Kenyan farmers' perceptions of and adaptations to climate change before and after a radio program intervention

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Fiona Mwaniki
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Nature of assistance	Contribution	Name, title and affiliation
Intellectual support	Proposal and thesis writing	Prof R. B. Stevenson, College of Arts, Society and Education, JCU Dr Philemon Chigeza, College of Arts, Society and Education, JCU
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Fiona Mwaniki **Date**

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Abstract

Farmers in Kenya are particularly vulnerable to the impacts of climate change yet their adaptive capacity remains low due to their high dependency on climate-sensitive natural resources and high poverty rates. Kenyan farmers are faced with limited public agricultural extension services, leaving them with few sources of useful information including adaptive strategies that would help them cope with the impact of climate change. Rural radio is a mass media extension tool that potentially can bridge this gap because its strength is widely regarded to lie in its ability to reach a wide audience of farmers and provide them with agricultural information in a language they understand (Chapman et al., 2003).This study investigated the potential of radio in influencing the utilsation of climate change information by farmers in Kilifi County, located along the Kenyan coast. The broad aims of this study were three-fold, to: (1) identify Kenyan farmers' perceptions of and responses to the impact of climate change; (2) develop and air radio programs that communicate climate change information to Kenyan farmers; and (3) evaluate the impact of this information on farmers' responses to climate change adaptation. A mixed methods pre-and post-intervention design provided the opportunity for triangulating results from both quantitative and qualitative data. Before the intervention, quantitative data were collected through semi-structured surveys with 421 farmers and qualitative data were derived from 11 focus group interviews and interviews with six key informants (e.g. chiefs and village elders) who provided a deeper and wider perspective of how the climate has been changing in Kilifi County. An analysis of farmers' climate change knowledge from the initial quantitative and qualitative data informed the development of radio programs with input from climate change experts from Kilifi County. Final quantitative and qualitative data collection (with the same farmers and focus groups after the intervention) and analysis enabled an assessment of the impact of climate change messages aired through radio on the farming community in Kilifi County.

The vast majority of the farmers in this study (87%) indicated before the intervention that they were already feeling the effects of climate change. Farmers viewed climate change as a risk that threatened their livelihoods, with some reporting that they had suffered negative impacts such as reduced crop yields as a result of the severe weather events (such as droughts and floods) they reported to have experienced. Consequently, many (87%) reported that their exposure to the impacts of climate change weighed negatively on their emotions, with some reporting to feel despair (23%), irritated (17%), confused (16%) and angry (13%). Farmers, before the intervention, mainly believed climate change was caused by entirely human activities (45%), followed by an act of God (34%) then by partly natural, partly human causes (10%) and natural causes (9%). Some farmers also reported that the weather information from the meteorological

department could only be trusted half the time and that they used indigenous knowledge to infer changes in weather patterns and to cope with the effects of climate change.

All farmers who participated in this study initially indicated that they owned a radio or had access to one. However, only 33% of the farmers reported to have listened to the programs of who 82% claimed to have implemented something they heard. The most commonly implemented interventions, from a long list, were growing drought tolerant crops (16%), water harvesting (14%), planting trees (13%), using manure (9%), growing both traditional and modern varieties of maize (6%) and accessing loans for farming (6%). A key finding was that farmers are likely to adopt climate change interventions despite their age, gender, income, level of education and what they believed were the causes of climate change. None of these factors were found to influence their reported decision to implement climate change interventions. Barriers identified by farmers to implementing the climate change practices they heard were lack of access to financial recources, high cost of adaptation measures, lack of labour and poor access to water. The major challenges to accessing the radio programs were no access to a radio or unsuitable program timing. The main challenge reported by listeners was the inability to store or record the programs resulting in farmers relying on their own recollection when implementing strategies. Recommendations to overcome these challenges include the use of social learning approaches that encourage group rather than individual listenership (such as community listening clubs and community-based radio schools), psychological interventions to help farmers cope with the emotional impacts of climate change, strengthening/enhancing early inclement weather warning systems, integrating local knowledge into climate change adaptation/mitigation efforts, and enhancing farmers' access to financial resources that would help them adapt to climate change.

