

Breaking barriers in accessing and uptaking climate change adaptation information by smallholder tomato farmers in Tanzania

Climate
change
adaptation
information

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Abstract

Purpose – This study aims to assess barriers in accessing and uptaking climate change adaptation information among smallholder tomato farmers in Tanzania.

Design/methodology/approach – This study was conducted in Iringa and Morogoro regions, Tanzania. It adopted cross-sectional research design. Multistage, purposive and random sampling techniques with a sample size of 183 smallholder tomato farmers were used. Questionnaires containing closed- and open-ended questions, interview guide and focus group discussions were used to collect data. To ensure validity and reliability of data collection instruments, pretesting of the questionnaires was conducted by administering them to a small group of smallholder tomato growers. Statistical Product and Service Solutions software was used to analyse quantitative data while NVivo was used for analysing qualitative data.

Findings – Lack of clear understanding of climate change information (132, 72.1%), scarcity of libraries and information centres (125, 68.3%), inadequate income (125, 68.3%), lack of trust of sources of information (114, 62.3%), lack of sufficient knowledge about climate change (111, 60%), illiteracy (110, 60.1%), poor distribution of electricity in rural areas (109, 59.6%) and use of jargons (93, 50.8%) in explaining climate change adaptation issues are hindrances for smallholder tomato farmers to access and uptake climate change adaptation information.

Research limitations/implications – This study was conducted in only two districts in Tanzania; thus, the findings cannot be generalized.

Practical implications – The government and relevant agencies are recommended to use appropriate strategies for breaking the barriers that impede easy access and uptake of climate change adaptation information by smallholder tomato farmers as one of the interventions to combat the impacts posed by climate change.

Social implications – This study has contributed to the ongoing discourses on climate change issues. Such discourses have influenced attention and understanding of the role of access and uptake of climate change adaptation information by smallholder farmers for planning and implementation of adaptation strategies through awareness creation.

Originality/value – This study is in line with goal number 13.3 of Sustainable Development Goals, which vows on taking necessary actions in combating climate change and its impacts. Thus, smallholder tomato farmers' awareness about climate change through access and uptake of climate change adaptation information is one of the interventions to combat climate change and its impacts.

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Keywords Access and uptake of information, Barriers to access and uptake of information, Climate change adaptation, Smallholder tomato farmers, Improving access and uptake of information, Tanzania

Paper type Research paper

Introduction

Climate change is one of the key challenges to development over the world which is caused by the unsustainable anthropogenic practices, especially that of burning fossil fuels, industrial pollution, deforestation and improper land use changes (IPCC, 2007; Weart, 2010; Cook *et al.*, 2013; Gadzekpo *et al.*, 2018; Lund, 2019). There is an evidence that climate change is now an established reality (Wolff *et al.*, 2020; Lindsey *et al.*, 2010). In the developing countries such as Tanzania, climate change is manifested by markers such as the rising temperature, melting of glaciers, rising of sea levels, changes in the precipitation patterns, recurrent droughts and devastating floods and outbreak of diseases, among others. Available scientific evidence shows that the earth experienced an average warming of approximately 0.6°C during the 20th century and is expected to warm by about 2°C–3°C by the end of the 21st century (Intergovernmental Panel on Climate Change [IPCC, 2007]). Thus, adapting to the problems brought by the climate change is necessary for improving rural communities' livelihoods.

Climate change adaptation refers to the process of adjusting to the impacts of climate change to minimize the negative effects and take advantage of any potential benefits. It involves implementing strategies and measures to protect communities, ecosystems and infrastructure from changing climate conditions (IPCC, 2007). Climate change adaptation information refers to knowledge, tools and strategies that help individuals, communities and organizations cope with the impacts of climate change (IPCC, 2007; Moser and Ekstrom, 2010). This information is essential for helping decision-makers understand and develop effective strategies for addressing the challenges posed by climate change (Smit and Wandel, 2006), as well as to prepare them to plan for their investments (Odikor *et al.*, 2023).

