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# Examining the Role of Lower-Level Local Government Leaders in Mitigating Climate Change Impacts on Smallholder Farmers

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

The agricultural sector remains the main source of livelihoods for rural communities in Tanzania, but faces the challenge of changing climate. This study aimed at assessing the roles played with local government leaders towards smallholder farmers escaping from climate change effects. Specifically, the study examined the influence of Climate change information Adoptive strategies, Updated farming knowledge from local government leaders on smallholders' ability to escape from climate change effects. The study employed a cross-sectional research design on 200 smallholder farmers. Data collection methods included survey, key informants' interview (KIIs) and focus group discussions. The study collected and analysed both qualitative and quantitative data from primary and secondary sources. Quantitative data were analysed using a multiple regression model while

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the qualitative data were analysed using thematic analysis. findings revealed that local government leaders are not effectively supporting smallholders farmers escaping from climate change effects since the result under this study reveal that local government leaders are not providing supporting knowledge to smallholder farmers on climate change and strategies towards its adoptions, it can be concluded that local government leaders has a slight influence on supporting smallholders farmers to escape from climate change effects in the study area since observed that local leaders are not providing adequate climate and its adoption strategies. The study concludes that local government leaders have less knowledge on climate issues hence negatively influencing smallholder farmers to escape from climate change effects due to the absence of local government employees development program particularly to wards and village executive officers who are directly closely to local natives by increasing the ability of the smallholders' farmers to have good wellbeing performance. The study recommends to the Moshi District Council particularly to local government leaders and ministry of agricultural to establish capacity building program to local government employees working at lower levels and local government leaders have to include climate change information agenda in their assembly to ensure farmers are updated with climate change issues.

*Keywords: Local government leaders; climate change knowledge; smallholder farmers; food insecurity and per capital income.*

## 1. INTRODUCTION

"The developing countries' agricultural landscape is characterized by sluggish growth, low factor productivity, declining terms of trade, and often also by practices that are aggravated by climate change related problems" [1]. "Tanzania among the less developing countries, whereby agriculture is the backbone of her economy, the industry is dominated by smallholder farmers who occupy the majority of land and produce most of the crop and livestock products" [2-5]. The key long-standing challenge of the smallholder farmers is low productivity stemming from climate change effects direct and indirect effects [6]. However, the government of Tanzania established Local government Authorities (LGAs) with its reforms aimed to promote service delivery to citizens at local levels, including supporting citizens to achieve their economic goals through advocacy, lobbying as well as technical assistances provisions to attain their wellbeing performance through their engaged socio-economic activities [7].

Nonetheless, smallholder farmers' yields have grown by a negative growth in 2020 and 2021 with rate of 0.35 tons and 0.39 tons per hector, respectively instead of 1.5 tons per hector which hamper their wellbeing performance due to the climate change effects [8]. The empirical literature evidence that, the increased climate change effects to smallholder farmers is due to the limited knowledge on mitigation and adoption measures to undertake since they are persistently relaying on traditional farming instead of employing adoptive mechanisms that combat and mitigate climate change effects in agriculture sector [9]. Moreover, recent studies examine constraints to smallholders' activities [10,11,12], but do not take a comprehensive view of the sector in relation to lower local government performance. In contrast, this study will investigates the role played by local leaders in supporting smallholders in escaping climate change effects which are resulting to extremely poverty among smallholder farmers in Tanzania, a case of selected Moshi District Council's lower level local government authorities. These outcomes are important to inform strategies to achieve Sustainable Development Goals No. 13 Goal 13, which intends to take urgent action to combat climate change and its impacts.

## 2. METHODOLOGY

### 2.1 Research Design

A cross-sectional research design was employed in this study because it allows for the collection of data on multiple variables from a representative sample with diverse characteristics at a single point in time, facilitating the analysis of variable relationships. This design was chosen because it enabled data collection from various respondent groups simultaneously, allowing for comparisons among different groups to examine relationships between independent and dependent variables. It also ensured high validity and reliability of the collected data while optimizing time and resource efficiency, as suggested by Wang et al. [13].

