

# DISSEMINATING AND USING INFORMATION ON CLIMATE CHANGE AND VARIABILITY: A CASE STUDY OF FARMERS IN MALUGA AND CHIBELA VILLAGES IN CENTRAL TANZANIA

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## ABSTRACT

This study formed part of a broader PhD research which investigated how access to, and use of, information enhances farmers' adaptation to climate change and

variability in the agricultural sector in semi-arid Central Tanzania. The research was carried out in two villages using Rogers' (2003) Diffusion of Innovations (DOI) theory and model to assess the dissemination of this information and its use by farmers. The predominantly qualitative study employed a post-positivist paradigm and some elements of a quantitative approach for the data collection and analysis. The principal data collection methods were interviews and focus group discussions. The study population comprised farmers, agricultural extension officers and the Climate Change Adaptation in Africa (CCAA) project manager. The qualitative data was subjected to content analysis, whereas the quantitative data was analysed to generate mostly descriptive statistics. The key findings showed that researchers, extension officers and village leaders disseminate information on climate change and variability to farmers, and that radio and mobile phones were the most relied upon sources in disseminating this information. Despite the benefits, however, the results showed that farmers felt there were several barriers to dissemination and use. To mitigate the adverse effects of climate change and variability on farming, the study recommends the repackaging of current and accurate information on climate change and variability, farmer education and training, and collaboration between researchers, meteorology experts, extension officers and farmers. Moreover, a clear policy framework for disseminating information related to climate change and variability is required.

**KEYWORDS:** dissemination, use, information, climate change, climate variability, agricultural services, agricultural development

## 1. INTRODUCTION

Climate change denotes a process during which greenhouse gases are released into the atmosphere due to industrialisation which then results in global warming. Climate variability, in contrast, refers to variations in the mean state and other statistics, such as standard deviations of the climate, on all spatial and temporal scales beyond that of individual weather events according to the Intergovernmental Panel on Climate Change (IPCC 2007).

As a result of climate change and variability, mean global temperatures are expected to increase from 1.4 to 5.8 degrees Celsius by 2100 (IPCC 2001). These increases have caused and will continue to result in erratic changes in rainfall, temperature, frequency and intensity of extreme weather events and rising sea levels. They will also affect human systems, such as agriculture, water resources, industry and human health (Orindi and Murray 2005).

Salinger, Sivakumar and Motha (2005) and Gwambene (2007) have pointed out that the adverse impacts of climate change and variability on agricultural production in developing countries are caused by the low levels of adaptive capacity, and limited use of technology and innovation. However, vulnerability to climate change and

variability in the agricultural sector of many sub-Saharan African countries can be alleviated with proper dissemination of appropriate information to farmers (Elia 2014).

Climate change and variability have both a direct and an indirect impact on development (Devereux and Edward 2004) and also have an impact on infrastructure, agriculture, poverty, conflict, health and education. Devereux and Edward (2004) have noted that countries in East Africa are already among the most food insecure in the world and that climate change and variability, through the increase in drought and floods which have already been observed in the region, will exacerbate falling harvests.

Hellmuth et al. (2007) have noted that the majority of people (70%) in sub-Saharan Africa depend on rain-fed subsistence agriculture, which plays an important role in the livelihood of rural communities in most developing countries, such as Tanzania. Over-dependence on rain-fed agriculture by the majority of people living in rural areas in developing countries is the major limiting factor in their agriculture production. Low levels of production are being threatened further by climate change and variability resulting in food insecurity and low income generation (Lema and Majule 2009).

Elia (2014) describes the dissemination of information on climate change and variability to farmers as the sending of agricultural and climate change information to farmers. He defines use as farmers' ability to apply the knowledge as a result of the information they have received from sources.

Dissemination of climate change information is of paramount importance to farmers as it helps them to access and use new knowledge on farming. Information dissemination thus promotes farmers' education and creates awareness of the best farming practices for improving productivity and adapting to climate change and variability (Mandleni and Anim 2011). In East and Southern Africa, various authors have demonstrated the importance of educating farmers through information dissemination targeting sustainable agricultural development. Meyer (2000), Shetto (2008) and Cherotich, Saidu and Bebe (2012) investigated the role of information dissemination in agricultural development. These authors found that effective information dissemination could promote farmers' food security and their adaptation to climate change and variability.

## 2. PROBLEM STATEMENT

Information dissemination, which in this study refers to making agricultural information available to farmers, plays an integral role in promoting farmers' adoption and usage of innovations (Rogers 2003) in coping with climate change impacts. However, the major challenge that Kadi et al. (2011) observed is that the information which would have helped farmers to adapt to climate change and variability had

not been disseminated effectively. The authors found that 50 per cent of the farmers in East African countries had not been exposed to research and extension services which are important sources in disseminating information to help farmers adapt to climate change and variability. Kandji and Verchot (2007) explain that information on climate change and variability is a critical component if farmers are to make the right decisions in agriculture and other socio-economic activities aimed at enhancing their livelihoods. Effective adaptation by farmers is essential in improving yields and promoting agricultural development.