Table of contents

List of Tables

List of figures

List of plates

Chapter One: Introduction

1.1 Background of the study

Climate change is considered a serious threat to sustainable development globally (Mitchel & Turner, 2006) and as one of the greatest ecological, economic and social challenges of our time (Cleugh, Smith, Battaglia, Graham, 2011). The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report defines climate change as (IPCC, 2007):

> a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. (p. 30)

Anthropogenic (human) activities increase the amounts of greenhouse gasses (GHGs) such as carbon dioxide, methane, nitrous oxide and halocarbons in the atmosphere, where carbon dioxide is the most important GHG. Anthropogenic increase of GHGs has contributed to severe global climate change impacts. These impacts include: greater food insecurity; rising sea-levels and accelerated erosion of coastal zones; increased frequency and intensity of extreme weather events (e.g. floods, droughts, cyclones, heatwaves); more species extinction and reduced biodiversity; and the spread of vector-borne diseases (United Nations, 2007; IPCC, 2014).

Developing countries are predicted to be hardest hit by climate change (IPCC, 2014). This is due to their location (frequently in tropical and drought affected regions) and high dependency on natural resources for their livelihoods, coupled with a low capacity to respond to climate related impacts. In Africa, yields from rain-fed agriculture in certain countries could reduce by 50% by 2020, sea levels are projected to rise towards the end of the 21st century and 75 to 250 million people are projected to be exposed to increased water stress (IPCC, 2007). Kenya, located in East Africa, will likely suffer from drought, reduced yields from rain fed agriculture, reduced livestock productivity, loss of biodiversity, increased food insecurity and malnutrition, and increased spread of diseases such as malaria and sleeping sickness (World Bank, 2012). These environmental effects are projected to lead to social consequences such as displacement of people and conflicts as resources become more scarce (IPCC, 2014). This study was undertaken in Kilifi County (located along the Kenyan Coast; Appendix A) which suffers from climate change effects such as drought and floods, and experiences five to six months of dry weather each year that leaves the ground bare and susceptible to erosion during short or intense rains. The rainfall patterns are unpredictable, in a County where 80% of the population supports itself through subsistence agriculture (Onyancha, Khaemba, Sabuni, 2010; Integrated Coastal Management Action Plan for Kenya, 2010-2014). However, climate change effects will not be negative for all regions and crops. Crop productivity may increase slightly at mid to high

latitudes for local mean temperature increases of up to 1–3 °C, depending on the crop (Thorton & Cramer, 2012). In Northern Europe, climate change is projected to increase yields and land area for agriculture and as a result agriculture may become more intensified (Bindi & Olesen, 2011).

The majority of the world's poorest people live in the rural areas of developing countries and their livelihoods depend on agriculture related activities, yet their capacity to adapt to the changing climate remains low (Tambo & Abdoulaye, 2013). The global demand for food is projected to increase by 60% by 2050 and small holder farmers, especially in developing countries, are expected to contribute to this projected demand (FAO, WFP, IFAD, 2012). Most African countries rely on agriculture for their national income and consider it a primary means for poverty alleviation and food security as rain fed agriculture contributes 30% of Gross Domestic Product and employs about 70% of the African population (Asafu-Adjaye, 2014; Ngetich, Mucheru-Muna, Mugwe, Shisanya, Diels, & Mugendi, 2014). This suggests that effective adaptation will be required by smallholder and subsistence farmers, pastoralists and fishermen, especially in the tropics, to enable them to respond to and cope with the effects of climate change. Adaptation to climate change has the potential to substantially reduce many of the negative impacts of climate change and exploit beneficial impacts (Smit & Pilifosova, 2003).

Farmers in Africa have been reported to adapt to the changing climate by adopting various practices such as planting early maturing crops, growing and breeding drought and pest tolerant crops and livestock respectively, shifting their timing and duration of crop growing seasons, diversifying their farming enterprises, using meteorological weather forecasts, migration and resettlement to other agriculturally productive areas, while others opted to do nothing (Hassan & Nhemachena, 2008; Deresa, Hassan, Ringler, Alemu, & Yesuf, 2009; Tambo & Abdoulaye, 2013). The fact that some farmers did nothing to cope with the changing climate of which they were aware indicates that perceptions of climate change (personal experience) do not always lead to adaptation (Adger et al., 2009; Pauw, 2013; Nyanga, Johnsen, Aune, & Kalinda, 2011; Bryan et al., 2013). Some of the barriers to climate change adaptation include poor access to credit, high cost of adaptation measures, lack of access to information and extension services, lack of labour, and poor potential for irrigation (Deressa & Ringler, 2011; Juana, Kahaka, & Okurut, 2013; Pauw, 2013).