## 2.2 Study Area Description

The study was conducted in Moshi District Council, located in the Kilimanjaro Region. This location was chosen due to its favorable climate, which is crucial for smallholder farmers [14]. Moshi is renowned as the leading district in smallholder farming and is a major producer of various cash and food crops in the region and neighboring Kenya [15]. Moreover, despite its significant number of smallholder farmers relying on agricultural labor and subsistence farming for household livelihoods, Moshi District stands out compared to regions like Singida and Dodoma. Therefore, this district was deemed suitable for studying the role of local leaders in supporting smallholders to mitigate the effects of climate change.

## 2.3 Study Population, Sample and Sampling Strategy

### 2.3.1 Study population

The population refers to a collection of people, services, elements, groups, or households under investigation, encompassing individuals, events, or objects sharing common observable characteristics. In this study focusing on the role of local leaders in supporting smallholders against climate change effects, the unit of analysis consisted of smallholder farmers from Kahe Mashariki and Makuyuni wards, which are known for their extensive farming activities in Moshi District. The sampling frame included a list of smallholder farmers from these two wards, totaling 400 individuals (MDC, 2021).

### 2.3.2 Sample Size

The sample size was determined by Yamane [16] formula in equation (1). as adopted by Umar and Wachiko, (2021). The formula was used because the study population is known. Proportion allocation was done for each selected ward. Apart from greater economy in terms of time and money, involving few smallholder farmers resulted into reliable and high-quality findings.

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

Where:

N = Total number of women farmers

n = Estimated individual sample size

e = standard error. In this study a standard error of 0.05(5%) will be used to obtain a manageable sample size of respondents

The level of confidence is 95%

$$n = \frac{400}{1 + 400\,(0.05)^2}$$

n= 200

### 2.3.3 Sampling techniques

A multistage sampling approach was utilized, where the population was stratified into two categories based on wards to minimize sampling errors: Kahe Mashariki and Makuyuni in the first stage. In the second stage, two villages were chosen from each ward. Smallholder farmers were selected using a systematic random sampling method. Specifically, the sample was drawn from the villages of Ghona and Kyomo in Kahe Mashariki ward, and Makuyuni and Lotima in Makuyuni ward.

## 2.4 Data Collection

The data were gathered using a survey method, employing questionnaires, focus group discussions (FGDs) with a discussion guide, and key informant interviews (KIIs) with an interview guide.

### 2.4.1 Survey

Primary data were gathered through a survey of 200 smallholder farmers. An interviewer-administered, structured questionnaire with close-ended questions was utilized to meet the study's objectives. The questionnaire was divided into sections addressing climate change information, adaptive strategies, updated farming knowledge, and limited per capita income. Each section comprised concise, straightforward, and positively framed questions designed to elicit the most relevant responses.

### 2.4.2 Key Informant Interview

The key informants' interview guide was utilized to gather data from two agricultural extension officers in the wards, chosen for their knowledge and experience with climate change in their areas. This approach was effective in obtaining detailed information, perceptions, and opinions, and allowed for the exploration of additional questions that other methods could not capture.

**Table 1. Sample size distribution**

| Regions | Kilimanjaro | | | |
|---|---|---|---|---|
| Districts | Moshi District Council | | | |
| Wards | Kahe Mashariki | | Makuyuni | |
| Villages | Ghona | Kyomo | Makuyuni | Lotima |
| Population | 112 | 68 | 168 | 52 |
| Proportion | 0.28 | 0.17 | 0.42 | 0.13 |
| Sample Size | 56 | 34 | 84 | 26 |

**Table 2. Multicollinearity test**

| Variables | Tolerance | VIF |
|---|---|---|
| Special public event for climate change effects provision | .683 | 1.465 |
| Never contacted my chairperson for climate change issues | .825 | 1.212 |
| My LGA haven't special platforms for public education | .821 | 1.219 |
| Since 2015 have facing food insecurity due to increased climate change | .710 | 1.409 |
| Have very limited capital | .828 | 1.208 |

## 2.5 Scales Development

Four focus group discussions were conducted, with two held in each ward (Kahe Mashariki and Makuyuni). These FGDs included ward agricultural officers, ward health officers, ward executive officers, village chairpersons, and community members involved in addressing climate change effects. Both male and female participants were included to ensure gender equity and to gather comprehensive responses from the community. Each focus group comprised eight to ten members, adhering to the range recommended by Kim et al. [17]. According to their guidelines, a focus group should not be too large to prevent full participation but also not too small to ensure a diversity of views and opinions is captured.