Globally, climate science generates agricultural information aimed at improving farmers' agricultural production and mitigating the adverse impacts of climate change. Recently, tremendous advances have been made in climate science worldwide (Hellmuth et al. 2007; Tarhule 2007). However, Tarhule (2007), Mutekwa (2009) and Mowo et al. (2011) argue that this progress has not benefited many rural farmers in Africa as a result of poor dissemination of information on climate change and variability. Besides, there is scanty research on how the dissemination of information and its use by farmers has the potential to mitigate the adverse impacts of climate change and variability and ultimately enhance agricultural development. Farmers' access to information on climate change and variability is of paramount importance if their adaptation and development are to be sustained (Chikozho 2010).

The current study was carried out in the villages of Chibeleda (in the Dodoma region) and Maluga (in the Singida region) in Central Tanzania. These regions are populated largely by peasant farmers. Farmers in the Maluga and Chibeleda districts underwent training on the use of the best improved farming practices by Climate Change Adaptation in Africa (CCAA 2009). These villages were chosen as study sites because in recent years they have experienced frequent periods of adverse weather conditions which led to inadequate supplies of food, making them food insecure. They were also selected because the farmers in these villages have received training from CCAA experts on ways of improving agriculture and mitigating the impacts of climate change and variability. The training these farmers received was integral in investigating the two concepts of disseminating agricultural information on climate change and variability to farmers and their use of this information.

### 3. PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The study aimed to investigate how dissemination and use of information improves farmers' farming practices and adaptation to climate change and variability. Assessing the role of dissemination and use of information prepared for farmers is crucial in reducing the adverse effects of climate change and improving food production. Thus, the article addresses the following two research questions:

1. What is the role of information disseminated to farmers on adaptation to climate change and variability?

2. Which factors affect dissemination and use of information on climate change and variability?

## 4. LITERATURE REVIEW

This section is categorised into three sections. Section 4.1 explains the sources used to disseminate information on climate change and variability; Section 4.2 describes the link between information dissemination and adaptation to climate change and variability; and Section 4.3 discusses factors affecting dissemination and use of information on climate change and variability.

### 4.1. Sources used to disseminate information on climate change and variability

Information on adaptation to climate change and variability is disseminated to farmers in a number, including of ways, agents such as non-governmental organisations (NGOs), researchers, extension services and social networks. The agents use leaflets, posters, workshops, demonstrations, such as those at Farmer Field Schools (FFS), radio and television (TV) stations to disseminate the information (Roncoli 2006; Elia 2014).

Lwoga (2009), Chilimo (2008) and Kaniki (1994) discovered that farmers in Tanzania and Zambia used the information disseminated by oral sources such as friends, relatives and neighbours. Their studies underscore the fact that, despite farmers using a number of sources for accessing information, they often rely on interpersonal communication as the main format they prefer for the agricultural information disseminated to them and they use this information to respond to their farming problems.

Roncoli's (2006) study noted that extension officers, NGOs, farmer representatives, village leaders and researchers were major channels of information dissemination on climate change and variability to farmers. However, Roncoli and Kirshen (2002) found that farmers preferred receiving information on climate change using their local languages. The use of native language enhances effective communication between the sender and receiver of information and could result in an increase in farmers' agricultural production. Proper use of the information in formats that are understandable for the target group has the potential of mitigating the adverse impacts of climate change and utilising emerging opportunities.

### 4.2. Dissemination and use of information on climate change

Several studies have shown a positive relationship between an increased flow of information and agricultural development (Raju 2000; Cash 2001; Manda 2002; Kalusopa 2005). In Tanzania and Malawi, rural information provision has been

demonstrated to have a positive impact on agricultural practices (Mchombu 2001, 2003; Muyepa 2002). Notwithstanding its potential for agricultural development, the majority of African countries have not put their efforts into disseminating information on climate change and variability in rural areas where most of the population live (Adomi, Ogbomo and Inoni 2003).

Tarhule (2007) observed that despite notable advances in climate research and climate forecasting, many African countries have not experienced the benefits of climate change research for mitigating the adverse impacts of climate change and variability. As a result, most African countries continue to suffer the climate change and variability impacts with severe implications for economic growth and development. Despite the progress, there is still low use of this information to adapt farming practices (Mutekwa 2009).

Kadi et al. (2011) and Mowo et al. (2011) also observed that the majority of potential users including farmers in East African countries have not benefited adequately from research aimed at addressing climate change and variability as they have not accessed research findings and extension services. Tarhule (2007) and Kandji and Verchot's (2007) studies in West Africa and East Africa, respectively, observed that farmers failed to apply and utilise climate research findings due to limited information being disseminated.

