Factors Influencing Smallholder Tomato Growers' Access to and Uptake of Climate Change Information in Iringa and Morogoro Regions

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Research Report 2023/22

Published by:

REPOA
157 Migombani/REPOA Streets, Regent Estate,
P.O. Box 33223
Dar es Salaam.

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Copy-editing & initial layout: Vincent Nalwendela | REPOA

Suggested citation:
Siyao, P.O., & Sanga, E.E. (2023). Factors Influencing Smallholder Tomato Growers' Access to and Uptake of Climate Change Information in Iringa and Morogoro Regions. REPOA, Dar es Salaam.

Research Report 2023/22

Suggested Keywords:
Smallholder, Tomato, Climate Change, Information, Iringa, Morogoro, Tanzania.

ISBN 978-9987-753-14-7

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

List of tables

LIST OF ABBREVIATIONS

CSDI - Communication for Sustainable Development Initiative

FAO - Food and Agricultural Organization

IPCC- Intergovernmental Panel on Climate Change

REPOA- Research and Poverty Alleviation

RTS - Radio and Technology Strategy

UNDP- United Nations Development Programme

URT - United Republic of Tanzania

EXECUTIVE SUMMARY

Climate change is one of the key challenges to development across the world, which is caused by unsustainable anthropogenic practices, especially that of burning fossil fuels, industrial pollution, deforestation and improper land use changes. All countries across the world are differently affected by the negative impacts of climate change. Smallholder farmers, particularly in developing countries such as in Tanzania, suffer the most from the adverse impacts of climate change because of their dependence on rain-fed agriculture, limited financial capacity, low adaptive capacity, high dependence on natural resources and climate change sensitive activities, inability to detect the occurrence of extreme hydrological and meteorological events, limited infrastructure, illiteracy, lack of skills, low awareness levels and lack of capacity to diversify their farming activities.

Access to proper and uptake of climate change information is of utmost importance for enabling awareness creation on climate change adaptation and mitigation among smallholder farmers. Awareness about climate change and its impacts among smallholder tomato growers will prepare them to cope and adapt to its negative impacts. Therefore, to effectively adapt to climate change and mitigate its effects, smallholder tomato growers need to have access to and uptake of timely and relevant climate change information to facilitate rational decision-making processes.

The current study assesses the factors influencing access to and uptake of climate change information for building adaptive capacity through awareness creation among smallholder tomato growers in selected rural parts of Tanzania. The study seeks to answer the following research questions: what are the factors that encourage access to and uptake of climate change information by smallholder tomato growers in Iringa and Morogoro; what are the types of climate change information used by smallholder tomato growers in Iringa and Morogoro; what are the sources of climate change information used by smallholder tomato growers in Iringa and Morogoro regions; what are the key barriers to the access and uptake of climate change information by smallholder tomato growers in Iringa and Morogoro; and what are the key strategies for improving access to and uptake of climate change information by smallholder tomato growers in Iringa and Morogoro regions - Tanzania.

The study was conducted in Morogoro and Iringa regions and adopted a cross-sectional research design. To achieve the objective of this study; various sampling techniques including multistage purposive and systematic random sampling strategy were used. A sample size 183 smallholder tomato growers who were drawn from a population of 400 smallholder tomato growers was used. Quantitative data was collected using semi-structured questionnaires, while semi-structured interviews were used to collect qualitative data. Quantitative survey data were analysed using IBM Statistical Product and Service Solutions (SPSS) Statistics Version 21 whereas qualitative data were analysed using content analysis.

Results of this study indicate that socio-demographic characteristics of the respondents are the major factors that influence access and uptake of climate change information by smallholder tomato growers in the study areas. Smallholder tomato growers mostly needed information on drought-tolerant and disease-tolerant tomato seeds, application of pesticides and various types of fertilizers. The most used information was on time for planting tomatoes and critical farming decisions in relation to land preparation. Relatives, friends, neighbours, radio and mobile phones were the most preferred sources of acquiring information by smallholder tomato growers for raising awareness about coping, adaptation and mitigation options. Lack of clear understanding of climate change information, along with lack of access to libraries and information centres, inadequate income to buy communication media, unreliability of climate change information and lack of skills and knowledge regarding the climate change subject matter were barriers that constrained smallholder farmers to access and uptake climate change information in the study areas.

Basing on the findings, the study concludes that appropriate intervention strategies should be employed to overcome constraining barriers to the access and uptake of climate change information for awareness creation among smallholder tomato growers in Tanzania. The study recommends that government and all other stakeholders should provide educational training programmes tailored to meet climate change information needs of farmers, so as to enable them to cope with the emerging challenges in order to enhance their productivity. The study recommends employment of sufficient extension workers at village levels, establishment of community information centres, libraries, telecentres', localized meteorological stations and climate change information centres. Furthermore, researchers, extension agents and meteorologists should work in tandem with smallholder tomato growers for improving access to and use of climate change information among smallholder tomato growers in the rural areas.

ABSTRACT

This Study assesses the factors influencing access to and uptake of climate change information for awareness creation among smallholder tomato growers in the selected rural parts of Tanzania. Specifically, this study seeks to answer the following research questions: What are the factors that facilitate access to and uptake of climate change information by smallholder tomato growers? What are the types of climate change information used by smallholder tomato growers? What are the sources of climate change information used by smallholder tomato growers? What are the key barriers to access and uptake of climate change information by smallholder tomato growers? What are the key strategies for improving access to and uptake of climate change information by smallholder tomato growers in Iringa and Morogoro Regions? The Study adopts a cross-sectional research design with a sample size of 183 smallholder tomato growers. Quantitative and qualitative approaches were used as data collection methods. Quantitative data was collected using questionnaires, while interviews were used for qualitative data. IBM SPSS Statistics software was used to analyse quantitative data, whereas qualitative data was analysed using content analysis procedure. Findings indicate that demographic characteristics of smallholder tomato growers are the major factors that influence the acquisition and uptake of climate change information. Smallholder tomato growers mostly needed information on drought-tolerant and disease-tolerant tomato seeds, application of pesticides and various types of fertilizers. The information most used was on time for planting tomatoes and critical farming decisions in relation to land preparation. Relatives, friends, neighbours, radio and mobile phones were the most preferred sources of acquiring information by smallholder tomato growers for raising awareness about coping, adaptation and mitigation options. Lack of clear understanding of climate change information, along with lack of access to libraries and information centres, inadequate income to buy communication media, unreliability of climate change information and lack of skills and knowledge regarding the climate change subject matter were barriers that constrained smallholder farmers to access and uptake climate change information in the study areas. The study recommends employment of sufficient extension workers at village levels, establishment of community information centres, libraries, telecenters, localized meteorological stations and climate change information centres. Furthermore, researchers, extension agents and meteorologists should work in tandem with smallholder tomato growers for improving access to and use of climate change information among smallholder tomato growers in the rural areas.

1. INTRODUCTION

Climate change is one of the key challenges to development across the world, which is caused by unsustainable anthropogenic practices, especially that of burning fossil fuels, industrial pollution, deforestation and improper land use changes (IPCC, 2007; UNDP, 2007; Canadel et al., 2011; Weart 2010; Cook *et al*., 2013; Gadzekpo *et al*., 2018; Lund, 2019). There is evidence that climate change is now an established reality (Wolff, *et al*., 2020; Lindsey *et al*., 2010). In developing countries such as Tanzania, climate change is manifested by markers such as rising temperatures, melting of glaciers, rising sea levels, changes in precipitation patterns, recurrent droughts and devastating floods as well as outbreaks of diseases, among others. Furthermore, available scientific evidence shows that the earth experienced an average warming of approximately 0.6 °C during the twentieth century and is expected to warm up by about 2–3 °C by the end of the 21st century (IPCC, 2001; IPCC, 2007).

All countries across the world are affected differently by the negative impacts of climate change. Smallholder farmers, particularly in developing countries such as in Tanzania, suffer the most because of their dependence on rain-fed agriculture, limited financial capacity, low adaptive capacity, high dependence on natural resources and climate change sensitive activities (Chaplin,2017), inability to detect the occurrence of extreme hydrological and meteorological events, limited infrastructure, illiteracy, lack of skills, low awareness levels and lack of capacity to diversify their farming activities (Kurukulasuriya & and Mendelssohn, 2006).

The negative impacts of climate change include erratic and unreliable rainfall, extreme temperatures, droughts, floods, low food production, destruction of basic infrastructure, outbreak of pests and diseases; death of animals and land degradation, among others (URT, 2012; 2021). These adverse impacts of climate change exacerbate threats to development and are thus regarded as one of the challenges in the implementation of the Second Five Year National Development Plan 2016/17 - 2020/21 (FYDP II), especially in the agricultural sector, which is most disturbed by climate change. Thus, upon the course of implementing the Third Five Year National Development Plan 2021/22 - 2025/26 (FYDP III), to solve the challenge posed by climate change to the smallholder tomato growers through awareness creation about climate change adaptation, coping and mitigation strategies emanating from deliberate strategic efforts of enhancing access to and uptake of climate change information is of paramount importance (URT, 2012; Mubiru *et al*., 2018).

Tomato is one of the seasonal commercial crops mostly grown by smallholder farmers in various parts of Tanzania, such as Morogoro and Iringa regions. The crop has multiple harvests that can generate profits to smallholder farmers per small unit area and it is consequently regarded as a very important crop in the country's agricultural sector (Mutayoba & Ngaruko, 2018). However, climate change poses many immediate

challenges for tomato growing agriculture in Tanzania and in the other parts of the world (Litskas *et al*., 2019), which is caused by its susceptibility to the impacts of changing climatic conditions. Guodaar (2015); Tshiala & Olwoch (2010) posted that although climate change affects crops differently, tomatoes are among highly affected crops because of their high dependence on climatic conditions such as temperature, rainfall patterns and water. Thus, effects brought about by climate change adversely affect their production.