Adaptation to climate change starts with access to the current and relevant information (Ageyo and Muchunku, 2020). Proper access to climate change adaptation information is important for enabling awareness creation on climate change adaptation among smallholder farmers. Awareness about climate change and its impacts will prepare smallholder tomato farmers to cope with and adapt to its negative impacts (Ajuang *et al.*, 2016), which will consequently ensure agricultural production and improve food insecurity (Odikor *et al.*, 2023). Authors like Antwi-Agyei *et al.* (2020), Nkiaka *et al.* (2019); Singh *et al.* (2018); and Vincent *et al.* (2017) observed that timely access to climate change information is important for effective decision-making process regarding shocks brought by climate change in sub-Saharan African countries. Access to information is also regarded as a prerequisite for climate change adaptation at the local level and it is identified to be one of the significant factors influencing uptake of information.

Information uptake is described as the action of making use of available information to informed decision-making. It is the process during which farmers recognize and use available information from identifiable sources to inform their adaptation-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 management of climate-related risks and help farmers to adapt to changes (Tall *et al.*, 2014). Use of climate change adaptation information can offer the potential to enhance agricultural resilience to climate change through improved agricultural decisions-making such as preparations for expected adverse or favourable conditions (Pathak and Stoddard, 2018).

In 2016, the Tanzanian Government embarked on the implementation of the Second Five Year National Development Plan commonly regarded as 2016/2017–2020/2021 (FYDP II) especially in

agricultural sector (URT, 2016). Tanzanian agricultural sector is mostly disturbed by the adverse impacts of climate change including erratic and unreliable rainfalls, extreme temperatures, droughts, floods, destruction of basic infrastructure, outbreak of pests and diseases; death of animals and land degradation, among others (URT, 2020, 2021). While the government is on the implementation of the third 2021/2022–2025/2026 FYDP III, it is necessary to solve the challenges posed by climate change to smallholder tomato farmers who are the important stakeholders of the development plans through awareness creation about climate change adaptation strategies (URT, 2012; Mubiru *et al.*, 2018; URT, 2021) for adaptive capacity building. Nelson *et al.* (2007) suggested that building adaptive capacity increases the ability of individuals, groups or organizations to transform their adaptive capacity into action through capacity building in the form of formal education, workshops and sensitization programmes (Benebere *et al.*, 2017).

Tomato is a seasonal commercial crop mostly grown by smallholder farmers in various parts of Tanzania, including the Morogoro and Iringa regions. It is regarded as a very important crop in the country's agricultural sector (Mutayoba and Ngaruko, 2018). However, climate change poses many immediate challenges for tomato cultivation. Guodaar (2015) and Tshiala and Olwoch (2010) posted that although climate change affects crops differently, tomatoes are among highly affected crop because of its high dependence on climatic conditions including temperature, rainfall patterns and water. Proper access to and uptake of climate change adaptation information is important for enabling awareness creation on climate change adaptation among smallholder tomato farmers. Awareness about climate change and its impacts will prepare these farmers to 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.

Locatelli *et al.* (2015) reported that timely use of climate change adaptation information by smallholder farmers may enable them to use various strategies to adapt to the ever-changing climate for lessening the adverse effects of climate change for improved agricultural production in other parts of the world. However, timely access to relevant and accurate information on climate change adaptation has continued to be a challenge for smallholder tomato farmers in Tanzania. Climate change adaptation 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 course of action (Jalango *et al.*, 2020). Furthermore, several studies have been undertaken in Tanzania to assess access to and use of climate change information (Siyao and Sife, 2020; Sanga and Elia, 2020). Nevertheless, little is known about factors preventing optimum access and uptake of climate change adaptation information for enhanced adaptive capacity among smallholder tomato farmers in Tanzania. Thus, the study attempts to fill this gap by assessing the factors that hinder access and uptake of climate change adaptation information for enhanced adaptive capacity among smallholder tomato farmers in Morogoro and Iringa regions.

This study sought to answer the following research questions (RQs):

- RQ1. What are the key barriers to the access and uptake of climate change adaptation information by smallholder tomato farmers?
- RQ2. What are the key strategies for improving access to and uptake of climate change adaptation information by smallholder tomato farmers?

Research methodology

This study was conducted in the Iringa and Morogoro regions. Iringa region is located in the southern highlands zone of Tanzania between latitudes 60° 55' and 9° 00' and between

longitudes 33° 45' and 36° 55' east of Greenwich (URT, 2013a; Figure 1). Morogoro region is located in the mid-eastern part of the Tanzanian mainland. It lies between latitudes 5°58' and 10' south of the equator and between longitudes 35°25' and 38°30' east of Greenwich (Figure 2).