Apart from other factors which influence adaptation to climate change and variability, information heavily triggers and enhances farmers' ability to adapt. Studies, such as that of Mengistu (2011) in Ethiopia, have found that the availability of timely climate information is a prerequisite to adaptation and mitigating the adverse impact of climate change and variability. Apata, Samuel and Adenola (2009) note that effective and reliable information disseminated to farmers on climate change and variability is a critical factor in adaptation. Moreover, Kandji and Verchot (2007) in East Africa found that climate information is a critical factor for farmers in making the correct decisions which are crucial in improving yields and agricultural development in the current observed climate change and variability.

Yanda and Mubaya (2011) argue that a key component in farmers' planning, coping and adapting to climate change and variability relies on the ability of information disseminators to disseminate credible information which will enable farmers to change their agricultural production systems. Supporting the role of information dissemination to farmers, Deressa et al. (2008) note that farmer to farmer extension, weather information and access to formal information from agricultural extension enhance farmers' capability to utilise adaptation programmes.

### 4.3. Factors affecting dissemination and use of information on climate change and variability

There are several factors which affect the dissemination and use of information on climate change and variability, including: inadequate education and awareness;

lack of certain necessary information dissemination qualities (accuracy, timeliness, relevancy, cost effectiveness, user friendliness and targeting the intended users); inadequate knowledge; cultural resistance; and economic factors.

Agwaru, Matsiko and Delve (2004), who studied approaches to the dissemination of research information to farmers in Tororo District, Uganda, found that despite information being disseminated to farmers, they still lacked adequate information on the availability and use of improved crop varieties, soil improvement, livestock breeds and post-harvest innovative practices. The study also discovered that farmers experienced problems with accessing improved seeds and observed that farmers needed more education and training for upgrading their crop practices. Mensah-Fosu, Vleck and Manschadi (2010) support Agwaru et al.'s observation. Mensah-Fosu et al. (2010) found that farmers' adaptation in Ghana was low and the problem was largely linked to the inadequate information on adapting to climate change and variability disseminated to farmers.

The inadequate knowledge and understanding of farmers and agricultural advisors affect their use of information on climate change and variability in most developing countries. Mutekwa (2009) researched climate change and variability impacts and adaptation by farmers in Zimbabwe and discovered that researchers and academics, who were supposed to be sources of information to ensure adaptation strategies are well packaged and disseminated to farmers, had limited awareness of the nature and magnitude of climate change and variability. Mutekwa (2009) further observed that extension workers lacked accurate information and knowledge on climate change which is a prerequisite tool used in adaptation strategies for enhancing farmers' agricultural production. Agwu, Ekwueme and Anyanwu (2008) found that extension officers were not disseminating agricultural information to farmers effectively as a result of their inadequate knowledge. This failure resulted in minimal information sharing and usage of information about innovations by farmers.

To enhance its usage, the information disseminated to farmers should have certain necessary qualities. According to Meyer (2005), these are accuracy, timeliness, relevancy, cost effectiveness, user friendliness and targeting the intended users. Orindi and Murray (2005) and Adejuwon, Odekunle and Omotayo (2008) explain the need to convert information on climate change and variability into simple and easily understood formats and whenever possible to interpret and translate this information into local languages to enhance its use. Mukhala (2000) notes that poor communication between experts and farmers contributes to farmers' limited access to and use of information in agriculture.

Cultural issues are among the factors affecting dissemination and use by farmers of information on climate change and variability in most developing countries. One of the cultural issues is farmers' resistance to changing their traditional farming practices. Another factor affecting dissemination and use of information is farmers' failure to utilise conventional methods, such as radio, which are convenient in disseminating

and accessing information on climate change and variability effectively. Farmers tend to use radio to access entertainment programmes rather than those related to agriculture and climate change issues. Lwoga (2009) reported that the majority of farmers in Tanzania used the medium of radio in receiving agricultural extension information from experts. However, Shetto (2008) found that despite the majority of farmers having radio in Tanzania, it was the medium least used to access the agricultural information which would improve their adaptation capacities. Shetto's (2008) study found that farmers were more interested in entertainment programmes than educational programmes. Supporting this observation, the findings of Agwu et al. (2008) indicated that despite many farmers having access to radio and believing that radio is a useful source of information for improving agricultural innovations, most did not listen to radio programmes for farmers.

Economic factors are among the factors which influence the dissemination and use of information on climate change and variability. According to Ingram, Roncoli and Kirshen (2002), despite government extension agents disseminating information to farmers, they were faced with financial challenges as the budget from government was insufficient. However, Roncoli (2006) noted that inadequate resources were not a problem only for government officials in disseminating information to farmers, but also a problem for farmers. Inadequate resources affect farmers' ability to access sources which can inform them on issues related to climate change and variability timeously. Furthermore, the meagre resources of many farmers inhibit their use of the disseminated information as they lack the financial capability to adopt issues suggested by experts. Roncoli's ethnographic study revealed that financial resources hindered farmers' ability to use information disseminated through extension services and media.