Information is among the basic human needs. To achieve development, human beings largely depend on the availability and access to accurate and reliable information (Capstick, 2013). Access to proper and uptake of climate change information is of paramount importance for enabling awareness creation on climate change adaptation and mitigation among smallholder farmers. Awareness about climate change and its impacts among smallholder tomato growers will prepare them to effectively cope and adapt to its negative impacts (Ajuang *et al*., 2016). According to Muema *et al*. (2018), climate change information is useful for addressing the threats posed by climate change when this information is accessed in a form that is easily understood by smallholder farmers. Access to information is regarded as a pre-requisite for climate change adaptation at the local level and it is identified as one of the significant factors that can influence uptake of the information. Ageyo and Muchunku (2020) are of the view that adaptation to climate change starts with access to current and relevant information. Several authors like (Antwi-Agyei *et al*., 2020; Nkiaka *et al*., 2019; Singh *et al*., 2018; Vincent *et al*., 2017) observed that timely access to climate change information is important for effective decision-making processes for addressing the shocks brought about by climate change in sub-Saharan African countries. To effectively adapt to climate change and mitigate its effects, smallholder tomato growers need to have access to and uptake of timely and relevant climate change information to facilitate rational decision-making processes.

The concept of information uptake is described as the action of making use of available information to make informed decisions. It is the process during which farmers recognize and use available information from identifiable sources to inform their adaptation and agricultural-related decisions, and to subsequently undertake appropriate strategies (Chaplin, 2017). Uptake of climate change information and advisory services can help a great deal in improving the management of climate-related risks and help farmers to adapt to changes (Tall *et al*., 2014). Use of climate change information can offer the potential to enhance agricultural resilience to climate change through improved agricultural decision-making, such as preparations for expected adverse or favourable conditions (Pathak &Stoddard, 2018).

1.1 Problem Statement and Research Questions

Access to and use of climate change information is essential for raising people's awareness about adaptation, coping and mitigation strategies in the face of changing

climatic conditions, for informed decision-making processes (Srinivasan *et al*., 2011; Noble *et al*., 2014; Jiri *et al*., 2016). This implies that people can successfully adapt and cope with climate change and especially its mitigation, if they have access to and they can use information and knowledge about the various aspects of climate change (Siyao & Sife, 2020). Effective access to and uptake of climate change information will enhance the adaptive capacity of rural smallholder farmers and consequently lead to higher agricultural production and improvement of livelihoods as well. Nevertheless, access to timely, relevant and practical information on climate change has continued to be a challenge for smallholder tomato growers. Climate change information received by farmers is not consistently delivered through accessible mechanisms. It is normally delivered too late to allow appropriate responses or is not accompanied by a recommended courses of action (Jalango et al., 2020).

Several studies have been undertaken in Tanzania to assess access to and use of climate change information (Siyao &Sife 2020; Sanga &Elia, 2020). However, little is known about the factors that influence optimum access to and uptake of climate change information for enhanced adaptive capacity among smallholder tomato growers in Tanzania. Thus, the study attempts to fill this gap by conducting an empirical research on the factors that influence access to and uptake of climate change information for enhanced adaptive capacity among smallholder tomato growers in Morogoro and Iringa regions in Tanzania.

This study aimed at assessing the factors influencing access to and uptake of climate change information for building adaptive capacity through awareness creation among smallholder tomato growers in selected rural parts of Tanzania. Specifically, this study sought to answer the following research questions (RQs)

RQ1. What are the factors that encourage access to and uptake of climate change information
by smallholder tomato growers in Iringa and Morogoro?
RQ2. What are the types of climate change information used by smallholder tomato growers
in Iringa and Morogoro?
RQ3. What are the sources of climate change information used by smallholder tomato
growers in Iringa and Morogoro?
RQ4. What are the key barriers to the access and uptake of climate change information by
smallholder tomato growers in Iringa and Morogoro?
RQ5. What are the key strategies for improving access to and uptake of climate change
information by smallholder tomato growers in Iringa and Morogoro?

2.0 LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 Factors that Encourage Access and Uptake of Climate Change Information by Smallholder Tomato Growers

Access to and uptake of reliable, timely and up-to-date information on climate change has been acknowledged as necessary for raising public awareness about the impacts of climate change, as well as for better management of climate-change-related risks (Debela *et al*., 2015; Dinshaw *et al*., 2012). Access to information about climate change is also necessary for understanding the scope of climate change, as well as its impact on socio-economic and environmental stability (Corner, 2011; Jiyane & Fairer-Wessels, 2012). On the other hand, lack of access to and uptake of climate change information by rural farmers may lead to low awareness levels about the causes of climate change, its impacts and hence poor understanding of appropriate adaptation, coping and mitigation strategies towards the adverse impacts posed by climate change. Williamson *et al*. (2010); Amdu *et al*. (2013) and Giordano (2014) posited that poor access to and uptake of information on climate change may in turn lead to low awareness about potential impacts of climate change, thus leading to low adaptive capacity which is one of the hindrances to the proper performance of agricultural activities such as tomato production.

Several studies have been conducted to examine factors that influence access to and uptake of climate change information. The study conducted by Kirui *et al*. (2014) indicates that climate information and services play a critical role in providing Early Warning Systems (EAS) as well as increasing awareness for building the capacity and disaster preparedness to a changing climate. Choice of dissemination channels can influence access to, and use of climate information and services disseminated to enable the vulnerable groups exposed to climate change hazards build adequate capacities. Ambani and Percy (2014) posited that appropriate communication channels would bring effective communication that is essential for making climate change information usable.

Income of the farmers is another factor that can encourage access to and uptake of climate change information. Better access to climate change information empowers farmers to proactively plan for adaptation measures against adverse impacts of climate change (Muema *et al*., 2018). Furthermore, farmers with better income can afford to buy and own communication media for obtaining information. Such media includes mobile phones, radio, television and print media, such as newspapers, among others.

The study conducted by Sen *et al*. (2022) indicates that ownership of communication assets such as television, radio and smartphones is also a determining factor for both access to and use of climate information by farmers. Authors of that study further pointed out that farmers who own such communication assets show greater propensity to access and use of climate change information than those who do not own such communication tools.

It has also been acknowledged that uptake of climate change information is determined by personal characteristics of the farmers such as age, gender, education, farm characteristics and institutional characteristics (Vaughan & Dessai, 2014; Webber, 2019). Furthermore, Kirui *et al*. (2014) reported that older farmers have less demand for seasonal climate information services because they can cope with climate change risks due to their skills in climate monitoring and risk spreading, and their preference for indigenous knowledge over modern climate information services, which are mostly preferred by younger farmers.

The study by Sanga and Elia (2020) suggested that education helps farmers in a number of ways with regard to accessing and using climate change information. This includes helping tomato growers to understand the extent of the climate change menace and seek adequate measures for ensuring harvest and increased production. Antwi-Agyei *et al.* (2021) posited that uptake of climate change information is related to levels of education. This implies that the more educated farmers do better appreciate the use of information for making informed decisions than the non-educated farmers.

Reliability of information is yet another factor that influences access to and uptake of climate change information. Mudombi and Nhamo (2014) found that for climate change information to be used by farmers, it should be reliable, trusted, and understandable.

2.2 Types of Climate Change Information Used by Smallholder Tomato Growers

The importance of climate change information to smallholder farmers cannot be overstated. It is useful for increasing the capacity of farmers to survive external shocks associated with climate change. Climate change information should be accessed in a form that is easily understood by smallholder farmers. Access to information is regarded as an important tool for managing a variety of risks posed by climate change (Codjoe *et al*., 2013; Muema *et al*., 2018). Antwi-Agyei *et al*. (2021) added that climate change information is useful for directing and guiding adaptation practices towards adverse impacts to climate change.

The study conducted by Siyao and Sife (2020) in the selected peri-urban areas in Tanzania indicates various types of climate change information used by farmers for rational decision- making on various issues. For example, information about onset and cessation of rainy seasons can be used to determine when crops are planted and harvested. Information on the amount of rainfall in a season is used for guiding decisions to grow drought-tolerant crops which are suitable for areas with little amount of rainfall. Information about the causes of climate change helps farmers to plan and make decisions on how to deal with the negative impacts of climate change and how to reduce vulnerability. Information on planting crops is required by farmers

as it can be used for guiding decision-making on whether to buy early maturing crops and seeds or not, and what is the appropriate time for planting them. Information on rainwater harvesting techniques is important for helping people to reduce the problem of water resource scarcity. Furthermore, information about land use is helpful for farmer's understanding of the appropriate and sustainable ways of utilizing their land, such as good land use practices. Tizale (2007) commented that people make use of climate change information for changing their farming practices in response to changing climatic conditions for improving their livelihoods.

2.3 Sources of Climate Change Information Used by Smallholder Tomato Growers

An understanding of sources used by smallholder farmers to extract information about climate change issues is of paramount importance. Siyao and Sife (2021) pointed out that knowledge of such sources helps the generators of climate change information to know the reliable and accessible channels through which they can direct this information for further dissemination. This, in turn, will improve communication of climate change information from the sources to the media and from the media to the public, for effective awareness creation.

Gupta and De (2011) posited that information sources play a key role in communicating innovative technologies to the ultimate users, making them not only aware of the useful information but also creating interest, promoting understanding and ultimately motivating them to adoption. Farmers in rural settings use many information sources and channels for acquiring various types of information, including climate change related issues to improve farming practices. They may use various and diverse information sources and channels including training, conferences, exhibitions campaigns, bulletins, seminars, radio, television, newspapers, friends, neighbours, the Internet, research stations and village extension workers, among others. For instance, tomato farmers can use these sources to gain valuable information that can ultimately be used for improving their farming activities (Moranga, 2016). In rural areas, radio is commonly used as a source of information. Other authors like (Laskar and Bhattacharyya, 2021; Prahmana *et al*., 2021 and Somanje *et al*., 2021) postulated that community radio stations are potentially powerful tools for disseminating climate change adaptation measures for smallholder farmers to adapt in rural areas, because they are linked to wider coverage, low cost, use of vernacular languages and low maintenance costs (Ingram etal.,2002; Oyekale, 2015). On the other hand, Ghatak (2007) reported that poor farmers with limited available resources are most affected in their ability to use information and communication technologies for accessing needed information.

2.4 Barriers to the Access and Uptake of Climate Change Information by Smallholder Tomato Growers

Various studies have cited numerous factors that prevent smallholder farmers from accessing and uptaking climate change information. Weak extension support services

caused by inadequacy of extension agencies is one of the challenges facing smallholder tomato growers. Sometimes the few available extension workers are not motivated. Less motivation is probably related to poor working environments, including a lack of reliable means of transport to reach the farmers, limited financial support to conduct demonstrations and field experiments on new technologies, lack of working facilities and low salaries, which is associated with insufficient government budget allocated to extension services (Lema & Majule, 2009; Mutayoba & Ngaruko, 2018).