Agriculture extension services traditionally in recent decades play an important role in providing relevant, practical and timely information to farmers including information that would help them cope with climate change impacts. These services are particularly beneficial to farmers who are aware that climate change is happening but lack knowledge on the specific

actions to take, how to undertake the actions and the beneficial impacts of those actions (Gifford, 2011). Extension officers are therefore a key component in creating awareness and training of farmers in technologies and practices for climate change adaptation. However, there has been a government freeze on employment of new extension officers in Kenya from the early 1990s leading to a reduction in the provision of extension services. Currently, the ratio of frontline agricultural extension providers is low, where one extension worker serves about 1500 farmers as opposed to the FAO recommended ratio of 1:400 (Brownhill et al., 2016). Media (newspapers, television, and radio) and ICT can bridge this extension gap by offering a channel for communicating climate change information to the public. Of the three main categories of mass communication tools for agricultural extension in Africa- radio, television and print media - radio is the most important (Sullivan, 2011) as it has the advantage of being mobile and can reach many farmers in their local language.

This study set out to understand and address the problem of the impact of climate change on farmers in Kilifi County through a radio intervention that investigated the potential and challenges of radio in influencing the utilisation of climate change information by farmers to adapt their farming practices. This was achieved in three stages. In the first stage farmers' experiences and perceptions of climate change as well as their responses in adapting their farming practices to the changing climate were identified. In the second stage radio programs that communicated climate change information to enhance their adaptive capacity were developed and aired. In the last stage an evaluation of the impact of this information on farmers' responses to climate change adaptation was conducted where the challenges and limitations of radio for increasing their adaptive capacity were identified.

Kilifi County was selected for this study because it is reported to suffer from the impact of climate change, and there are not many studies in the literature addressing this issue from the perspective of the County. Other attributes that contributed to the selection of this County are its coastal location and the fact that the County faces serious economic challenges. Kilifi County is one of the six counties on the Kenyan Coast (Chapter three provides a more detailed description of the County). According to the Kilifi County Integrated Plan (KCIP, 2013), the primary economic driver of the County is agriculture, with 56% of the land being suitable for agricultural activities. Other activities include fishing, tourism and mining (of salt and limestone used in the manufacture of cement). The County is reported to have high poverty levels which have partly been attributed to high population growth rates, high illiteracy levels and frequent natural disasters (Kenya National Bureau of Statistics and Society for International Development, 2013). In the recent past, Kilifi County has been reported to experience an increase in the intensity and frequency of extreme weather events such as severe droughts and floods (KCIP, 2013). Human activities such as the uncontrolled felling of trees in gazetted and

non-gazetted forests for charcoal, firewood and timber have contributed to exacerbating the problem of climate change. According to the KCIP (2013), climate change has negatively impacted various sectors in the county including agriculture (by causing reduced crop and animal yields leading to food insecurity) and health (by causing an increase in the incidences of water borne diseases due to floods).

1.2 Rationale of the study

Changes in climatic conditions have been observed in Kenya but climate change understanding remains low especially among the rural population, who also happen to be the most vulnerable. Their vulnerability to climate change impacts is a result of their high dependency on climate-sensitive natural resources and high poverty rates (Government of Kenya, 2010). Agriculture is the backbone of Kenya's economy contributing 24% of the Gross Domestic Product directly and 27% indirectly and accounting for 65% of the country's total exports, providing more than 70% of informal rural employment (Agriculture Sector Development Strategy, 2010). Providing information on how farmers can adapt to the changing climate through extension services is therefore important. However, agriculture sector performance has declined because of reductions in the number of extension workers and funding for extension services and research (National Agriculture Sector Extension Policy, 2010). This study posits that radio can bridge the current agriculture extension gap by educating and communication about locally relevant climate change adaptive practices to farmers in Kenya.