The study adopted a cross-sectional research design, which enabled data relevant to this study to be collected from a cross section of targeted communities to achieve the objectives of the study. The design involved a systematic approach to data collection and presentation to reflect a given situation within the period of the study. Both qualitative and quantitative research approaches were used. Qualitative and quantitative approaches provide a more comprehensive understanding of a research problem than when either of the approaches is used alone (Creswell, 2014).

Multistage sampling technique was used to obtain the sampling units. Iringa and Morogoro were purposively selected. Two districts were purposively selected; one district from each region.



Figure 1.
Iringa region sketch
map

Source: Adapted from URT (2013a)



Figure 2.
Morogoro region
sketch map

Source: Adapted from URT (2007)

Mvomero-Morogoro and Kilolo-Iringa were selected. These districts were selected because of their prominence in smallholder tomato growing and their vulnerability to the adverse impacts of climate change (URT, 2013b, 2012; Mutayoba and Ngaruko, 2018; Jalango *et al.*, 2020).

From each district, one ward was selected which are Mlali-Mvomero and Image-Kilolo district. From each ward, four villages were selected (Table 1). These villages were selected because they are among the areas where smallholder farmers predominantly are engaged in tomato-growing activity.

Smallholder tomato famers were randomly selected to give each of them equal chance of inclusion in the study and could enhance generalization of results. Total population of smallholder tomato famers in the study areas was 401. Sampling frames were obtained from Image and Mlali Ward Agricultural Extension Officers (WAEOs). From this population, the sample size of 201 was obtained using Yamane's (1967) formula for sample size calculation as follows:

$$n = \frac{N}{1 + N(e)2}$$

where n = sample size (201), N = total study population (401) and e = level of significance (5%). After obtaining the sample size of 201, a representative sample per each village was calculated. This representative sample size per each village facilitated the determination of the total number of respondents to distribute the questionnaires. It was calculated as:

$$\frac{\text{Total sample size} \times \text{No. of smallholder tomato farmers per village}}{\text{Total No. of population}}$$

For example, Kijiji Namba Saba = $\frac{58 \times 201}{401} = 29$

This calculation was repeated for the rest of the villages. Table 1 illustrates the sample size of each selected village.

Data collection was conducted in March–April 2022 as part of a larger research project that assessed factors influencing smallholder tomato farmers' access to and uptake of climate change information in the selected rural parts of Tanzania. Questionnaires, interview guide and focus group discussions (FGDs) were specific data gathering tools used in this study. Questionnaires containing closed- and open-ended questions were administered to all selected respondents using

Name of the village from each Ward	No. of smallholder tomato farmers (N)	Probability proportional to size (n)	No. of questionnaires finally allocated
<i>Image ward – Iringa</i>			
Kijiji Namba Saba	58	29	26
Kijiji Namba Nane	62	31	29
Liasa	45	23	20
Uhominyi	35	18	15
<i>Mlali ward – Morogoro</i>			
Kipera	60	30	28
Kinyenze	54	27	26
Majengo	47	23	20
Vitemvu	40	20	19
Total	401	201	183

Table 1.
Distribution of
smallholder tomato
farmers

Source: Authors' own field work, 2022

drop-off and pick-up method recommended by [Allered and Ross-Davis \(2011\)](#). Use of questionnaires enabled study to collect both quantitative and qualitative data. To ensure the validity and reliability of the data collection instruments, pretesting of the questionnaires was used with 25 smallholder tomato farmers in Mbigiri Village, Mvomero District. Questionnaires were pre-tested to see whether they were related to the research topic and also whether they actually addressed the research questions raised in the study, to assess time for data collection and to check whether the findings were relevant.

Two research assistants were trained and administered questionnaires to respondents. Face-to-face interview sessions were arranged. Before starting the interview, a script to guide the process was developed. Interviewees were asked open-ended questions during the interview sessions. This enabled the interviewees to express themselves to the fullest to help the study obtain accurate and necessary information. The interviews lasted for about one to half an hour. Two FGDs were conducted to supplement data collected through structured questionnaires.

Purposive sampling technique was used to select one key informant (KI) from each village making eight KIs who comprised of experienced tomato farmers, WAEOs, environmental officers, ward leaders, village leaders and elderly people.