The study conducted by Antwi-Agyei *et al*. (2021) indicates that inadequate information on seasonal forecasts for long-term planning is yet another key barrier constraining smallholder farmers' ability to uptake climate change information. This is attributed to the fact that smallholder farmers find it very difficult to plan for long-term farming practices and take farm management decisions based on daily forecasts. For example, farmers are not able to plan for their farming activities if they do not have a clue about when seasonal rainfalls will start and end.

In a study conducted in Tanzania by Siyao and Sife (2021), it was found that lack of trust regarding climate change issues hinders use of climate change information. This is because sometimes the information about rainfall patterns forecast provided by the Tanzania Meteorological Agency (TMA) is not always reliable and it is not received in a timely manner. Muema *et al*. (2018) and Africa (2018) reported that lack of trust and unreliability of the climate information services are the main hindrances to the utilization of climate information services. In his findings Elia (2014) reported that sometimes farmers tend to criticize the truthfulness of the information they receive from TMA for not being explicit on the rainfall distribution in a given geographical location and season.

Technical language used in communicating information is yet another barrier constraining access to and uptake of climate change information. Climate change issues communicated using jargon for common people (Antwi-Agyei et al., 2021; Siyao & Sife 2020) who cannot easily understand difficult climate change concepts.

Illiteracy is also a factor constraining farmers' access to and uptake of climate change by smallholder rural famers. This is more applicable to the smallholder farmers who do not have formal education, and this makes it difficult for them to appreciate and understand climate change information and the sources from which it can be obtained.

Constraints in accessing and uptaking climate change information by smallholder farmers is also linked to lack of proper infrastructure, such as electricity in rural areas. This is associated with poor distribution of electricity in the rural parts of Tanzania. Furthermore, even if the rural areas are supplied with electricity, they experience frequent power outages, which hinders them from using their communication tools such as radio, mobile phones and television to access climate change information (Kapinga *et al*., 2020).

2.5 Strategies for Improving Access to and Uptake of Climate Change Information by Small-Holder Tomato Growers

Information sharing is recognised as one of the strategies to assist the dissemination of information to rural-based subsistence farmers (Mapfumo *et al*., 2016). Rural communities' social networks based on their kinship, ethnicity and age among others may enable access to and communication of climate change information (Kolawole *et al.,* 2016; Egeru, 2016). Such information communication is acknowledged to improve the perceived salience, credibility and legitimacy of the information crucial for improving information uptake by smallholder farmers (Lemos *et al*., 2012; Jones *et al*., 2000).

To improve access to and uptake of climate change information by smallholder rural farmers, Msuya (2021) is of the view that training organs should conduct training needs assessment through participatory approaches to identify relevant knowledge, skills, attitudes and new ways of extension service delivery needed to build capacity of extension workers for enabling them to perform their roles effectively for improving performance of the agricultural sector.

Moranga *(*2016) commented that smallholder farmers can cope with climate change through practices such as early preparation of land, changing planting dates, increasing the frequency and timeliness of weeding and using early maturing crop varieties when they are provided with current, relevant and the most accessible information aimed at creating awareness.

Media such as radio play a major role in the dissemination of development messages, including climate change to both rural and urban communities across the country. Establishment of local FM radio stations covering the entire country and broadcasting largely in local languages and location-specific information may act as facilitating factors for ease of understanding of the communicated messages about climate change information (Tenywa *et al*., 2017).

3. RESEARCH METHODOLOGY

This study was conducted in Morogoro and Iringa regions. The study adopted a cross-sectional research design that enables data to be collected at a single point in time to capture important aspects and allow for questionnaire survey (Sedgwick, 2014). Multistage sampling technique was used to obtain the sampling units. In the first stage, Iringa and Morogoro were purposively selected. Purposive sampling technique was also used to select two districts: one district from each region. Purposively selected districts were Mvomero in Morogoro region and Kilolo district in Iringa region. These districts were selected because of their prominence in smallholder tomato production and their vulnerability to the adverse impacts of climate change, such as erratic and unreliable rainfall, drought, floods, low food and crop production, outbreak of pests and diseases, among others (URT, 2013; Paavola,2008; URT, 2012; Sangeda *et al*., 2013; Mutayoba and Ngaruko, 2018; Jalango, Begasha, and Kweka, 2020).

One ward was purposively selected from each district. The selected wards were Mlali (Mvomero) and Ilula (Kilolo) and from each ward, one village was then selected, which are Kipera (Mlali) and Image (Ilula). Kipera and Image villages were selected because they are among the areas where smallholder growers predominantly produce tomatoes. Also, these villages have large proportions of their communities who engage in small-scale tomato growing activities. The sample size for this study was 183 smallholder tomato growers in Morogoro and Iringa, drawn from a population of 400 smallholder tomato growers. Using a systematic random sampling strategy, 90 smallholder growers were randomly selected from a sampling frame obtained from Image Village Agricultural Extension Office (VAEO). Additionally, using sampling frame obtained from Mlali Ward Agricultural Extension Office, 93 smallholder growers were randomly selected from Kipera village. Simple random sampling technique was used to ensure that all smallholder tomato farmers had an equal chance of being included in the study. Both quantitative and qualitative approaches were used as data collection methods. Using the Drop-Off and Pick-Up (DOPU) method recommended by Allered and Ross-Davis (2011), quantitative data was collected using semi-structured questionnaires, while semi-structured interviews were used for qualitative data.

Purposive sampling technique was also used to select six key informants (KIs) from each village, making 12 KIs who were comprised of experienced tomato growers, agricultural extension officers, environmental officers, ward leaders, village leaders and the elderly. Quantitative data collected from the survey (questionnaires) were analysed using IBM Statistical Product and Service Solutions (SPSS) Statistics Version 21, based on descriptive statistics such as frequencies and percentages. Since descriptive statistics were not sufficient to determine significant relationships between dependent and independent variables, Chi square tests were used to determine the association between variables. Creswell (2007) opined that quantitative data analysis is a systematic process of both collecting and evaluating measurable and verifiable data. It contains a statistical mechanism of assessing or analyzing quantitative data. SPSS

was used in this study because it is a strong data analysis software, especially useful for analysing large-scale survey data.

Qualitative data was analysed using content analysis, in which phrases and issues that commonly recurred during the discussions were sorted to establish themes that captured something important about data in relation to the research questions (Braun and Clarke, 2006).

4.0 RESULTS AND DISCUSSIONS

4.1 Factors Encouraging Access to and Uptake of Climate Change Information by Smallholder Tomato Growers

4.1.1 Socio-Demographic Profile of the Respondents

Demographic characteristics of the respondents in this study include sex, education, marital status and age. Such characteristics are important as they influence access, use of information and the choice of sources of information used by smallholder tomato growers to get information about climate change. Findings in Table 1 indicate that of the total 183 respondents, the majority (132; 72.1%) were males, whereas only (51; 27.9%) were females. This indicates that the tomato crop is a male-dominant commercial crop mostly grown by smallholder farmers aged between 19 to 58 years old. This age group comprises the most productive labour force of the study population (youth and middle-aged population), compared to low age or high age of the population, who may not be able to actively participate in tomato farming activities because of their tender or old ages. Youth provide a bulk of the farm labour, such as land preparation, planting and harvesting (Mutayoba & Ngaruko, 2018). This means that smallholder growers start to engage in tomato cultivation from early age in their youth, and they continuing doing so for longer periods of time, i.e. for up to 39 years, before they get retired. Other studies (e.g. Muema *et al*., 2018; Sanga & Elia, 2020) have shown that young farmers are more reactive and responsive to the adverse effects of climate change. Younger farmers are more likely to adopt new technologies aimed at responding to the adverse effects of climate change because of their capability and readiness to seek and access multiple sources of climate change information. This may be associated with the current trends of learning institutions' efforts in establishing curricula that incorporate environmental issues, including climate change, hence enhancing younger peoples' likelihood to access and uptake of climate change information.

Furthermore, the longer periods spent in tomato growing may help farmers to gain more experience on how they can access and uptake climate change information for a rational decision-making process. These findings differ from the previous study by Guodaar and Asante (2018), who reported that the farming population in the Offinso North District of Ghana comprised of relatively young people, aged between 31 and 40 years, the group with a relatively greater potential for sustainable tomato cultivation. Pertaining to age and use of climate change information, the results in Table 2 indicate that there is a significant association between the use of climate change information and age ($p = 0.003$). This finding implies that smallholder tomato growers' ability to use climate change information is influenced by their ages.

Regarding marital status, more than half (127; 69.3%) of the smallholder tomato growers comprised of married couples. Of the total 127, more than half (70; 38.3%) of

the married smallholder tomato growers are from Kipera Village. The findings imply that tomato growing is performed more by married couples in Kipera village in Morogoro than their counterparts in Image village in Iringa. Guodaar and Asante (2018) observed that generally, the married respondents might have family labour, particularly children, in their tomato growing activities that require a substantial labour force. Labour force is highly needed in the preparation of land, planting, cultivation, weeding, irrigation, fertilizer application, pesticides application, harvesting and transportation of the products to the market (Kiros, 2008). An increased family size increases chance of accessing climate change information, because a bigger family needs to produce more food for livelihood sustenance; hence the need for information to improve farming practices. This indicates that there is a gender sensitivity, synergy, the need for more information and sustainability in tomato growing in the study areas. This may also positively influence the acquisition and uptake of climate change information among smallholder tomato growers in the study areas for awareness creation. Deressa *et al*. (2009) posited that households with more members are more likely to adapt to climate change due to a readily available labour force that increases the demand for climate change information. A Chi-square test involving farmers' marital status and the use of climate change information produced χ^2=0.892; df=3; p=0.001 (Table 2). The findings imply that farmers' marital status significantly influences the use of climate change information by smallholder tomato growers.