## 5. APPLICABILITY OF THE DIFFUSION OF INNOVATIONS THEORY AND MODEL TO THE STUDY

Rogers (2003, 12) defines an innovation as any idea, object or practice that is perceived as new by members of a social system. In the current study, innovation is perceived in the context of information which has been introduced to farmers to enhance their adaptation to climate change and variability. Diffusion is the process by which an innovation is communicated through certain channels, over time, and among the members of a social system (Rogers 2003, 5).

Rogers (2003) Diffusion of Innovations (DOI) theory and model is useful as it explains attributes, such as relative advantage, trialability, observability, knowledge, attitude to change and compatibility, which are crucial in understanding how farmers use information in adapting to climate change and variability.



The DOI model has had a major influence on the way information is disseminated to end-users, such as farmers, and in creating awareness about innovation adoption factors (Rogers 2003). The channels which users employ to access information are important in creating knowledge, and in changing people's attitudes to innovations. These channels of communication enhance the flow and exchange of information among users by facilitating farmers' access to, and use of, such information.

## 6. METHODOLOGY

The current study formed part of a broader PhD research (Elia 2014) which investigated how farmers' access to, and use of, information enhances their adaptation to climate change and variability in the agricultural sector in Central Tanzania. The study was a case study of farmers in Maluga and Chibelela villages in Central Tanzania. The case study approach was applied as the dissemination of information process under inquiry occurred in a real-life context, which is suited to case study research. It also allowed for the use of both qualitative and quantitative methods, which better suit studies that explore causality.

In 2012, data was collected from subsistence farmers in Maluga and Chibelela villages. The two study villages were selected randomly from the four villages (including Laikala and Sanjaranda) which had been exposed to the CCAA project in the Dodoma and Singida regions. Eighty-four respondents were chosen from the body of CCAA-trained farmers using purposive and snowballing sampling techniques to participate in the interviews: 36 respondents were from Maluga village while 48 respondents were from Chibelela. The study focused on farmers who engage mainly in crop production.

A post-positivist approach was used to conduct the qualitative and, to a certain extent, quantitative aspects of the study using interviews and focus group discussions (FGDs). Post-positivism was considered as a suitable approach for the study as it recognises the intricate relationship between individual behaviour, attitudes, external structures, and socio-cultural issues (Crossan 2003), all of which were important in the current study. The population for the study comprised farmers, agricultural extension officers and the CCAA project manager. One FGD constituting eight participants was carried out in each study village, yielding a total of 16 FGD participants. Both semi-structured interviews and FGD checklists<sup>1</sup> were used to collect information from the farmers on various issues related to the dissemination and use of information to adapt to climate change and variability. The questions in the research instruments solicited information on the types of information on climate change and variability provided to farmers; the barriers affecting dissemination; and the farmers' use of information to adapt to climate change and variability.

The data collected was analysed both qualitatively and quantitatively. Qualitative data from the interview schedules and focus group discussions was systemically

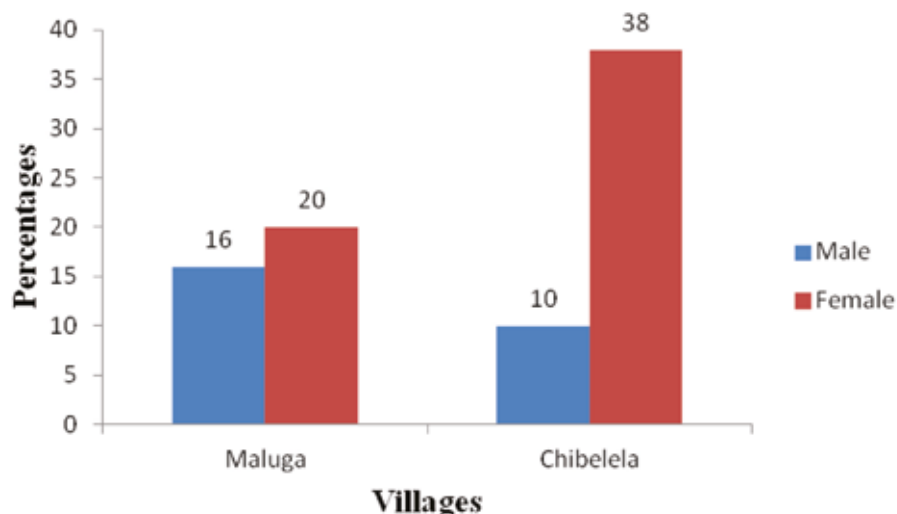
arranged into themes based on the study research questions. Thematic analysis is a type of content analysis which is a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases (Leedy and Ormrod 2005, 142). For the quantitative data, descriptive statistics such as means and frequencies were generated using SPSS version 20 because it offers powerful and easy ways to extract data; reduces the time required to analyse the data; reduces errors involved in coding the data, analysing data with in-depth statistics and producing charts (Pickard 2007, 278).