Study sought informed consent from participants by writing to them a consent letter. Participants were not induced to participate and they were informed of their willingness to withdraw from the study at any time if they wished to do so. Respondents' answers were kept confidential/anonymous. Privacy was maintained by not attaching participant's names to the information. Research clearance was granted by Regional Administrative Secretaries, which enabled researcher to obtain research permit for data collection.

IBM Statistical Product and Service Solutions software was used to analyse quantitative data. Descriptive statistics were used in the data analysis. The qualitative data gathered from in-depth interviews and FGDs were arranged into themes that captured important aspects of the data in relation to research objectives by using the qualitative data analysis software NVivo, which involved the iterative process of coding, categorizing and identifying patterns and themes within the data.

Literature review

Access to and use of climate change adaptation information is essential for raising people's awareness about adaptation, coping and consequently mitigation strategies in the face of changing climatic condition for informed decision-making process ([Jiri et al., 2016](#)). This implies that people can successfully adapt and cope to climate change especially on its mitigation if they have access to and they can use information and knowledge about various aspects of climate change ([Siyao and Sife, 2020](#)).

Various studies have cited numerous factors that prevent smallholder farmers from accessing and uptaking climate change adaptation information. A weak extension support services caused by inadequacy of extension agencies is one of the challenges. There are few extension workers who are not motivated. Less motivation is related to poor working environments including a lack of reliable means of transport to reach farmers, limited financial supports to carry out demonstrations and field experiments on new technologies, lack of working facilities and low salaries associated with insufficient government budget allocated to extension services ([Lema and Majule, 2009](#); [Mutayoba and Ngaruko, 2018](#)).

Lack of financial resources is one of the main constraints to adjust to climate change. [O'Brien et al. \(2000\)](#) reported that despite numerous adaptation options that farmers are aware of and willing to apply, a lack of sufficient financial resources to purchase necessary inputs and other associated equipment, e.g. seeds, acquiring transportation, hiring temporary workers and communication tools, is a significant constraint to adaptation.

Antwi-Agyei *et al.* (2021) indicated that inadequate information on seasonal forecast for long-term planning is a barrier constraining smallholder farmers' ability to uptake climate change adaptation information. This is attributed by 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 cease.

It has been reported that lack of trust to climate change issues and unreliability of climate information services hinder use of climate change adaptation information because information about rainfall patterns forecast provided by the Tanzania Meteorological Agency (TMA) is not always reliable and it is untimely received (Muema *et al.*, 2018; Africa, 2018; Siyao and Sife, 2021). Elia (2014) added 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.

Technical language and illiteracy are barriers constraining access to and uptake of climate change adaptation information. Climate change issues communicated using jargons or difficult concepts cannot easily be understood by common people (Filho, 2009; Moser and Dilling, 2012; Moser, 2014; Antwi-Agyei *et al.*, 2021; Siyao and Sife, 2020). Smallholder farmers who do not have formal education cannot appreciate and understand climate change adaptation information and sources from which it can be obtained (Benebere *et al.*, 2017).

Inadequacies of proper infrastructure, such as electricity, in rural areas associated with poor distribution of electricity in rural parts of Tanzania are constraints to the access and uptake of climate change adaptation information. Even if 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 televisions to access climate change information (Kapinga *et al.*, 2020).

Lack of awareness related to limited access to information is a constraining barrier in accessing and uptaking climate change adaptation information because smallholder tomato farmers may not be aware of the risks that climate change poses to their crops or the available adaptation strategies that can help mitigate these risks. Limited access to information could be due to a lack of infrastructure or limited access to the internet facility (Gbetibouo, 2009). Without awareness, farmers may not understand the need for accessing climate change adaptation information.

To improve access to and uptake of climate change adaptation information by smallholder rural farmers, training organs should conduct training needs assessment through participatory approaches to identify relevant knowledge, skills, attitudes and new ways of delivering extension services needed to build the capacity of extension workers. This will enable them to perform their roles effectively, improving the performance of the agricultural sector (Msuya, 2021). Moranga (2016) commented that when smallholder farmers are provided with current, relevant and the most accessible information aimed at creating awareness, they are able to cope with climate change through practices such as early preparation of land, changing planting dates, increasing frequency and timeliness of weeding and using early maturing crop varieties.

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. Establishing local FM radio stations covering the entire country and broadcasting largely in local languages and location-specific information may act as a facilitating factor for ease of understanding of the communicated messages about climate change (Tenywa *et al.*, 2017).