More than half (118; 64.5%) of respondents had a primary school level of education followed by those with ordinary level secondary school education (31;17%), non-formal education qualification (19; 10.4%), diploma education level (10; 5.5%), certificate (3; 1.6%) and those who had university education qualifications were only (2; 1%). These findings imply that most of the tomato growers in the study areas had primary school education, followed by those with secondary school level of education and approximately only one-tenth of the respondents comprised of all those who did not attain even a minimum level of education. Low levels of education may hinder smallholder tomato growers in acquiring and uptaking scientific climate change information. Levels of education and use of climate change information was determined. The Chi-square test in Table 2 showed χ^2=3.631; df=5; p=0.004. This indicates that there is a positive relationship between education and adaptation strategies to climate change. Nor-Diana (2021) reported that educational level plays an important role as an indicator in measuring the success of the climate change adaptation strategies. This implies that the more educated farmers are more likely able to cope with and adapt to the adverse impacts of climate change. This is an indication that education plays a major role in creating awareness, which, in turn, will assist farmers to apply appropriate climate change adaptation measures. According to Abid *et al*. (2017) and Deressa *et al*. (2009), educated people make better use of climate forecast information in their agricultural activities because of their advanced intellectual capabilities that allow them to understand agricultural practices related to changing climatic conditions.

On the other hand, smallholder tomato growers with no formal education prefer to seek information from broadcast media, through watching television and listening to the radio - a practice that does not involve reading and writing capabilities. This means that getting information from agricultural agents, agricultural input vendors and from friends and neighbours through word-of-mouth may be helpful to them because they cannot seek information from print media due to their inability to read and write. This implies that information repackaging should take into consideration the literacy levels of such groups of farmers.

Table 1: Socio-Demographic Profile of the Respondents

Category	Frequencies	Percent
Sex:		
Males:		
Kipera Village	75	41.0
Image Village	57	31.1
Females:		
Kipera Village	18	9.8
Image Village	33	18.0
Age Distribution		
Below 18	10	5.5
19-28	33	18.0
29-38	49	26.8
39-48	45	24.6
49-58	31	16.9
59-68	12	6.6
69+	3	1.6
Marital Status:		
Kipera Village:		
Single	19	10.4
Married	70	38.3
Divorced	2	1.1
Widower	2	1.1
Image Village:		
Single	28	15.3
Married	57	31.1
Divorced	1	0.5
Widower	4	2.2
Education Levels:		
Kipera Village:		
None	9	4.9
Primary	69	37.7
Secondary	12	6.6
Certificate	0	0
Diploma	2	1.1
University	1	0.5
Image Village:		
None	10	5.5

Primary	49	26.8
Secondary	19	10.4
Certificate	3	1.6
Diploma	8	4.4
University	1	0.5

Table 2: Chi-Square Tests for Relationship Between Age, Marital status, Gender, Education Levels, Income, Land Ownership and Use of Climate Change Information

Category	**Use of climate change information**		
	Value	**Df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square			
Gender	0.493*	1	.003
Age	3.018*	6	.003
Marital status	0.892*	3	.001
Sex	2.722*	1	.002
Educ. Level	3.631*	5	.004
Income	1.196*	4	.002
Land ownership	1.106*	7	.004
N. of Valid Cases	**183**		

4.1.2 Climate Change Awareness

Smallholder tomato growers were asked to indicate whether they were aware of climate change. The majority (151; 82.5%) of the respondents said they were aware, while only (32; 17.5%) of respondents were not aware (Table 3). The previous study conducted in the peri-urban areas of Morororo indicate that majority of farmers were aware of climate change (Siyao & Sife, 2020). These findings imply that the majority of the smallholder tomato growers understand the concept of climate change. Understanding the concept of climate change does not ensure action to adapt, cope and mitigate. Nevertheless, findings suggest that, perhaps those smallholder tomato growers who understand the concept of climate change will consider engaging in seeking for information with regards to adaptation, coping and mitigation strategies against climate change.

Table 3: Climate Change Awareness Among Smallholder Tomato Growers

Category	**Responses**		**Means through which farmers became aware about climate change**				
Villages:	Yes	No	Training conducted by Agric. Ext. Officers	Seminars conducted by Environmentalists/Climate Change Scientists	Personal observations and experiences	Broadcasting media news such as Television and Radio	Reading from print media
Kipera	78(42.6%)	15(8.2%)	33(18.0%	52(28.4%)	8(4.4%)	0	0
Image	73(39.9%)	17(9.3%)	32(17.5%	37(20.2%)	15(8.2%)	14(7.7%)	2(1.1%)
Total	**151(82.5%)**	**32(17.5%)**	**65(35.5%)**	**92(50.3%)**	**23(12.6%)**	**14(7.7%)**	**2(1.1%)**

Furthermore, the findings of this study indicate that smallholder tomato growers became aware of climate change through various means, such as by attending seminars conducted by climate change scientists 92 (50.3%), training conducted by agricultural extension officers 65 (35.5%), personal observations and experiences 23 (12.6%). These findings suggest that seminars and training conducted by climate change scientists and agricultural extension officers were significant ways of disseminating climate change information among smallholder tomato growers in Kipera and Image villages for awareness creation. Furthermore, 14 (7.7%) of the respondents indicated that they were made aware through broadcast media such as television and radio, whereas only (2;1.1%) of all respondents indicated that they became aware of climate change issues through reading print media, such as books and articles, among others. These findings are contrary to the facts that broadcast as well as print media are the most accessible sources of information that can help people to raise public attention about climate change impacts through relevant climate information (Kapinga *et al*.,2020).

Media can also play the role of sensitising and undertaking various educational programmes on environmental issues that can influence public interest, commitment and awareness on the adaptation and mitigation strategies towards the impacts of climate change (URT, 2012). Other researchers (e.g. Chand, 2017) observed that broadcast media is an important information channel that transmits useful information about climate change to the public, thus it acts as an educational tool for raising awareness. Pearce *et al*. (2015) and Schäfer (2015) view television and radio as important tools for raising awareness and motivating wide support for climate change. This implies that smallholder tomato growers can adapt and mitigate negative impacts associated with climate change if they are aware and knowledgeable about this concept and its associated potential impacts. Actions associated with building mitigation and adaptive capacity may include communicating climate change information for building awareness about potential impacts of climate change.

Table 4: Smallholder Tomato Growers' Beliefs on the Causes of Climate Change

Villages	**Causes of climate change**		
	Anthropogenic activities	Natural phenomenon	Don't know
Kipera	60 (32.8%)	28 (15.30%)	5 (2.7%)
Image	62 (33.9%)	27 (14.75%)	1 (0.6%)
Total	**122 (66.6%)**	**55 (30.05%)**	**6 (3.3%)**

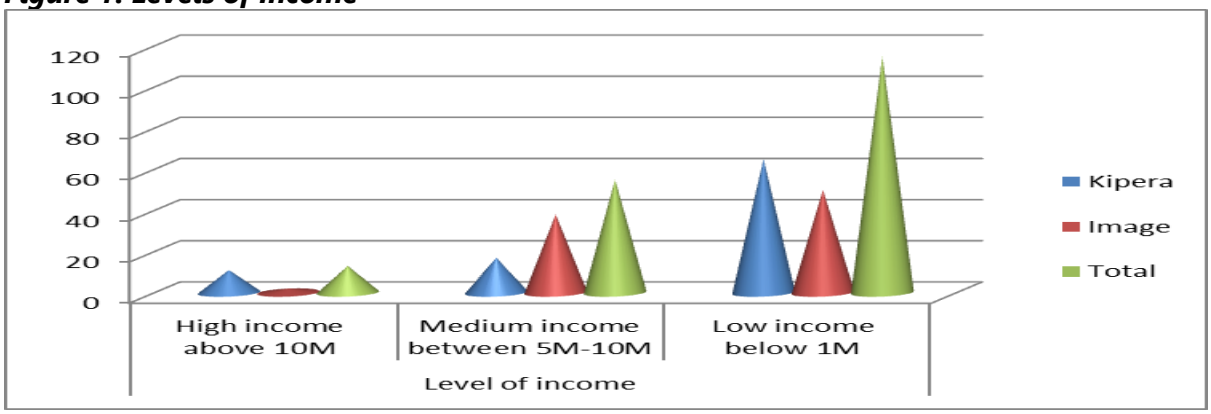
Smallholder tomato growers were asked to indicate their perceptions about the causes of climate change. Majority (122; 67%) of the respondents indicated that climate change is caused by anthropogenic activities, whereas far less than half (55; 30.5%) of the respondents indicated that climate change is a natural oriented phenomenon. These findings are similar to the observations from other authors (e.g. Gadzekpo *et al*., 2018 and Lund, 2019) who reported that climate change in the least developing countries is caused by natural and anthropogenic factors. This is very an interesting

discovery in that if smallholder tomato growers are knowledgeable about the causes of climate change, then this may predict their future participation in the acquisition of information with regards to climate change coping, adaptation and mitigation strategies in their localities.

4.1.3 Smallholder Tomato Growers' Levels of Income

Findings indicate that majority (63%) of the respondents had a low income followed by those with medium income (30%) while those who had high income were only (7%) (Fi.1).

Figure 1: Levels of Income



It has been acknowledged that efforts to adapt to climate change are reinforced by income. Farmers with steady incomes and who are financially stable tend to be more committed to adapting new techniques (Nor - Diana, 2021). According to Muema *et al*. (2018) and Dang *et al*. (2019), income affects access to and use of climate change information. Chi-square test was employed to determine the relationship between income and use of climate change information by smallholder farmers (p=0.003) (Table2). This implies that tomato growers' incomes influence their use of climate change information. According to these findings, tomato growers with higher incomes have more adaptive capacity to climate change and are more likely to adopt measures that might be expensive for others.

Table 5: Household Ownership of Communication Assets

	Cross tabulation of household owned assets						**Total**
Name of the Village	Radio	Television	Mobile Phone	Computer with internet connection	Radio, TV and Mobile phone	Radio, TV, Mobile phone and computer	
Kipera	26(14.2%)	10(5.5%)	47(25.7%)	0	10(5.5%)	0	**93(50.8%**
Image	11(6.0%)	6(3.3%)	31(17.0%)	1(0.54%)	40(22.0%)	1(0.54%)	**90(49.2%)**
Total	**37(20.2%)**	**16(8.7%)**	**78(42.6%)**	**1**(0.54%)	**50(27.3%)**	**1**(0.54%)	**183(100.0%)**

Communication tools are significant for accessing and uptaking of information about climate change. Findings in Table 5 indicate that 78 (43%) of respondents owned mobile phones, 37 (20.2% owned a radio, 18 (8.7%) owned a television while only (1; 0.54%) owned a computer with Internet connection. Furthermore, the cross tabulation of findings indicates that of the total smallholder tomato growers, only (50; 27.3%) respondents owned a radio, a television and mobile phones. Use of information and communication technology (ICT) tools such as mobile phones, radio and television have been acknowledged to facilitate access to climate change related information for enhancing adaptive capacities among rural communities in Tanzania (Kapinga *et al*.,2020). Sife (2010) added that in the changing climatic scenario, such ICT communication tools could provide access to educational and other pieces of information which can be used to create awareness for adapting and mitigating the negative impacts caused by climate change. In the current study, mobile phones are only owned by less than half (43%) of the respondents comprising of 25.7% from Kipera village and only (17%) of respondents from Image village.