## 7. RESULTS

This section presents the study findings on the research conducted on sources used to disseminate and use information on climate change and variability. The section also provides findings on the barriers to dissemination and use of the information on climate change and variability.

### 7.1. Socio-economic profile of the respondents

The socio-economic data was collected to inform the context for the study. There were more female (58 or 69%) than male (26 or 31%) respondents. Maluga Village had 20 (55.6%) female and 16 (44.4%) male respondents, while Chibeleda Village had 38 (79.1%) female and ten (20.8%) male respondents. The distribution of gender in the study villages is depicted in Figure 1.



**Figure 1:** Gender distribution in the study villages

In addition, the respondents' ages ranged from 15 to 60 years. Most of the respondents, 63 (75%) were primary school leavers, 12 (14.3%) were illiterate and eight (9.5%) had attained secondary education. Only one (1.2%) had a post-secondary (college/university) education. Of the 84 respondents interviewed, the majority were involved in farming activities to earn a living. Specifically, 78 (92.8%) of the respondents indicated that farming was their primary source of income. Only six (7.2%) of the respondents indicated that they did not depend entirely on farming as their major economic activity.

## 7.2. Sources used to disseminate information

The farmers were asked to state how they gained access to information on climate change and variability. The findings from the semi-structured interviews and FGDs showed that farmers used radio, mobile phones, fliers, magazines, brochures and television as media for accessing information. However, the in-depth interviews with extension officers and FGD findings indicated that farmers predominantly used radio and mobile phones, rather than other media, to access this information. One farmer commented, 'These days we have access to mobile phones. We call our fellows from other areas and ask them about rainfall.'

The findings also showed that farmers who had prior information on climate change and variability agricultural practices were in a better position to seek further information. One extension officer also stated: 'Farmers who have been trained seek more information on climate change and variability from extension officers through mobile phones.'

## 7.3. Dissemination and use of information

The programme manager and the extension officers were asked how information on climate change and variability was disseminated to farmers. The findings from the interviews and FGDs showed that oral sources, such as researchers, extension officers, village meetings, village leaders, NGOs, farmer to farmer communication, seminars, workshops, as well as print sources (e.g., fliers and brochures) were used to disseminate information on climate change and variability. The findings revealed that researchers, extension officers and village leaders were the sources used to disseminate information to farmers. One extension officer explained: 'Farmers prefer oral means to communicate with them ... They prefer it as they can ask you questions and get clarification.'

The farmers were further requested to state the type of information on climate change and variability that was disseminated to them to enhance adaptation. Results from the FGDs and interviews showed that farmers received information on planting times, use of improved seed varieties and drought resistant seeds, early warning information, rainfall patterns, food preservation, fertilizer usage and type of crops to

grow in a season. Comments from the in-depth interview with the project manager were:

... before receiving training, farmers had poor harvests... These days farmers tell us they have increased their annual agricultural yield as a result of the information disseminated to them ... They have increased the use of improved quality seeds in farming, fertilizers, soil tillage methods and other best agricultural practices.

The farmers were also required to rate the usefulness of the information on climate change and variability that had been disseminated. The majority of the respondents (76 or 90.5%), found the innovations received useful (Table 1). The respondents indicated that they used the information to apply new farming practices which improved harvesting and adaptation to climate change and variability.

**Table 1:** Farmers' categories of usefulness of innovations on climate change and variability

Level of usefulness of innovations (N = 84)	Frequency	Percentage
Very useful	33	39.3%
Useful	43	51.2%
Neither useful nor not useful	6	7.1%
Fairly useful	1	1.2%
Not useful	1	1.2%
Total	84	100%

#### 7.4. Factors affecting dissemination and use of information

The programme manager (P) and the extension officers (E) were asked about the challenges they experienced in the dissemination and use of information on climate change and variability by farmers. The findings from the in-depth interviews showed that factors which affected dissemination and use of information were: a negative attitude to change; unreliable seasonal forecast information; low income/wealth; an inadequate government budget, and cultural barriers such as resistance to a change of crops, ignorance and a lack of preference for educational and awareness-raising radio programmes. Some comments were:

E1: Some farmers still resist changing to other crops of high economic return ... They prefer to grow similar crops which are highly affected by climate change and variability ... They need exposure to see how other farmers have changed their farming practices as a result of climate change and variability in other areas of the country.

E2: To get agricultural information and use it to adapt to climate change needs income ... The majority of farmers cannot afford new innovations without government support.

P: Farmers ignore [us] when we call them to give new farming knowledge. They are always busy with their daily activities. They can come one day and disappear.