Results

Findings in Table 2 indicate that various challenges impeded tomato farmers access to and uptake of climate change information for the decision-making process. More than half (132, 72.1%) of the smallholder tomato farmers indicated that they could not access and uptake information because information about climate change adaptation was not clearly understood. Findings indicate that 125 (68.3%) of smallholder tomato farmers cited lack of libraries and information centres as barrier to accessing and uptaking climate change adaptation information.

Findings indicate that 125 (68.3%) of smallholder farmers agreed that inadequate income to buy information communication tools, such as TV, radio and newspapers, was another barrier for smallholder tomato farmers to access and uptake climate change information. Income of the farmers can encourage access to and uptake of climate change adaptation information. Farmers with better income can afford to buy and own communication media for obtaining information.

Lack of trust/reliability of the sources of information (114; 62.3%) was cited as a barrier to the access and uptake of climate change information. Perhaps this is because sometimes the information about rainfall patterns forecast by TMA is not always reliable and is untimely received. Concerning lack of skills and knowledge, slightly more than half (111; 60.7%) of the smallholder tomato farmers agreed that they did not have sufficient knowledge about climate change. With regards to the issue of illiteracy, 110 (60.1%) of smallholder farmers admitted that low literacy affects their abilities to access and uptake climate change information.

Findings further indicate that 109 (59.6%) of smallholder tomato farmers could not access and uptake climate change information because of lack of electricity and the batteries are very expensive. In total, 59% of smallholder tomato farmers indicated that they could not access and uptake climate change adaptation information because of the lack of seasonal forecast for long-term planning.

Table 2.
Barriers in accessing and uptaking climate change information by smallholder tomato farmers

Barriers (<i>n</i> = 183)	<i>N</i>	Never a barrier		Moderate a barrier		Extremely a barrier	
		<i>F</i>	%	<i>F</i>	%	<i>F</i>	%
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	48.0
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 clearly understood	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

Source: Authors' own field work, 2022

The unavailability of extension services is an obstacle for smallholder farmers to access and uptake information about climate change. Extension officers are key change agents for the provision of agricultural information to farmers. With the help of information from these services, farmers can transform their reliance on indigenous knowledge (IK) for combating climate change into smart agriculture (Mullins *et al.*, 2018).

Furthermore, findings indicate that 93 (50.8%) of the smallholder farmers agreed that language barriers, particularly the use of jargons or difficult concepts in explaining climate change issues, made it difficult for the smallholder tomato farmers to access and uptake climate change information for decision-making.

Findings in Table 3 indicate that 31 (17%) of smallholder farmers indicated that increasing the number of extension officers and effectively using them will help them access and uptake climate change-related information. The interview with AEO yielded that:

There is a need for frequent and continued education provision to smallholder farmers in climate change issues. Extension services enhance access and understanding of the climate change information by farmers for enabling them to adopt new agricultural technologies. In that context it has been reiterated that the need to have AEOs in every village in Tanzania Mainland by the year 2025 is one of the government's important agenda.

Six (11%) smallholder tomato farmers mentioned that the provision of education and training on climate change issues is important for improving smallholder tomato farmers' ability to access and uptake climate change information in the study areas. Five (9%) mentioned that there should be improvements in the contents and timely delivery of climate change information on tomato growing in the study areas. One interviewee said that:

The contents of climate change information need to consider skills and level of understanding of smallholder farmers. 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 adaptation information for improving access to and uptake of the information by smallholder tomato farmers.

Findings indicate that local meteorological stations (11; 6%) and information centres (11; 6%) are needed for providing timely and relevant climate change information in the rural areas.

