the households. Planting drought-tolerant crops was the most widely adopted, with 89.7% of the households, followed by crop diversification with an average of 84.2%, rainwater harvesting with 78.1%, and rearing of indigenous animals with an average of 76.1%. Drought-tolerant crops can survive with minimal precipitation, and the high adoption rate of drought-resistant crops indicates a proactive approach towards adapting to water scarcity. These crops require less water to thrive, minimizing losses during dry periods. Crop diversification with water-efficient varieties, on the other hand, reduces dependence on any single crop that might be highly susceptible to water stress. This practice helps maintain food security and income even during droughts.

The high intensity of adoption of the rainwater harvesting strategy indicates a strong community focus on capturing and storing rainwater for later use. This can be vital during droughts when natural water sources become unreliable. Rearing of indigenous animals' strategy likely involves adopting animals with lower feed requirements, such as goats, and raising breeds of livestock well-suited to local climate conditions, including drought. These animals often require less water and can survive on sparse vegetation. Agroforestry had a medium intensity of adoption, being adopted by 62.4% of the households on average. Across the wards, planting trees, especially drought-tolerant varieties, can improve soil moisture retention and create microclimates that benefit surrounding vegetation. It also combats desertification in the long run.

The study found that on average, five DMS had low adoption intensity. Diversifying income (livelihood diversification) of 26% beyond agriculture can provide a safety net during droughts when agricultural productivity suffers. This could include encouraging skills development and fostering non-farm businesses. The Community-Based Organization on drought mitigation shows an adoption rate of approximately 23.2%. This low adoption rate suggests a potential gap in community-wide collaboration and planning for drought preparedness. Strong community organizations could play a vital role in resource sharing, knowledge dissemination, and coordinated action during droughts.

The relatively low adoption rate (15.1%) of irrigation might be due to factors like limited access to water sources, high infrastructure costs, or energy constraints. It's crucial to explore sustainable irrigation techniques that minimize water usage. A low adoption rate for early warning systems (10.8%) is a major concern. These systems can provide crucial lead time to prepare for a drought and implement water-saving measures. The soil water conservation strategy was the least adopted on average (6.1%) across the wards.

Practices that improve soil health and water retention capacity are essential for drought preparedness. This could involve techniques like mulching and cover cropping, as noted by Njeru et al. (2020). The results reveal a positive trend in DMS with high adoption rates for rainwater harvesting, crop diversification, and drought-resistant crops. However, the low adoption of crucial approaches like early warning systems and soil water conservation requires immediate attention. By promoting community collaboration, raising awareness, and exploring sustainable solutions, the community can improve its preparedness for future droughts and become more resilient to water scarcity. The data provided sheds light on the adoption rates of various DMS within Tharaka South Sub-County. This information is crucial for understanding how prepared the population is to face water scarcity and its associated challenges.

The study revealed that on average, slightly above three-quarters (78.1%) of the respondents had adopted rainwater harvesting as a DMS (Table 2). This percentage shows that more than three-quarters of the sample population had adopted the strategy in the area. Rainwater harvesting was mainly done from the rooftops, which involved collecting rainwater from rooftops using gutters and pipes that directed water into storage tanks. The majority of the households were only able to collect on a small scale and used it for domestic purposes. Other methods of collecting rainwater that were observed included farm ponds and subsurface dams across rivers.

This study revealed that Tharaka South is characterized by an arid and semi-arid climate. This region experiences erratic and unpredictable rainfall patterns, with long dry spells and frequent droughts. Rainwater harvesting helps communities in this region to store and utilize the limited rainfall effectively during the dry periods. The study findings mirror those of Mucheru-Muna et al. (2017) in their study in Tharaka South, who found that the Tharaka South residents had immensely adopted rainwater harvesting as a DMS. Although due to limited storage, the majority of the households tap rainwater on a small scale for domestic purposes, as compared to agricultural practices. The main challenges to harvesting rain water were cited as in availability of capital to finance projects like buying a huge tank, digging dams, and even acquiring the tools necessary for rain water harvesting. This aligns with the findings of Nabwire (2020), which indicate that the primary challenges to rainwater harvesting stem from limited financial resources to support the necessary infrastructure, including the purchase of large storage tanks, the construction of dams, and the procurement of essential harvesting equipment.

## CONCLUSION

Based on the study objectives, the study concluded that planting drought-tolerant crops, crop diversification, and rainwater harvesting were the most applied strategies to mitigate the impacts of drought. Membership in community-based programmes, irrigation, and soil water conservation were the least adopted strategies, yet highly perceived as effective in drought mitigation among households in Tharaka South Sub-County.

## RECOMMENDATION

The recommendations of this research are: 1) providing financial assistance and incentives to poorer households is essential to enable them to adopt effective drought mitigation measures. This could include subsidies for purchasing drought-resistant seeds, irrigation equipment, and other necessary technologies; 2 enhancing educational opportunities for farmers can significantly improve their ability to understand and implement advanced agricultural practices. Extension services should focus on providing training and workshops that increase farmers' knowledge and skills in drought mitigation. 3 Intensifying extension services is crucial for increasing awareness and adoption of DMS. Governments should invest in strengthening these services to ensure timely and effective dissemination of information and support to farmers; and 4 encouraging farmers to participate in community organizations and social networks can foster a supportive environment for sharing knowledge and experiences. These platforms can serve as valuable forums for discussing and promoting effective drought mitigation practices.

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