The farmers were asked to explain the barriers to their effective use of information for adaptation to climate change and variability. The results from the FGDs and interviews revealed the barriers to be the experts' inadequacies regarding their ability to disseminate information; improper interpretation of information; poor collection and storage of weather forecasts at village and district levels; and not receiving timely information on improved seeds. One farmer explained: 'The experts usually delay to come and help us when we need them. They give us information on weather changes and crops to plant late after we have already planted our crops.'

Furthermore, the findings from the FGDs and interviews showed that other barriers to adaptation to climate change included: high seed prices; low income levels; unreliable extension services; and inadequate knowledge of climate change and variability issues held both by farmers and village/opinion leaders which contributed to a problem with the dissemination and use of adaptation information. One farmer stated: 'Sometimes we are being misled by our village leaders as they disseminate to us information on climate change and agriculture. I think they fail to understand well what they are being told to disseminate by extension officers.'

## 8. DISCUSSION

This section describes issues pertaining to the dissemination and use of climate change and variability based on the study findings.

### 8.1. Sources used to disseminate information

The study found radio to be the most widely used media in disseminating agricultural information to farmers. These findings confirm those of Ingram, Roncoli and Kirshen (2002), who observed that radio was preferred by the majority of farmers in Burkina Faso in disseminating forecast information. Chilimo (2008) and Lwoga (2009) also found radio to be mostly used by farmers to access information in the rural areas of Tanzania. Similarly, the study showed a growing use of mobile phones in disseminating and verifying information on climate change and variability. Farmers use mobile phones: (1) to learn from their colleagues on best farming methods which promotes adaptation, such as types of seeds and weather pattern from neighbouring villages; (2) to consult experts on agriculture-related climate change issues; and (3) to confirm or reject the information they have received from the radio or from other information disseminators. Technology and climate change and variability have changed the way farmers, and climate change and agricultural experts seek, access and disseminate information. Modern technological changes have empowered farmers to use mobile phones to disseminate and access information which enhances

adaptation to climate change and variability. Climate change and variability, on the other hand, has changed the way farmers disseminate, access and share information on climate change and adaptation. In this regard, farmers use a combination of sources to seek information on ways to adapt to climate change.

In addition, the study findings showed the use of interpersonal channels to be effective in disseminating information to farmers. These findings confirm those of Lwoga (2009) and Munyua (2011) who observed that in Tanzania and Kenya respectively, agricultural extension, social networks and village government leaders were important in disseminating agricultural information to local community for agricultural development. This study also found these sources to be used by farmers in disseminating information on climate change and variability to farmers. These sources were mostly preferred by farmers as they ensure reliability and prompt feedback from information disseminators.

Meyer (2000, 2003) also found that the use of indigenous communication channels, such as oral channels, was effective in disseminating agricultural information and had the potential to promote development. These findings confirm those of Ingram, Roncoli and Kirshen (2002) who showed that in Burkina Faso, although information on the adaptation to climate change and variability was disseminated to farmers through various channels, the farmers wanted more information from experts on the envisaged climate risks such as drought, plant diseases and response measures available to them. Oral channels provide farmers with adequate time to seek clarification from the source disseminating information on climate change and variability. The use of oral channel thus promotes the use of the disseminated information. In this regard, to enhance farmers' usage of information for adaptation to climate change and variability, both interpersonal and other sources, such as radio and mobile phones, should be used in a complementary way.

## **8.2. The role of information disseminated to farmers in promoting use of innovations**

The current study findings showed that the information disseminated to farmers enhanced the use of information for farming and adaptation to climate change and variability. Farmers' adoption of information improved their adaptation capacity and increased annual harvests. The nature of information delivered to farmers contributed to their ability to apply new knowledge in their farming activities to a large extent. Meyer (2005) discovered that the ability of a sender to use appropriate means for communication and having knowledge of the nature of the information enhanced the effective use of information for the development of rural people. Thus, to promote usage, Meyer (2005) argues that the information should have attributes such as being easy to access, being in an appropriate medium, as well as affordability, value, multiplicative quality, and culture dependency.

In East Africa, Orindi and Murray (2005) also found that the quality of the information disseminated to farmers affected the extent of usage. These authors observed that despite farmers receiving the seasonal weather forecast information, they were not using it effectively, because the information was not disseminated to farmers timeously. The East African study findings are supported by those in the West African countries of Mali, Niger, Burkina Faso and Nigeria by Tarhule and Lamb (2003). The West African study showed low usage of information disseminated to rural people as a result of their limited access to weather forecasts. Tarhule and Lamb (2003) found that the majority (57%) of rural people in West Africa were unaware of seasonal climate forecasts, which implied they were not using the information available to them to inform their farm decision making. Therefore, despite farmers' concern that climate change and variability was a major threat to their agricultural activities, poor access affected their use of the information available and minimised their capacity to adapt. The current study findings imply that to promote usage, information on climate change and variability should have necessary qualities, such as timely dissemination to give farmers time to familiarise themselves with the innovation. Acquainting farmers with timely information helps them to make carefully considered decisions on ways to adapt to climate change and variability effectively.