## 2.6 Multicollinearity

Multicollinearity refers to the extent of correlation between independent variables [18]. In regression analysis, independent variables should not exhibit high correlations with each other. Multicollinearity arises when these variables are highly correlated. Variance Inflation Factors (VIFs) equal to one indicate no or minimal multicollinearity; VIFs between one and five suggest moderate multicollinearity; VIFs from five to ten indicate a high correlation. If VIFs exceed ten and tolerance is below 0.2, coefficients are poorly estimated, indicating a multicollinearity issue that needs correction. In this study, the multicollinearity was found to be one, and tolerance levels were above 0.2, indicating no multicollinearity problem, as shown in Table 2.

## 2.7 Data Analysis

### 2.7.1 Qualitative analysis

Thematic analysis was employed to examine qualitative data from key informant interviews. Initially, the interviews were transcribed into Word documents. From these transcripts, significant themes, concepts, and phrases related to the roles of local government leaders and the impact of climate change on smallholder farmers were identified. This process aimed to organize the data into recurring themes that emerged after addressing specific questions. The topics were then grouped logically and provided an overview of the main findings. Both qualitative and quantitative results were triangulated to derive accurate and significant conclusions.

### 2.7.2 Quantitative analysis

A multiple regression analysis was employed to examine the effects of each variable on climate change impacts on smallholder farmers using quantitative data. The study included 12 items, and factor analysis was utilized to identify which items formed coherent, relatively independent subsets. This method produced small sets of uncorrelated variables from 55 initial variables. Factor analysis helped establish the number of dimensions within the variable set. The four variables considered were climate change information, adaptive strategies, updated farming knowledge, limited per capita income, and food insecurity. The suitability of data for factor analysis was tested using the Kaiser-Meyer-Olkin (KMO) and Bartlett tests. The results,

**Table 3. KMO and bartlett's test**

| | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | **.729** |
| **Bartlett's Test of Sphericity** | **Approx. Chi-Square** | **402.175** |
| | df | 28 |
| | Sig. | .000 |

**Table 4. Reliability test for Likert-type scale**

| Variable | Cronbach's Alpha | N of Items |
|---|---|---|
| Climate change information | .851 | 5 |
| Adoptive strategies | .825 | 5 |
| Updated farming knowledge | .701 | 6 |
| Limited per capital income | .844 | 5 |
| Food insecurity | .835 | 6 |

presented in Table 3, indicated that all four variables were suitable for factor analysis, with KMO values greater than 0.5 (0.729) and significant Bartlett test p-values (p = 0.000).

#### 2.7.3 Reliability

The questionnaire was pre-tested to assess its validity, and suggestions and recommendations from the pre-testing were incorporated into the final version before the main data collection. The collected data underwent a reliability test, including Cronbach's Alpha coefficient analysis. As shown in Table 4, all Likert-type scale questions demonstrated good consistency, with Cronbach's Alpha values exceeding the acceptable threshold of 0.7.

#### 2.7.4 Validity

Expert interviews were done to get feedback on the instruments used for validation, which enabled the researcher to make the required corrections. In order to evaluate content validity, this study looked at how successfully the research instruments gathered the necessary data. Two weeks before to data collection, a pre-test of the questionnaire was carried out in each of the two villages, one from each ward, to guarantee the validity of the data. Pre-testing was done to see if the data was valid, to see how long it took to gather the data, to see how well the research team collaborated, to see if there was enough funding, and to see if the data collection methods needed to be adjusted.

## 3. RESULTS AND DISCUSSION

### 3.1 Multiple Regression Model

A multiple regression model was employed to assess the role played by local leaders in supporting smallholders in escaping climate change effects. Specifically, the study under this objective looked at climate change information, adoptive strategies, updated farming knowledge provided on climate change effects to smallholder farmers escaping capacity. The R-squared was 101 and is above the required R-squared of greater than 50 as presented in Table 5, indicating the significance of the model for measuring the relationship between local government leaders' roles and smallholder farmers ability to escape in Moshi District Council. This implies that the combined effect of the three variables used was able to explain smallholders' capacity to escape climate change effects in term of in terms of per capita income and food insecurity.