With regards to land ownership, 75 (41%) respondents indicated that the land on which they cultivated tomatoes was rented, less than one-third (52; 28.4%) indicated that they inherited, or they acquired the land as a gift of deed followed by those who had freehold land 17 (9.3%) (Fig.2). Mode of land ownership can further influence ownership of communication tools for acquiring and disseminating information about climate change among smallholder tomato growers. For example, farmers who own their own pieces of land can use them as collateral for enabling them to get access to credit facilities from financial institutions. Financial assistance can enable them to procure the requisite communication tools and farm inputs, which in turn will boost their adaptive capacities about the types of adaptation and mitigation strategies to be employed. The opposite is also true for the farmers who use rented and freehold lands (Guodaar & Asante, 2018). Domeher and Abdulai (2012) reported that lack of land ownership limits access to formal credit that is often attributed to the lack of acceptable insurance, resulting from the absence of formally registered land titles.

Figure 2: Land ownership

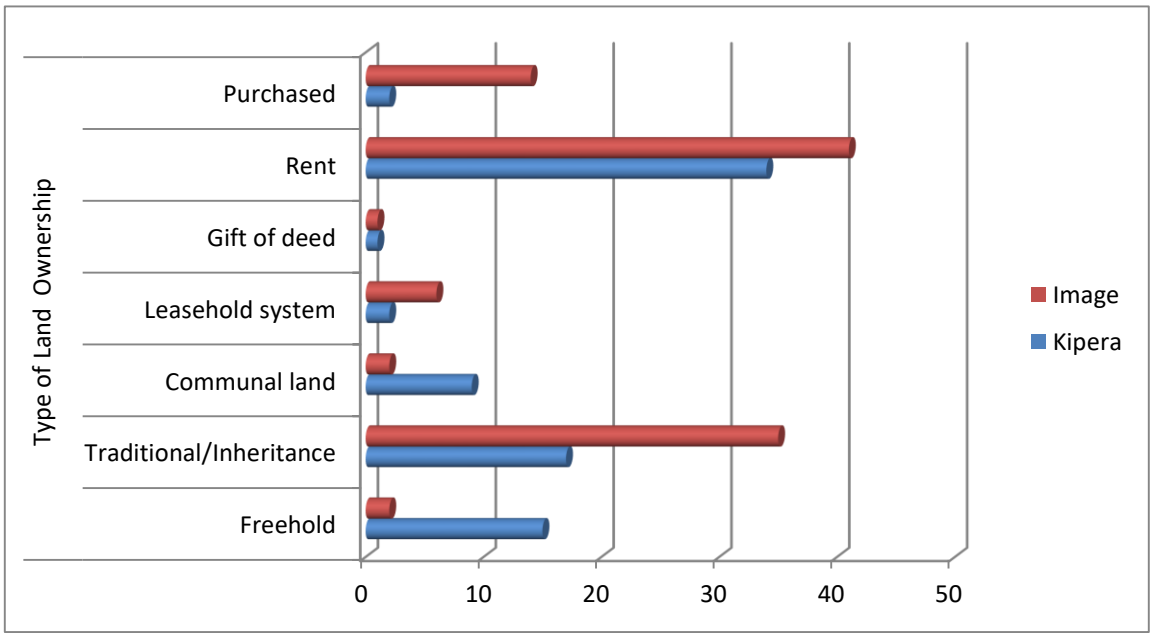
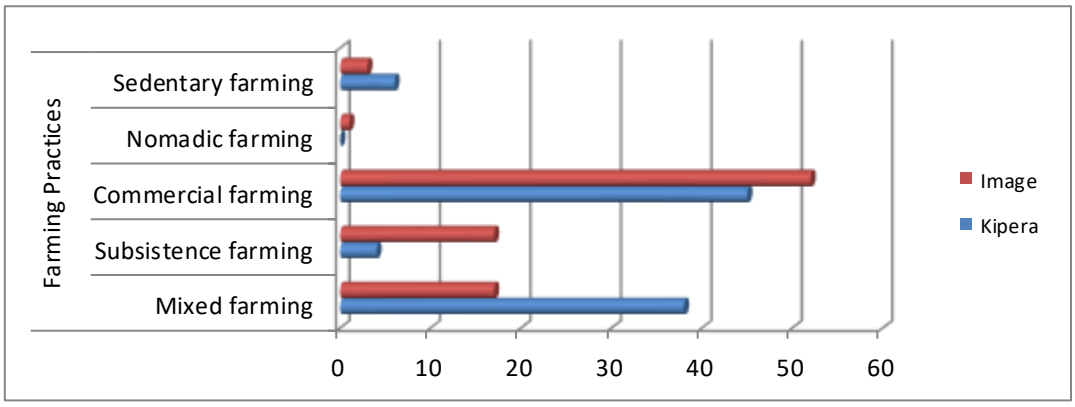


Figure 3: Types of Farming Practiced by Smallholder Tomato Growers



Findings indicate that more than half (97; 53%) of the respondents practiced commercial farming, followed by mixed farming (55; 30.1%) and subsistence farming (21; 11.5%) (Fig.3). Types of farming practiced by smallholder tomato growers can influence their access to and uptake of climate change information. Commercial farmings are more likely to attract more income, which enables farmers to acquire communications tools such as mobile phones, radio and televisions to enable them to access and use climate change information, as opposed to their subsistence farming counterparts, who are characterized by low-income earnings (Yaro, 2013).

4.1.4 Types of Climate Change Information Needed by Smallholder Tomato Growers

Respondents were asked to agree or disagree on the types of climate change information needed by smallholder tomato growers. The findings indicate that majority (175; 95.6%) of respondents agreed on drought-tolerant tomato seeds as the type of climate change information needed by tomato growers for climate change adaptation, disease-tolerant tomato seeds (173; 94.5%); application of pesticides (171; 93.4%), application of various fertilizers (170; 92.9%) and the least (124; 67.8%) of

respondents agreed on the harvesting time decisions as the type of information needed for climate change adaptation (Table 6).

Table 6: Climate Change Information Needed by Smallholder Tomato Growers in the Study Areas

Category of information needed		Agree		Disagree	
	N	F	%	F	%
Application of pesticides	183	171	93.4	12	6.6
Application of herbicides	183	163	89.1	20	10.9
Applications of various fertilizers	183	170	92.9	13	7.1
Tomato planting time	183	157	85.8	26	14.2
Information on temperature	183	165	90.2	18	9.2
Weather forecast	183	164	89.6	19	10.4
Information about drought	183	160	87.4	23	12.6
Drought-tolerant tomato seeds	183	175	95.6	8	4.4
Disease-tolerant tomato seeds	183	173	94.5	10	5.5
Market information	183	162	88.5	21	11.5
Tomato transportation costs	183	137	74.9	46	25.1
Soil characteristics	183	141	77	42	23
Tomato storage	183	141	77	42	23
Harvesting time decisions	183	124	67.8	59	32.2
Land use	183	142	77.6	41	22.4

These findings indicate that farmers needed different types of information on climate change to allow them to take scientific decisions on how to carry out their farming activities. These kinds of information are also important for enabling tomato growers to better manage opportunities and threats associated with climate change. An in-depth interview with one agricultural extension officer revealed that…

> "*There is a notable growing acceptance, recognition and realization of the benefits accrued from the need and use of climate change information for making quick, informed decisions related to tomato production, due to its perishability and sensitivity to the effects of climate change. Furthermore, a better link to climate change information with decision-making and better engagement between users and the providers of climate change information for addressing multiple farmers' needs, as well as consistent projections of climate change at regional and local scales is critical for better adaptation and therefore increased tomato production"*
>
> *(*Agricultural Extension Agent, Kipera village, March 2022).

The need for climate change information on diseases and pests in tomato production cannot to be overemphasized. One FGD respondent articulated that …

> *"Tomato plants in this area are normally attacked by pests such as leaf miner (tuta absoluta) and other diseases, such as leaf curl and black spot which are attributed to effects of climate change. Despite the increase in number of pests*

*and diseases, the productivity has, however slightly increased due to proper use of pesticides. Additionally, plastic house technology, use of hybrid tomato seeds, application of organic pesticides and fertilizers has increased tomato yield significantly (*Image village FGD' participant response, March 2022).

Findings indicate that smallholder tomato growers needed information on the use of improved and disease-tolerant tomato seeds, changes in timing of farm operations and use of pesticides. This kind of information is deemed useful for targeting increased tomato yields. In one of the interviews, it was revealed that farmers' need for climate change information was propelled by their need to adopt new technologies and selection of disease and drought–tolerant tomato seeds. Farmers' need for climate change information was also apparent during FGDs. During these sessions, it was revealed that farmers needed information on early preparations of land, soil characteristics, changes in planting dates and use of early maturing crop varieties. For instance, one FGD participant stated that*, "Climate change information needed by farmers is on crop diversification to counteract the effects of mono-cropping to our land"*.

4.2 Climate Change Information Used by Smallholder Tomato Growers

Considering that access to information does not necessarily guarantee its use, this study sought to identify the climate change information used by tomato growers. The findings indicate that majority (173; 94.5%) of the respondents agreed on the selection of tomato seed varieties as the climate change information used in their tomato growing and other farming activities, while the least (114;62.3%) agreed on the use of tomato storage information (Table 7).