Emphasising the role played by the nature of information in enhancing effective knowledge transfer to and the adoption of innovations by rural people, Chikozho (2010) and Mengistu (2011) found that timely access to information increased farmers' usage of said information to adapt to climate change and variability. Nevertheless, timely information may not meet farmers' needs if its content lacks credibility and reliability (Apata et al. 2009; Yanda and Mubaya 2011). The current study findings revealed that oral communication channels were widely used as the medium to disseminate information and enhance information and knowledge exchange. The use of oral communication channels, such as farmer field schools, farmer groups and village meetings, as compared to other channels was effective in enhancing the credibility and reliability, and use of innovations for adapting to climate change and variability by farmers. Thus, oral communication channels were found to promote information transfer and knowledge sharing among farmers.

Disseminating climate and agricultural information to farmers through oral means is more effective to rural farmers in most African countries for two main reasons. One is the low level of formal education farmers generally have. The other reason is that oral communication provides an avenue for discussion and feedback between the innovators and receivers. Rogers (2003) observed that the use of interpersonal sources is effective in changing strongly held attitudes, such as those pertaining to adoption of innovations related to climate change and variability. As climate change and variability is still a new concept to many farmers in rural areas, oral communication also helps to clarify related issues. Clarification from

reliable sources fosters greater trust in farmers about whether they should apply the information on climate change disseminated to them.

In addition, the study findings revealed that farmers' ease of access to knowledge sources and field practices enhanced their use of information to adapt to climate change and variability. It was found that access and direct contact with the CCAA project experts and their field practice promoted farmers' information sharing, feedback and field practices. During researcher-farmer training, farmers were provided with equipment, such as weather equipment, hoes, access to quality seeds and technical information, in order to facilitate farmers' adaptation and decision making. It was revealed that effective communication between the farmers and experts provided farmers with credible, timely and affordable information of good quality which enhances adoption of innovations. These findings confirm those by Meyer (2000) who found that knowledge transfer from experts to rural farmers was effective if provided orally and directly. It is important to ensure farmers have access to information on climate change issues as the findings showed that previous information on climate change and variability and best agricultural practises solicited by farmers was a great motivation for them to seek more information.

The results revealed further that uncertainty and a lack of relevancy regarding information on climate change and variability had an impact on farmers' use of information. These findings are in line with those of Gwimbi (2009) who found that despite the availability of plentiful information on climate change and variability at regional and national levels, most farmers in Zimbabwe could hardly use the information for farm level decision making as a result of poor interpretation of its relevancy. Similarly, a study conducted in the semi-arid areas of Zimbabwe by Mutekwa (2009) found that farmers relied less on conventional seasonal forecast in farm decision making and planning as a result of uncertainty. The uncertainty and lack of relevance of the information on climate change and variability being provided reduces users' need of that information. Information is mostly used when it has meaning and when it is perceived to benefit users. This barrier poses a great challenge to the scientists who provide information on climate change and variability.

However, farmers should not be blamed for the uncertainty of weather information as it is a challenge to both disseminators and receivers of information. Hulme et al. (2001) and Yanda and Mubaya (2011) observed that despite scientists being able to project the extent of global warming, there is much uncertainty in Africa about the direction and magnitude of rainfall changes. In this regard, the major contentious issue as highlighted by Hellmuth et al. (2007) is how to integrate the probabilistic climate information, with its clear uncertainties, into decision making. This integration will enhance the use of information by receivers, increase harvest, improve farming methods, increase income and promote adaptation to climate change and variability.



### 8.3. Factors affecting the dissemination and use of information on climate change and variability

Despite the study having shown that farmers adapt to climate change and variability as a result of the information they receive, a number of studies have revealed barriers which affect the dissemination and use of weather forecast information in agriculture. The study by Chang'a, Yanda and Ngana (2010) in Tanzania revealed that although the majority (96%) of rural people in Tanzania were aware of seasonal forecast information, only 58 per cent were using the information to plan for their farm activities. The low use of forecasts in Tanzania was found by Mukhala (2000) and Shetto (2008) to be caused by barriers in the communication and dissemination of information to farmers.

The current study findings revealed that inadequate knowledge was the major factor affecting dissemination and use of information on climate change and variability. The findings revealed that both information receivers and disseminators had insufficient understanding of climate change and variability agricultural issues. This lack creates a major barrier in the flow of information from the sources to the receivers. The inadequate knowledge of users and disseminators was also emphasised by Mutekwa (2009) who researched climate change and variability impacts and adaptation by farmers in Zimbabwe. He discovered that researchers and academics who were supposed to be sources of information to ensure adaptation strategies were well packaged and disseminated to farmers had limited awareness of the nature and magnitude of climate change and variability. He also observed that extension workers lacked accurate information and knowledge on climate change and variability, which are prerequisite tools in adaptation strategies for enhancing the agricultural production of farmers. Agwu et al. (2008) also noted that extension officers were not disseminating agricultural information to farmers effectively resulting in minimal information sharing and usage of information about innovations among farmers. However, this could be attributed to the inaccurate knowledge available on climate change and variability. Farmers' ignorance of climate change and variability issues contributes to the low use of information to make effective on-farm decisions. In this regard, knowledge on climate change and variability by farmers, researchers and extension officers is crucial in enhancing usage of information towards mitigating climate change adverse impacts.