Discussions

A clear understanding of climate change information acts as a motivation for its access and uptake by users. However, smallholder tomato farmers could not access and uptake climate

Strategies (<i>n</i> = 183)	Freq.	%
Increase number of extension officers and effectively use them on climate change-related matters	31	17.0
Education and training on climate change issues to all farmers through seminars, workshops and field demonstration	20	11.0
Improve contents and timely delivery of climate change information on tomato growing	17	9.0
Establish meteorological centres in the local areas (i.e. village, ward, district and regional level)	11	6.0
Establishment of information centres for sharing experiences and a simplified manuals should be prepared on adaptation and mitigation strategies of climate change	10	6.0
Agricultural show events or exhibitions at village levels of small-scale farmers	6	3.3

Source: Authors' own field work, 2022

Table 3.
Farmers' strategies
to improve access to
and uptake of climate
change information

change adaptation information because the information about climate change was not clearly understood. Inadequate knowledge about climate change science can be a limiting factor for farmers' ability to access the right climate change adaptation information at the right time and from the right sources. [Rioba \(2012\)](#) and [Media Council of Tanzania \(MCT\) \(2012\)](#) reported that inadequate knowledge about climate change issues tends to affect its critical analysis, thus accessibility to information related to such issues becomes difficult.

Smallholder tomato farmers could not access and uptake climate change adaptation information because of the scarcity of libraries and information centres in their areas of vicinity. Findings corroborate [Lund \(2019\)](#) and [Agyemang \(2017\)](#), who reported that libraries are scarce in the most developing countries. This implies that library scarcity is an impediment to accessing various types of information; thus the availability of public libraries and information centres in the smallholder tomato farmer's areas of vicinity can be one of the points at which the readers can easily access and uptake climate change adaptation information.

Inadequate income to buy information communication tools such as TV, radio and newspapers is a constraining barrier for smallholder tomato farmers' access to and uptake of climate change information. It has been reported that rural farmers become knowledgeable about climate change by getting information through the media ([Elum and Snijder, 2023](#)). However, ownership of television and radio or the ability to buy newspapers depends on the purchasing power of rural farmers. These imply that the income of the farmer predicts the ownership of household assets by the respondents 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 rural settings in developing countries such as Tanzania lack financial capital to enable them to afford communication tools.

Lack of trust/reliability of the sources of information was another barrier to accessing and uptaking climate change adaptation information by smallholder farmers. TMA is a government agency entrusted with the provision of information such as rainfall patterns forecast. However, sometimes the information provided by TMA, such as onset and cessation of rainfall, is untrusted/unreliable. These findings are in congruence with those of [Muema *et al.* \(2018\)](#), who reported that lack of trust and reliability of climate information services are the main hindrances to their utilization. These findings are also in resonance with those 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 about the rainfall distribution in given geographical locations and seasons. This suggests that there is a dire need for the governments' entrusted agencies to provide reliable, trusted and understandable information on climate change adaptation. These findings corroborate the study by [Sen *et al.* \(2022\)](#), who reported that if users do not trust the information or are unable to analyse it, they will not use this accessible information for decision-making with regards to climate change adaptation strategies.

Smallholder tomato farmers' insufficient knowledge about climate change is a barrier to the access and uptake of climate change adaptation information. Such insufficient knowledge is linked to poor information-search strategies. Furthermore, insufficient knowledge is perhaps associated with a lack of climate change-relevant subject matter understanding ([Siyao and Sife, 2021](#)).

Illiteracy makes it very difficult for the farmers to understand information communicated through printed or broadcast media, which is often written or broadcasted in the alien languages. This implies that farmers who cannot read and understand communicating languages such as English cannot access and use the information about

climate change. These findings are in congruency to the study by [Benebere *et al.* \(2017\)](#), who cited illiteracy as the major barrier against obtaining various types of information by most rural farmers in Africa. This means that smallholder tomato farmers with low levels of literacy depend on other sources of information, such as word-of-mouth from friends, neighbours and agro-chemical input vendors. Smallholder tomato farmers testified that “Because of my inability to read and write, I normally seek information from agricultural input vendors in our area”. The findings imply that there is a need to introduce climate change literacy to rural communities, which involves being aware of both climate change and its anthropogenic causes and strengthening informed decision-making adaptation responses ([Simpson *et al.*, 2021](#)).

Poor distribution of electricity in rural areas, frequent power outages, higher prices of dry cells coupled with unreliable network coverage are one of the impedances for the rural smallholder farmers to use their ICT communication tools such as televisions and radios to access and uptake broadcasted information. These findings corroborate those of the study by [Ugboma \(2010\)](#), who identified an unreliable supply of electricity as among the factors hindering access to information by rural smallholder farmers. Smallholder tomato farmers could not access and uptake climate change information because of the lack of a seasonal forecast for long-term planning. This is associated with the fact that smallholder farmers were not provided with the seasonal forecast information at the possible earliest time for enabling them to plan for their long-term farming activities.