Table 7: Climate Change Information Used by Smallholder Tomato Growers

Climate change information used by smallholder tomato growers	Agree		Disagree	
	F	%	F	%
Critical farm decisions in relation to land preparations	167	91.3	16	8.7
Selection of tomato seed varieties	173	94.5	10	5.5
Selection of time for planting tomato	170	92.9	13	7.1
Making choice for pesticides and insecticides	163	89.1	20	10.9
Updating market information of tomato	155	84.7	28	15.3
Understanding soil characteristics	128	69.9	55	30.1
Used for tomato storage information	114	62.3	69	37.7
Used for adaptation technologies	136	74.3	47	25.7

Findings show that tomato growers use climate forecast information to decide when to prepare their fields for tomato growing. The interviewed extension officer explained that "*Tomato growers in this area use climate change information to decide on the planting dates and improved tomato seeds, such as drought-tolerant tomato seeds for better yields*".

Similarly, one FGD participant stated that, "*Climate forecast information is used to determine time to prepare land and adjust planting dates*".

Findings further show that uptake of this information was limited by its untimely dissemination and unreliability. This suggests that tomato growers are unlikely to perceive the climate change information as useful when they are doubtful of its reliability. Mullins (2018) opined that perception creates individual behavioural responses to particular situations. It has been further observed that farmers in Tanzania do not use climate forecast information when making decisions on types of crops and animal husbandry activities because they consider it unreliable (Ajuaye, 2010). However, during the interview session, the extension officer stressed on the use of climate forecasts information. The officer said that… "*Tomato crop is very sensitive even to minor changes in weather conditions, thus reliable, timely and accessible climate change information is highly needed by tomato growers for creating awareness"*. Moreover, climate change information needs to be understood and demand-driven for the farmers to use it in their farm management decisions. During discussions, it was noted that although farmers in this study accessed climate and weather forecast information, few of them made effective use of it in their agricultural activities for decision-making. As such, those farmers who did not use the information missed out on the benefits they would enjoy by using the information, such as easing uncertainties surrounding production decisions (Komba & Muchapondwa, 2018; Muema *et al*., 2018; Iturriza *et al*., 2020).

4.3 Sources of Climate Change Information Used by Smallholder Tomato Growers

Findings in Table 8 indicate that relatives, friends and neighbours are the most preferred sources of acquiring information in the rural parts of Tanzania. The preference to such sources of information is attributed to the fact that they are the most trusted sources, mainly because the information is delivered through word-of-mouth, there is physical contact, which makes room for clarification regarding the questions asked. These findings corroborate the study conducted by Sen *et al*. (2022), who reported that informal channels such as relatives, friends, neighbours and community meetings (URT, 2012; Chang'a *et al*., 2010; Egeru 2016) are important sources of information for raising awareness about successful climate change adaptation options.

Radio is an effective medium through which rural farmers such as smallholder tomato growers can access information about climate change. Authors like (Chand, 2017; Nor-Diana *et al*., 2021) reported that broadcast media such as radio are one of the important information channels that could quickly transmit useful and up-to-date information about climate change to farmers for decision-making. Radio acts as an educational tool for raising awareness. Useful information received by farmers from radio and shared can gradually bring changes in farming methods by applying new agricultural technologies (Khanal, 2011; Ango *et al*., 2013). Farmers can prepare for mitigation and adaption to the negative effects of climate change only if they understand it and they know its impacts (Farm Radio International, 2009).

Table 8: Sources of Climate Change Information Used by Smallholder Tomato Growers

		Frequently used		Occasionally used		Never used	
Sources of climate change information	N	F	%	F	%	F	%
Workshop and seminar	183	42	23.0	22	12	86	47.0
Extension agents	183	73	39.9	24	13.1	113	61.7
Researchers	183	46	25.1	24	13.1	89	48.6
Community groups/ meetings	183	77	42.1	27	14.8	97	53.0
Social media	183	65	35.5	21	11.5	57	31.1
Television	183	101	55.2	25	13.7	26	14.2
Radio	183	134	73.2	23	12.6	26	14.2
Newspapers	183	52	28.4	25	13.7	113	61.7
Posters	183	46	25.1	30	16.4	42	23.0
Mobile phones	183	114	62.3	17	9.3	39	21.3
Relatives, friends and neighbours	183	144	78.7	14	7.7	84	45.9
Leaflets	183	66	36.1	33	18	107	58.5
Agricultural show events/exhibitions	183	55	30.1	21	11.5	145	79.2
Library	183	24	13.1	14	7.7	117	63.9
Training programmes	183	35	19.1	31	16.9	60	32.8
Fellow farmers	183	111	60.7	12	6.6	39	21.3
Personal observation	183	122	66.7	12	6.6	39	21.3

Rural populations can have their own community radio stations, which are normally operated, owned and financed by the communities they serve (Al-Hassan, 2011). Such community radio stations can enable rapid and accurate dissemination of information on various issues like climate change (CSDI, 2009). Lwoga (2010) adds that community radio stations have also been effective in reaching resource-poor farmers across great distances in Tanzania. In Morogoro and Iringa, there are FM radio stations. For example, Abood and Planet FM radio stations are in Morogoro Municipality, whereas Furaha FM, Ebony FM, Country FM and Nuru FM radio stations are in Iringa region. Others are like TBC FM, Radio One and Radio Free Africa (RFA) which are in Dar es Salaam and Mwanza regions, respectively.

Advantages of radio as a tool for disseminating various types of information have been acknowledged. Radio enables rural communities to overcome problems of distance, illiteracy and language diversity better than any other media (RTS, 2009; URT, 2012). Radio can also be used by rural farmers with low literacy levels to easily access and understand what is being broadcast, because even vernaculars are used, and even farmers with low income can afford to buy one (FAO, 2001). Muema *et al*. (2018) reported that vernacular languages enhance the utilisation of climate change information by all farmers. Furthermore, with advancement in technology, nowadays people can use mobile phones to access FM radio frequencies, which in turn helps them to access broadcast information at their own convenient places and times. These findings are similar to the study conducted in the rural parts of East Africa by Kirui *et*

al. (2014) and Kapinga *et al*. (2020). In those studies, it was reported that broadcast media such as radio are used to access climate change adaptation and mitigation related information by most of the rural dwellers for enabling them to respond appropriately to the negative impacts of climate change.

In this study it was further found that more than half (122; 67%) of the respondents used personal observations as a source of information about climate change**.** Personal observations are based on the indigenous knowledge (IK) of the smallholder tomato growers in the study areas. Smallholder tomato growers indicated that through IK, they could for example, predict the onset of rainy seasons and adaptation that enabled them to prepare for their farming activities. Kirui *et al*. (2014) posted that elderly people preferred IK for accessing climate change information.

Mobile phones are other important sources from which farmers can access information about climate change. Singh *et al. (*2016) acknowledged that the use of mobile phones, especially smartphones, could enable farmers to receive timely and relevant climate change agro-advisory services to improve their farms' productivity. Farmers' preference to access information using mobile phones may be attributed to the fact that 78 (42.6%) of the respondents in the study areas are in possession of these ICT tools (Table 5), and they possibly know the importance of using them to access climate change information for decision-making with regards to tomato growing activities. In one of the interviews with smallholder tomato growers, one respondent posted that, *"I normally use my mobile phone to get information about availability of agricultural inputs from local vendors and information about the price and market for my tomato produce"* (Tomato grower, Image Village, March 2022).

Findings indicate that experienced fellow farmers were yet another source of climate change information for smallholder tomato growers in the study areas. This information seeking behaviour is attributed to the fact that some farmers in rural settings do not own ICT tools such as televisions and radios, and they lack extension services from extension agents. In that scenario, the rural farmers prefer to consult fellow farmers to meet their information needs concerning tomato growing activities and climate change issues.

It has also been acknowledged that the interpersonal sources of information in developing countries are preferred and more trusted, due to the nature of how societies interact and information sharing through the word-of-mouth. These sources offer comparatively easy access to climate change information, as farmers who are resource constrained incur less costs to access information. The interview with tomato growers yielded that, *"I like to seek information from my fellow tomato growers because I feel free to do so without being shy, even by using our own vernacular for better understanding*" (Tomato Grower, Kipera Village, March 2022).

Another respondent was quoted as saying*:*

"I like seeking information from my fellow tomato growers in this village because it is the cheapest method of gathering information, as it doesn't cost me even a single penny. I share many things with my fellow farmers, and thus they cannot charge me anything just for asking them questions and seeking clarifications" (Tomato Grower, Image village, March 2022)**.**

The findings indicate that respondents cited a television as an important communication channel used by smallholder tomato growers in the study areas to access climate change information. Compared to other communication tools, television gives quick, reliable and well-packaged information regarding various issues because it involves the senses of both listening and seeing, and in top of it, information is provided in a more appealing manner so that most of it is adopted (Halakatti *et al*., 2010). Kirui *et al*. (2014) added that television is preferred because it involves visual communication of location-specific information.

4.3.1 Never Used Sources of Climate Change Information by Smallholder Tomato Growers

The findings in Table 7 indicate various sources of information which were not used by smallholder tomato growers, such as agricultural exhibitions (79.2%), Mkulima Library (63.9%); extension agents (61.7%); newspapers (61.7%), community groups/meetings (53%), researchers (49%), workshops and seminars (47%).

Every year the Tanzanian Ministry of Agriculture conducts agricultural exhibitions in various parts of the country for the sole purpose of enabling all agricultural stakeholders to have an opportunity to see and learn modern agricultural practices, among others. The event, which is commonly known as 'Nane Nane', involves agricultural exhibitions that are held in different regions in Tanzania, such as in Mororogo for eastern zone regions, Dodoma, Southern Highlands for Iringa, Njombe and Mbeya regions, Northern Zone for Arusha, Kilimanjaro, Manyara and Tanga regions, among others.

Despite the importance of agricultural exhibitions, the majority of smallholder tomato growers in the study areas indicated that they did not take trouble to attend such exhibitions. Various reasons for not attending agricultural exhibitions such as costs were given. Various interviews with smallholder farmers captured the following responses:

*"Agricultural exhibitions for the Southern Highlands regions are conducted in Mbeya region. We would like to attend but the location in which the exhibitions take place is very far from Iringa region and one needs money for transport, food and accommodation for the complete scheduled period of the event. Thus, only sponsored farmers can afford to attend." (*Respondents from Image Village. March 2022*).*

Respondents from Kipera village- Morogoro region attested that:

"Nane Nane agricultural exhibitions take place in Morogoro Municipality, a little bit far from here. Fare to attend the event is affordable but time constraint is a major hindrance".

This is an indication that smallholder tomato growers are willing to attend such events, but they are financially and time constrained.