### 3.2 Updated Farming Knowledge Provision

Consequently, this study utilized multiple regressions to assess whether farmers could mitigate the effects of climate change due to the updated farming knowledge provided by local leaders in the study area. Table 5 displays the results. From Table 5, the estimated coefficient β=0.1940386, p=0.001 indicates that the updated general farming knowledge provided by local leaders had a significantly positive relationship with farmers' ability to cope with climate change effects in the study area. These findings align with dependency theory, which asserts that good farming practices depend on the extent of farming information provision [19]. The results are also supported by Olounlade *et al.* (2020), who demonstrated significant positive impacts of farming knowledge. The more farmers are gaining best farming knowledge the more the get high productivity towards their performance. Updated farming knowledge is therefore, a reasonable instrument that can help

**Table 5. Local government leaders' roles on climate change effects to smallholder farmers**

| **Source** | **SS** | **df** | **MS** | **Number of obs** | | **200** |
|---|---|---|---|---|---|---|
| Model | 26.1857862 | 3 | 8.728595 | F (3, 197) | = | 7.4 |
| Residual | 232.223269 | 197 | 1.178798 | Prob > F | = | 0.0001 |
| | | | | R-squared | = | 0.1013 |
| | | | | Adj R-squared | = | 0.0876 |
| Total | 258.409055 | 200 | 1.292045 | Root MSE | = | 1.0857 |
| climate change impact to smallholder farmers | Coef. | Std. Err. | t | P>\|t\| | (95% Conf. Interval) | |
| Updated general farming knowledge provision | 0.1940386 | 0.578503 | 3.35 | 0.001 | 0.079953 | 0.308124 |
| Climate change information provision | -0.0799963 | 0.052872 | -1.51 | 0.132 | -0.18426 | 0.024271 |
| Climate change adoption strategies provision | -0.1000347 | 0.597565 | -1.67 | 0.096 | -0.21788 | 0.01781 |
| Cons | 3.82575 | 0.408067 | 9.38 | 0.000 | 3.021009 | 4.630491 |

farmers increase their income and improve their food security in the Department of Alibori. Moreover, key informants (KI, 2022) confirmed that:

> *"In my ward, I observed that farmers engaged in groups are more likely to get farming education compare those doing their farm activities alone……." Another (KI, 2022) added that "the available high number of extension officers in our wards supporting us in our daily farming activities…….”* (KII, Makuyuni, 13 Nov, 2022).

The findings imply that farming updated knowledge helping farmers to have the faming practice. According to Addisu [20], “farming updated knowledge’s critical to reducing harvest losses and eventually increasing per capita income. The farming updated knowledge provision, which has been identified as a driver of smallholder commercialization, exemplifies firm farmer integration and agricultural transformation in the country”. “This is due to the fact that farming updated knowledge’s an emerging institutional innovation in Tanzania, linking farmers to reliable markets, open access to inputs, technology and advisory services that lead to improved productivity, production and income” [21]. Specifically, the malt barley farming updated knowledge provision is an innovative platform harbouring public-private partnerships. This informs that the available extension officers are in contact with farmers throughout their farming activities

## 3.3 Climate Change Information Provision

Climate change information provision is a core part of farmers’ ability to escape from climate change effects. The Climate change information provision questions in this study were designed to determine whether the farmers’ escaping capacity from is related to the Climate change information provision. The results of the climate change information provision, (Table 5). The estimated coefficient $\beta = -0.0799963,\ p = 0.132$ indicates that the Climate change information provision has no relationship with farmers’ climate change effects in the study area.

The study findings concurred with the study by Slater, [22], who reveals that climate change information provision does not well support the wellbeing of smallholders’ farmers since it depends on the characteristics of each producer who are differently in using integrated local government media for farmers’ information sharing. Also, he added that smallholder producers in developing countries do not believe their local leaders on the issues related to climate change due to their limits to NGOs available in their locality. He also added that farmers are not much attending to local assembly meetings. Also supported by key informants (KI, 2022) that

> *“in our village assembly we haven’t any specific agenda related to climate change we may be informed on other agricultural related information such as the right time to plant as well as how to use agro chemicals….” Another key informant added that ‘our expert in agricultural sector have limited knowledge on the issues related to climate change since we haven’t employees’ development program. Therefore farmers are not depend much to local government authority to provide climate change related information but can access such information through radio and televisions.....”* KIIs, Kahe Mashariki, 15th November, 2022.