It has been reported that farmers with access to extension services are more likely to perceive changes in the climate because extension services provide information about climate and weather ([Gbetibouo, 2009](#)). On the contrary, smallholder farmers’ inaccessibility to the extension officers may reduce their efforts to adapt to the adverse effects of climate change in developing countries where the impacts are severe. One respondent reported that:

Extension officers are very few and not available in most of the time. They do not visit our farms when we request them for consultations, as a result we use our own experience through IK to deal with threats caused by climate change.

These findings corroborate the study by [Mutayoba and Ngaruko \(2018\)](#), who reported that weak extension support services is a constraining challenge for tomato production.

Climate change information written and expressed in technical terms that are difficult for the common people to understand was cited by smallholder tomato farmers as a barrier to access to and uptake of climate change adaptation information. [Luseno *et al.* \(2003\)](#) and [Benebere *et al.* \(2017\)](#) reported that climate change information with technical complexity of contents and use of difficult technical terms and terminologies may not be easily understood by local communities. Climate change adaptation information becomes more accessible and useable when such information is delivered in the language easily understood by the end users ([Dilling and Lemos, 2011](#); [Perez *et al.*, 2015](#)).

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 adaptation information. Tomato farmers acknowledged that with reliable and accessible extension officers, farmers can easily make consultations on critical issues related to adaptation to climate change in their areas.

Education and training provision on matters related to climate change adaptation information search strategies are fundamental for improving access to and uptake of climate change adaptation information among smallholder tomato farmers. Education and training justify 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 adaptation information from different sources for easy, timely access to and uptake of relevant climate change adaptation information. Such information attests to farmers' ability to cope with climate change-related threats and to make better-informed decisions. Education will increase literacy level of smallholder tomato farmers, which will in turn enable them to understand climate change adaptation issues, and thus they will be able to device appropriate adaptation strategies (Deressa *et al.*, 2009; Benebere *et al.*, 2017). At the local-level, 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 Van Aalst, 2008). Closing this information gap is therefore essential for increasing access to and uptake of climate change adaptation 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; Benebere *et al.*, 2017).

The contents of climate change information produced by the scientists need to be simple for most farmers to comprehend, fits the farmer's needs and which can be easily integrated into farmers' decision-making processes (Singh *et al.*, 2018; Onyango *et al.*, 2022). Establishment of meteorological centres in the local areas (i.e. village, ward, district and regional level) and information centres will make ease the process of acquiring information about climate change adaptation. Climate information services at local level will bridge the generation and application of scientific climate and agricultural information. This 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. Mapfumo *et al.* (2016) and 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 adaptation to local farmers. The centres will enhance available information uptake for informed decision-making process. Establishment of localized meteorological stations will facilitate delivery of location-specific information on climate change adaptation.

Conclusion

The study concludes that inadequate knowledge on climate change adaptation information, scarcity of libraries and information centres, inadequate number of extension agents, low level of literacy, poor distribution of electricity in rural areas, frequent power outages, higher prices of dry cells coupled with unreliable network coverage, lack of seasonal forecast for long-term planning, use of jargons or difficult concepts in explaining climate change issues, inadequate financial resources and time constraints are barriers for the smallholder tomato farmers to access and uptake climate change adaptation information in the study areas. If these barriers are not unpacked, they may impede policymakers to take appropriate actions on climate change adaptation for smallholder farmers in Tanzania. Thus, appropriate strategies need to be used to break the barriers that impede access and uptake of climate change adaptation information by smallholder tomato farmers.

Recommendations

Based on the findings and conclusion of this study, it is recommended that the government should increase the number of extension officers, coupled with motivation and a good working environment. Non-governmental organizations should collaborate with other government agencies to provide education and training on climate change adaptation-related issues to smallholder tomato farmers; climate change adaptation information generators should repackage information before being delivered to end users for enhanced

ability to develop effective policies and strategies for helping smallholder farmers adapt to climate change; government should establish localized meteorological stations for enabling timely delivery; and location-specific information on climate change adaptation and climate change adaptation issues should be integrated into policies.

Contributions of the study

This study has contributed to the ongoing discourse on climate change issues. Such discourses have influenced attention and understanding of the role of access and uptake of climate change adaptation information by smallholder farmers in the planning and implementation of adaptation strategies through awareness creation.

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