Library was another source of information that was not used by smallholder tomato growers. In Morogoro region, smallholder farmers can access information from the Regional Public Library, located at the centre of Morogoro Central Business Area (CBA) and Sokoine National Agricultural Library (SNAL), where '*Mkulima'* (Farmer's Library) is hosted. Likewise, Iringa region is endowed with a Regional Public Library, Ilula Orphanage Programme Information Centre (IOPIC) and Ilula Telecentre as well, that can be used for acquiring various information, including information on climate change. However, the findings indicate that most smallholder tomato growers in these areas do not utilize the available Public Library Services and information centres because these services are not available in their vicinities. To get such services, farmers have to travel from Mvomero District to Morogoro CBA, whereas as for Image village, the farmers must travel for more than 60 kilometres from Kilolo District to Iringa CBA, where the Iringa Regional Public Library is located. This means that the financial cost and the time involved hinder farmers from accessing the services provided by the Public Libraries in both villages. Additionally, non-use of library as a source of information may be attributed to the fact that most people in rural areas lack a culture of reading and they consequently do not see the need to visit a library. A reading culture needs to be cultivated to make it a daily activity for promoting individuals' lifelong learning skills, where they apply critical thinking and problem-solving skills (Wema, 2018). On the other hand, smallholder tomato farmers stated that Ilula IOPIC and Ilula Telecentre were not used by farmers because of multiple reasons, such as perceptions and lack of awareness about the role of these centres. An interview with an elderly person and experienced tomato grower in Image village revealed the following:

"*Smallholder tomato growers do not have a tendency of visiting the available information centres because of the perception that the* IOPIC *has nothing to offer to the tomato growing business, as it deals with orphanage-related issues. With regards to Ilula Telecentre, the reality is that I have never visited the centre and therefore I don't know anything about it" (*Smallholder tomato grower, Image village, March 2022).

The role of agricultural extension in the development of agriculture has been acknowledged by authors like (Anaeto *et al.,* 2012), who posited that a nation cannot achieve real growth in the agricultural sector if there are no effective agricultural extension services. However, the results of this study indicate that smallholder farmers did not adequately use extension agents as one of the sources of information. The farmers further indicated that they experienced poor contacts with extension agents. This is an indication that there is inadequate number of extension workers in Tanzania,

which is a hindrance for smallholder farmers to access information. These findings are similar to that of Antwi-Agyei *et al* (2021), who posited that inadequate number of extension agents in the rural areas make it difficult to deliver information to smallholder farmers in a timely manner.

It has been reported that newspapers are important sources of information for raising people's awareness and influencing behavioural change about climate change (Shrestha 2002; Falaki and Adegbija,2013; Schmidt *et al*.,2013; Chand, 2017 and Harris, 2017). However, in this study it was found that smallholder tomato growers did not use newspapers as one of the sources of acquiring climate change information. This is compounded by the fact that there is poor newspaper circulation in the rural areas. In this study, it was also observed that there were no newspaper vending centres in those areas. Cost is yet another reason for newspapers not being circulated in the study areas. Lunyelele *et al*. (2016), posited that access to information in newspapers comes with the direct cost of buying a copy. This may be a barrier for the readers who do not have a stable income to buy serious newspapers with reliable information. This is an indication that low income hinders potential readers from buying newspapers which would enable them to access climate change information (Siyao & Sife 2020). These findings are in congruency to the study by Yohanna *et al*. (2014), who reported that most of the relevant climate change information in the newspapers might not reach the intended audiences because of the cost barrier.

Seminars and training workshops are important sources for farmers' adaptation training to climate change, as they play an important role of strengthening the concerted efforts and actions of individuals and government support through awareness creation (Nor-Diana, 2021). Nevertheless, the findings of this study indicate that smallholder tomato growers did not source out information from seminars and training workshops about climate change. An interview with a smallholder tomato grower in Image village revealed the following: *"I don't remember the last time I attended a training seminar or a workshop which was conducted in our village*. (Smallholder Tomato Grower, Image village, March 2022*)*. This indicates that training for climate change adaption related practices is not provided to rural farmers.

4.4 Barriers that Impede Tomato Growers to Access and Uptake Climate Change Information

Findings in Table 9 indicate that there are various challenges that impede tomato growers to access and uptake climate change information for decision-making processes. Respondents indicated that they could not access and uptake climate change information because it was not clearly understood. Clear understanding of climate change information acts as a motivation to its access and uptake by users.

Absence of accessible libraries and information centres was cited as another barrier to accessing and uptaking of climate change information. Availability of public libraries and information centres in the smallholder tomato growers' areas could be one of the

points at which the readers might access climate change related information easily. These findings are consistent with Lund (2019) and Agyemang (2017), who reported that libraries are scarce in most developing countries. The library users regard scarcity of libraries as an impediment to accessing various types of information.

The unavailability of extension services is without a doubt an obstacle for the farmers to access information. Extension officers are key change agents for the provision of agricultural information to farmers. With the help of information from extension services, farmers can transform their reliance on IK for combating climate change into smart agriculture (Mullins et al., 2018). Inaccessibility of extension officers reduces efforts to minimise adverse effects of climate change in developing countries, where the impacts are severe. In one of the interviews, one respondent indicated that,

*"Generally, extension officers are very few. On top of that, these extension officers do not visit our farms when we request them for consultations, as a result, we tend to use our own experiences through IK to deal with threats caused by climate change" (*Tomato grower, Kipera village, March 2022).

In one of the FGDs' sessions, it was revealed that farmers do not visit extension workers' offices of their own volition, even when they are available. Only few farmers reported that they obtained information on climate change from extension officers through village meetings. Similarly, another participant in FGD revealed that farmers' inability to get information from extension officers was largely due to their lack of recognition of the value of extension services in their farming operations, high level of illiteracy among farmers, difficulties in understanding technical language used in communicating climate information and misalignment between the climate information provided and what smallholder farmers actually need (Antwi-Agyei, Dougill & Abaidoo,2021). Climate change information needs to be linked directly to agricultural impact and management of decision-making, to ensure that it is both available and useable by smallholder farmers.

Table 9: Barriers in Accessing and Uptaking Climate Change Information by Smallholder Tomato Growers

Barriers to accessing and uptaking of climate change information among smallholder tomato growers		**Never a barrier**		**Moderate a barrier**		**Extremely a barrier**	
	N	**F**	**%**	**F**	**%**	**F**	**%**
Format of information delivered	183	70	38.3	25	13.7	88	48.1
Language used cannot be easily understood	183	62	33.9	28	15.3	93	50.8
Poor understanding of information delivered	183	58	31.7	32	17.5	93	50.8
Inadequate time to listen and watch TV	183	64	35.0	32	17.5	87	47.5
Inadequate number of extension agents	183	65	35.5	28	15.3	98	53.6
Lack of skills and knowledge	183	52	28.4	20	10.9	111	60.7
Lack of libraries and information centres	183	41	22.4	17	9.3	125	68.3
Inadequate income to buy TV, Radio and newspapers	183	41	22.4	17	9.3	125	68.3

Excessive costs of getting climate change information	183	60	32.8	38	20.8	85	46.4
Lack of electricity and the batteries are very expensive	183	50	27.3	24	13.1	109	59.6
Inadequate information	183	61	33.3	34	18.6	88	48.1
Lack of seasonal forecast for long-term planning	183	47	25.7	28	15.3	108	59
Low accessibility of climate change information	183	61	33.3	44	24	78	42.6
High level of illiteracy	183	65	35.5	8	4.4	110	60.1
Climate change information is not clear	183	31	16.9	20	10.9	132	72.1
Misalignment of information provided, needed and timeliness of weather forecast	183	48	26.2	38	20.8	97	53
Socio-cultural barriers (norms, values**)**	183	44	24.0	33	18	106	57.3
Lack of trust/reliability of the sources of information	183	38	20.8	31	16.9	114	62.3

Inadequate income to buy TV, radio and newspapers was reported as a barrier to accessing climate change information by the smallholder tomato growers. Television and radio ownership or ability to buy newspapers depends on the purchasing power of the rural farmers. In this study, it was found that majority (63%) of the respondents had a low income, whereas only (27%) of the respondents owned the requisite ICT communication tools (Fig.1 & Table 5). These findings imply that income predicts ownership of household assets of the smallholder tomato growers in the study areas. Muema *et al*. (2018) and Dang *et al*. (2019) reported that socio-economic factors such as income affect access to and use of climate change information. Low ownership of communication assets is linked to the effect of excluding smallholder farmers from accessing useful information (Luseno *et al*., 2003; Kangalawe *et al*., 2017). Chang'a *et al*. (2010) reported that a high proportion of smallholder farmers in the rural setting in developing countries, such as Tanzania, lack physical income which would enable them to afford acquisition of communication tools.

Lack of trust/reliability of the sources of information was cited as another barrier to the access and uptake of climate change information in the study areas. Perhaps this is because sometimes, information about rainfall patterns forecast provided by the Tanzania Meteorological Agency (TMA) is not always reliable and not received in a timely manner. These findings resonate with the study by Muema *et al.* (2018), who reported that lack of trust and unreliability of the climate information services are the main hindrances to the utilization of climate information services. The findings are also in resonance with that of Elia (2014) who reported that sometimes farmers tend to criticize the truthfulness of the information they receive from the TMA for not being explicit on the rainfall distribution in a given geographical locations and seasons. In one of the interview sessions, one respondent pointed out that*, "The major challenges associated with dissatisfaction of the information were the inaccuracy and contents of information provided by TMA*."
(Smallholder Tomato Grower, Kipera village, March 2022).

This suggests the need for the provision of reliable, trusted and understandable information on climate change for utilizing it to adapt, cope and mitigate against

climate change. The findings corroborate the study by Sen et al. (2022), who reported that users may not trust the information or are unable to analyse the information and therefore do not use this information for decision-making.

Concerning lack of skills and knowledge, respondents agreed that they did not have sufficient knowledge about climate change. Smallholder tomato growers' insufficient knowledge about climate change is linked to poor information-search strategies. Furthermore, insufficient knowledge is perhaps associated with a lack of climate-change-relevant subject matter understanding (Siyao &Sife 2021).