From the findings, it was concluded that the negative relationship between Climate change information provision form local government leaders and climate change effectives escaping capacity among smallholder farmers might be attributed to the limited with employees’ development program in local government authorities in Tanzania.

## 3.4 Climate Change Adoption Strategies Provision

“Limiting the damage due to climate change has become a challenge for the global community now. In this regard, climate change mitigation and adaptation are crucial. Adaptation can manage the impacts but cannot by itself solve the problem of climate change, but rather as an inclusive element particularly, knowledge is viewed as a key element for smallholder farmers escaping from its results. Smallholder farmers in developed countries are sharing adoption strategies knowledge through constructed village demonstration farms” [23]. Also, this study assessed if smallholder farmers’ climate change effects has a relation to climate change adoption strategies in the farming processes. Results are presented in Table 5. The estimated coefficient $\beta = -0.1000347,\ p = 0.096$ indicates that local

government leaders are not providing climate adoption strategies since seems has no relationship with farmers' climate effects indicators facing smallholder farmers in the study area. The adoption of climate change adoption techniques is crucial to lowering farmers' losses and increasing revenue in the direction of betterment. Determining the economic outcome for farmers is also crucial. The majority of farmers, he continued, have not received training on adopting measures related to climate change. They mostly employ risky and inaccurate techniques to mitigate the effects of climate change on their farming operations, and they have inaccurate information about the phenomenon and its hazards. Also, the study by Slater [22] reveals that farmers' knowledge climate change adoption strategies can control the amount of its impact and a critical step could be holding training programmes for the farmers. In addition to a training programme for farmers, simultaneous implementation of farm implements should be based on technical climate change adoptions. Also supported by key informant (KI, 2022) who argued that

> *"…. a good number of farmers have limited climate adoption strategies knowledge which results in inadequate performance of their wellbeing as climate change affects smallholder food security. Also, he added that the absence of demonstration-based farms in the ward whereby farmers are helping each other with very limited knowledge on climate change resilience farming mechanisms…"* (KIIs, Kahe Mashariki, 16th November, 2022).

Due to the lack of specific government assistance for climate change adoption measures, the smallholder industry is vulnerable. The results of the study align with those of Bronson's [24] investigation, which found that smallholder farmers in affluent nations like China and Canada possess exceptional knowledge about climate change because they are highly educated and skilled locals. From the discussion above, it can be argued that smallholder farmers in developing countries, like Tanzania, are discriminated against for their limited adoption of climate change strategies, which have led to food insecurity. In particular, smallholder farmers face discrimination because of their limited adoption of climate change policies from local leaders.

## 4. CONCLUSION AND RECOMMENDATIONS

The study assessed the role played by local government leaders on supporting smallholder farmers escaping from climate effects such as food insecurity and inadequate per capital income case of smallholder farmers in Moshi District Council, specifically in Kahe Mashariki and Makuyuni wards. Specifically, the study assessed the effects of Climate change information, Adoptive strategies and Updated farming knowledge on the wellbeing performance of smallholder farmers. From the findings discussed above, it can be concluded that local government leaders has a slight influence on supporting smallholders farmers to escape from climate change effects in the study area since observed that local leaders are not providing adequate climate and its adoption strategies. The study concludes that local government leaders have less knowledge on climate issues hence negatively influencing smallholder farmers to escape from climate change effects due to the absence of local government employees development program particularly to wards and village executive officers who are directly closely to local natives by increasing the ability of the smallholders' farmers to have good wellbeing performance. The study recommends to the Moshi District Council particularly to local government leaders and ministry of agricultural to establish capacity building program to local government employees working at lower levels and local government leaders have to include climate change information agenda in their assembly to ensure farmers are updated with climate change issues.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

## ETHICAL APPROVAL AND CONSENT

Permission for data collection was requested from the Kilimanjaro Regional Administrative Secretary to obtain a research permit for this study. The respondents consented to participate in filling out the provided questionnaires and were consulted before the interviews. The researcher informed the respondents that the

study was academic in nature and assured them that their anonymity would be protected.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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