The results of the current study also showed that despite farmers receiving information from the disseminators, they perceived information to be untimely, difficult to access and unreliable. These findings confirm those of Mengistu (2011) in Ethiopia, that the availability of timely climate information was a prerequisite for adaptation and mitigating the adverse impact of climate change and variability. Apataet al. (2009) also noted that effective and reliable information disseminated to farmers on climate change and variability was a critical factor in adaptation. Similarly, Meyer (2005) found accuracy, timeliness, relevancy, cost effectiveness,

user friendliness and targeting the intended users to be important factors. Mensah-Fosu, Vleck and Manschadi (2010) observed that farmers' adaptation in Ghana was low and the problem was largely linked with the inadequate information disseminated to farmers on adapting to climate change and variability. Farmers' lack of timely and reliable information on climate change and variability reduces proper decision making and exacerbates poverty as a result of low yield.

Notwithstanding the study findings and those of Mensah-Fosu et al. (2010) and Mengistu (2011), which showed that information is critical in adaptation to climate change and variability, the dissemination and use of information remains a complex area in information behaviour research. There are many issues which inform behaviour and the adoption process. The barriers to information dissemination and use largely emanate from the receivers' embedded attitudes and cultural values in a particular society. One aspect of users' attitudes which affects information usage is how they perceive the relative advantage of the information compared to what they know. A study in Kenya and Tanzania by Eriksen, Brown and Kelly (2005) revealed that despite farmers in semi-arid areas receiving information on drought-resistant seed varieties for adaptation, they were hesitant to use them. The major reasons pointed out by farmers were high labour investment, low consumption values and low market value. However, effective provision of information to farmers gives them an opportunity to decide whether to adopt and use the innovation which would not be possible in the absence of such information.

Cultural values also contribute to effective utilisation of information by users. These include, among others, attitude to change, ignorance, and exposure on how to adopt new knowledge to enhance their adaptive capacity. The current study findings indicated that farmers' culture affects access to and use of information on climate change and variability. The notion is supported by Shetto (2008) and Agwu et al. (2008) who found that despite farmers having access to information through media such as radio for adoption of innovations and ultimately adaptation to climate change and variability, most did not listen to the programmes. The studies found that farmers were more interested in entertainment programmes than educational programmes.

From the study it was observed that institutional factors, such as lack of finance; poor coordination of farmer programmes; lack of access to farm implements; fertilizers; and the uncertainty of weather information affect dissemination and use of information for adaptation. The results are supported by those of Roncoli and Kirshen (2002), Gwambene (2007), Yanda and Mubaya (2011) and Deressa et al. (2008) who also noted that these factors retard adaptation and development. On a similar note, Agrawal (2008) emphasised that local governance and institutions facilitate the utilisation and implementation of adaptation strategies to improve livelihoods. Thus, it remains clear that both farmers and government officials experience financial constraints which hinder the dissemination and use of information to enhance climate change adaptation. The availability of a well-organised government system

and information dissemination programmes will minimise institutional barriers and provide an effective system for disseminating climate change and variability information to farmers in order to enhance usage thereof. Users are motivated by accessing reliable information which benefits them and motivates them to seek more information from the sources. This is an important entry point in enhancing innovations and information dissemination to increase usage and promote adaptation to climate change and variability.

## 9. CONCLUSION AND RECOMMENDATIONS

To strengthen farmers' adaptation to climate change and variability, the study concludes and recommends that disseminators and users of information need to use appropriate channels and prepare timely, accurate information on climate change and variability. The use of proper channels and timely, accurate information could overcome the challenges farmers encounter in the course of adapting to climate change and variability. Thus, to mitigate climate change and variability, farmers' access to information and knowledge is of paramount importance as it has the potential to enhance adaptation by changing farming norms, responding to change of weather patterns, improving annual yields and increasing income.

The study further recommends more education and training for farmers and collaboration between researchers, meteorology experts, extension officers and farmers. The collaboration among agricultural stakeholders is crucial in combating climate change and variability challenges. These joint efforts are especially urgent for those farmers living in deep rural areas where information from formal sources hardly ever reaches. In addition, a comprehensive policy framework on dissemination of information related to climate change and variability is needed. The policy would streamline the dissemination of information to farmers who in most cases are deprived of the right to access accurate and timely information through proper channels.

## NOTE

1. Copies of the instruments are available from the first author.

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