Pertaining to the issue of illiteracy, respondents admitted that low literacy affects their ability to access and uptake climate change information. Illiteracy makes it difficult for the farmers to understand the information communicated through print or broadcast media, because it is often written or broadcast in unfamiliar languages. In this case, only those who can read and understand those languages, such as English, can access and use the information about climate change. These findings are in congruency to the study by Momudu (2002), who cited illiteracy as the major barrier against obtaining various types of information by most rural farmers in Africa. Smallholder tomato growers with low levels of literacy depended on other sources of information, such as word-of-mouth from friends, neighbours and agro-chemicals input vendors. In one of the interviews, one smallholder tomato grower attested that:

> "*Because of my inability to read and write, I normally seek information from agricultural input vendors in our area"* (Smallholder farmer, Image village, March 2022).

Findings further indicate that respondents could not access and uptake climate change information because of lack of electricity and batteries are very expensive. Poor distribution of electricity in rural areas, frequent power outages, high prices of dry cells, coupled with unreliable network coverage, are some of the impedances for the rural smallholder farmers to use their ICT communication tools, such as televisions and radios to access and uptake broadcast information. These findings corroborate that of the study by Ugboma (2010) who identified unreliable supply of electricity as among the factors hindering access to information by rural smallholder farmers.

Smallholder tomato growers indicated that they could not access and uptake climate change information because of the lack of seasonal forecasts for long-term planning. This is associated with the fact that smallholder farmers were not provided with the seasonal forecast information in good time, which would enable them to plan for their long-term farming activities.

Findings indicate that language barrier, particularly the use of jargon or difficult concepts in explaining climate change issues, made it difficult for the smallholder tomato growers to access and uptake climate change information for decision-making. This is because sometimes climate change information is written and expressed in

technical terms that are difficult for common people to understand it. Other researchers like Lusino *et al*. (2003) reported that climate change information with technical complexity of content and use of technical terms and terminologies may not be easily understood by local communities. Dilling and Lemos (2011) and Perez *et al*. (2015) reported that climate change information becomes more accessible and usable when such information is delivered in language easily understood by the end-users.

Smallholder tomato growers indicated that inadequate time to listen and watch television was another barrier to access and uptake climate change information. Respondents indicated that they were not able to follow news broadcast through television because the programmes were explicitly described as too short and inappropriately scheduled. For the case of radio, the programmes were scheduled at times when farmers were busy with farming activities and thus, they could not listen to them. In this scenario, rural women are more affected because of being overwhelmed with domestic chores that cause them to experience time constraints to watch television and listen to the radio, as compared to their male counterparts. For example, it is a normal practice for rural women in Tanzania to be in the kitchen preparing evening meals or breakfast for their families, when it is a prime time for television and radio programme. According to Antwi-Agyei *et al*. (2021) time, constraints due to household labour commitments and chores on the part of women sometimes preclude them from watching television and listening to the radio, so as to obtain climate change information.

4.5 Strategies for Improving Access to and Uptake of Climate Change Information by Smallholder Tomato Growers

Farmers ranked the key strategies for improving access to and uptake of climate change information in the study area (Table 10).

4.5.1 Increase the Number of Extension Officers

Findings indicate that there is a need for the government to increase the number of extension officers as one of the strategies to improve access to and uptake of climate change information. Tomato growers acknowledged that, with reliable and accessible extension officers, farmers can easily make consultations on critical issues related to coping, adaptation and mitigation to climate change (Table 10).

Table 10: Farmers' Strategies to Improve Access to and Uptake of Climate Change Information Among Smallholder Tomato Growers

	Strategies for improving access and uptake of climate change information	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	Increase the number of extension officers and effectively use them on matters of climate change	√	√	√	√	√	√	√	√	√

2	Education and training on climate change issues to all farmers through seminars, workshops and field demonstration	√	√	√	√	√	√
3	Improve contents and timely delivery of climate change information on tomato growing	√	√	√	√		
4	Establish meteorological centres in the local areas (i.e. village, ward, district and regional level)	√	√	√			
5	Establishment of information centres for sharing experiences and a simplified manuals should be prepared on adaptation and mitigation strategies of climate change	√	√	√			
6	Agricultural show events or exhibitions at village levels of small-scale farmers	√	√				
7	Provision of specific and realistic research output for close link and trust between farmers and researchers	√					

The interview with one agricultural extension officer on the need for their services regarding climate change matters yielded that:

> *"There is a need for frequent and continued education provision to small scale farmers on climate change-related issues. Extension services enhance access and understanding of the climate change information by farmers. Information from extension officers enable farmers to adapt new agricultural technologies.*
> *Recently, the Minister responsible for agriculture in Tanzania invited Extension Officers in Dodoma where they were given Motorcycles for enabling them to easily visit rural farmers, the exercise which was officiated by Her Excellence President Samia Suluhu Hassan. The Minister further reiterated that the need to have Extension Officers in every village in Tanzania Mainland by the year 2025 is one of the government's top priorities. (*Agricultural extension agent, March 2022).

4.5.2 Education and Training on Climate Change

Findings of this study indicate that provision of education and training on climate change related issues is of particular importance to smallholder tomato growers. Education and training programs justify an on-going learning, planning and adjustments for increasing adaptive capacity to respond to the changing threats of climate change (Chaplin, 2017). Effective farmers' adaptation to climate change strategies requires an understanding of climate change information from different sources. In the perspective of small-scale farmers in developing countries, timely access to and uptake of relevant climate information, such as extreme weather and seasonal forecasts, as well as related agricultural production is necessary. Such information attests farmer's ability to cope with climate change-related threats and to make better-informed agricultural decisions. Education will increase a literacy level of smallholder tomato growers, which will in turn enable them to understand climate change issues, and thus they will be able to device appropriate adaptation strategies (Deressa *et al*., 2009). Muema *et al*. (2018) reported that educated farmers are expected

to actively search, grasp and apply information about climate change as compared to none-educated farmers.

At the local level, a lack of information restricts improvement in knowledge, understanding and skills needed in helping farmers to cope with the impacts of climate change and undertake strategic adaptation measures (Agrawala and Aalst, 2008). Closing this information gap is therefore essential for increasing access to and uptake of climate change information for reducing impacts of climate change to rural livelihoods. This can be achieved through continuing education and training of small-scale farmers through seminars, workshops and agricultural exhibitions (Chaplin, 2017).

4.5.3 The Contents and Timely Delivery of Climate Change Information

The contents of climate change information produced by the scientists need to be simple for most farmers to comprehend, fit the farmer's needs and which can be easily integrated into farmers' decision-making processes (Singh *et al.,* 2018; Onyango, Ochieng & Awit, 2022).

In one of the interviews, a participant said that:

> "*The contents of climate change information need to consider skills and levels of understanding of smallholder farmers. Specifically, the information needs to fit farmer's needs*".
>
> Another interview participant said that…
>
> "*There is a need to use simple language, simple formats and simple terms when delivering climate change information for improving access to and uptake of information by smallholder tomato growers*".

4.5.4 Establishment of Localized Meteorological Stations

Findings indicate that local meteorological stations are needed for providing timely and relevant climate change information. Climate information services at local level bridges the generation and application of scientific climate and agricultural information that will consequently offer great potentials to strengthen the ability of smallholder farmers to manage climate-related threats. Bryan et al. (2013) and Mahoo et al. (2015) reported that climate information services at local level support farmers' ability to adapt and strengthen their adaptive capacity to climate change. Other authors (e.g., Mapfumo *et al*., 2016; Tarchiani *et al*., 2017) acknowledged that developing countries are becoming increasingly aware of the need to establish meteorological centres for the provision of information on climate change to local farmers. The centres will enhance information uptake for informed decision-making process. Establishment of localized meteorological stations should go hand in hand with delivery of location-specific information on climate change.

5.0 CONCLUSION AND RECOMMENDATIONS

The findings of this study indicate that demographic characteristics of smallholder tomato growers are the major factors that influence the acquisition and uptake of climate change information. Furthermore, lack of clear understanding of climate change information coupled with lack of libraries and information centres, inadequate income to buy communication media, lack of reliability of climate change information and lack of skills and knowledge on climate change subject matter were barriers that constrained smallholder tomato growers to access and uptake climate change information in the study areas. Interventions strategies should be employed to overcome such constraining barriers.

5.1 Recommendations

i. Government and all other stakeholders should provide educational training programmes tailored to meet climate change information needs of farmers, so as to enable them to cope with the emerging challenges in order to enhance their productivity. To achieve this, the TMA should be sufficiently equipped to give accurate reliable, correct, relevant and timely accessible information to help farmers to cope, adapt and mitigate against the adverse impacts associated with climate change.

ii. The study recommends that the Government of Tanzania should use appropriate, reliable and accessible sources to provide farmers with relevant and timely information on climate change. As such, the study recommends that local and central government authorities should establish community information centres, community libraries, telecentres, localized meteorological stations and climate change information centres, to ease access and uptake of climate change information. This will consequently contribute to the National Climate Change Communication Strategy (NCCCS), whose aim is to raise public awareness on climate change adaptation, mitigation, opportunities and threats resulting from climate change at all levels.

iii. The study recommends that the government should align the provision of climate change information activities with farmers' information needs. Involving farmers and accommodating their needs when formulating policies on climate change is of crucial importance.

iv. Government should employ more agricultural extension agents at the village level, motivate them and get them trained on how to repackage climate change information that fits farmers' information needs for building their adaptive capacities and resilience to increase tomato production in the study area.

v. There is a need for public and private financial institutions to provide farmers with some financial support to enable them to get access to farming inputs such as agrochemicals, to improve tomato production levels, which will consequently

enable them to afford acquisition of communication tools for acquiring and disseminating climate change information.

vi. This study calls for cooperation between all stakeholders such as smallholder farmers, climate change researchers from both government departments and the private sector, extension agents, environmentalists and meteorologists to work in tandem for improving access to and uptake of climate change information among tomato growers, for awareness creation.

5.2 Areas for Further Research

i. Future studies may be carried out in other areas in different regions and districts using qualitative research approach to explore the factors that influence access to and uptake of climate change information among smallholder tomato growers in Tanzania.
ii. Further research may also be carried out to investigate the determinants of access to and uptake of climate change information to other perishable and commercial crops such as vegetables, onions, avocado and potatoes among others in Tanzania.

5.3 Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this research work.

5.4 Funding

The authors received financial support for the research from Research and Poverty Alleviation (REPOA).

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