There are varying views by the public on the existence, extent and causes of climate change. These views may be influenced by, amongst other factors, personal experience as well as political, institutional, ecological, geographical, psychological, social or cultural factors (Wiid & Ziervogel, 2012). Knowing the climate change perceptions of a population and understanding the psychological, social and cultural reasons for the variation in climate change perceptions is paramount in formulating communication, education and policy interventions that can produce greater convergence in beliefs and willingness to act (Weber, 2010). Worldwide, few studies on farmers' perceptions on climate change have been undertaken, with most of the studies carried out in developing countries, where climate change effects will be felt most (Barnes & Toma, 2012). Several studies on farmers' perception of climate change have been done in Africa (Mubaya, Njuki, Mutsvangwa, Mugabe, & Nanja, 2012; Mengistu, 2011; Yaro, 2013; Clarke, Shackleton, & Powell, 2012; Mertz, Mbow, Reenberg, & Diouf, 2009; Nyanga et al, 2011; Tambo & Abdoulaye, 2013; Osbahr, Dorward, Stern, & Cooper, 2011). These studies have shown that the majority of African farmers are aware of climate change, but have a limited capacity to deal with its impacts due to challenges related to access to financial resources and extension services (Juana et al., 2013).

Globally, several surveys have established the position of the public on climate change (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013; Reser, Bradley, Glendon, Ellul, Callaghan, 2012; Pew Global Attitude Project, 2009; World Bank, 2009; Smith, 2010; HSBC, 2009; Dunlap, 1993; Brechin &Bhandari, 2011; Eurobarometer survey, 2011; Leiserowitz, 2007; Pidgeon, 2010). These global surveys present limitations when comparing statistics between countries. The surveys are geographically limited, with little representation from Africa, and no clear criteria used in deciding which and how many countries are included in a given survey. Whether the samples in a given country represent the rural or urban population is mostly unclear. This makes it difficult to compare statistics between surveys across years when sampling methods, wording and types of questions differ. Surveys, especially in Africa, mainly focused on farmers' observations in change of climatic conditions over a number of years. Farmers' wider understanding of climate change, their beliefs, attitudes and what they thought were its causes were seldom investigated. This study sought to address these gaps by investigating farmers' perceptions and adoption of adaptive practices before and after a radio intervention in order to build a farming community that is more climate change aware, prepared and resilient.

1.3 Significance of the study

Climate change effects will hit farming-dependent households the hardest. Most African farmers are aware that climate change is happening but lack the technological, financial and informational resources to adapt to the changing climate (BBC World Service Trust, 2010). Understanding farmers' perceptions of and barriers to the adoption of climate change practices is paramount in determining and developing relevant and practical climate change information that would increase their adaptive capacity. This study documents farmers' experience with climatic variability in Kilifi County as well as their understanding, beliefs, and emotions about climate change. The barriers that farmers reported to face when implementing climate change practices aired on radio provide a background upon which policies and strategies by different actors can be formulated in order to address them. Lessons learnt from this study provide a model for scaling up and sharing the potential of radio in promoting climate change adaptation practices to farming communities in Kenya and Africa. The results also form a foundation for enhancing radio extension in the Kenyan agriculture education curriculum and promoting networking between interested institutions.

1.4 Research Questions

i. What are Kenyan farmers' perceptions of climate change and its causes?

ii. What beliefs and emotions influence Kenyan farmers' responses to climate change?

iii. What strategies do farmers report as having put in place in adapting to climate change?

iv. How does radio as a channel for disseminating climate change messages impact on farmers' perceptions of and response to climate change?

v. What challenges do farmers face in implementing climate change interventions that are aired on radio?

1.5 Researchers' background

I employed my academic and work experience in the agriculture and forestry sectors of Kenya in this study. I have worked at Tree Biotechnology Program (TBP), the Kenya Forestry Research Institute (KEFRI) and Farmer Voice Radio (FVR). During my interaction with farmers while working at TBP, I observed that they majorly relied on farming as a source of livelihood, but suffered from recurrent crop failure due to droughts. Farmers had poor access to firewood for cooking, or timber for construction, forcing them to illegally encroach into natural forests with the result of slowly diminishing the countries forest cover. I also observed that farmers had little understanding of climate change with some reporting to be unaware of adaptation and mitigation measures. This inspired me to carry out a study, as part of my Masters' research project on cheaper on-farm methods of vegetatively propagating superior and fast maturing Eucalyptus hybrid clones. As a result, a cheaper, easy to adopt protocol for propagating Eucalyptus hybrids, using locally available material was developed that would be used by farmers at the grass root level to start their own nurseries. Farmers planted the Eucalyptus hybrids as a source of fuel wood, posts and timber while others sold the hybrids at different stages of growth for income. More farmers planting trees on their farms would remove the need for them to go into natural forests in search of fuel wood, leading to forest conservation, in the long run.

My most recent engagement with Farmer Voice Radio (now rebranded to Kilimo Media International) provided me with a first-hand opportunity of engaging with farmers while conducting surveys across Kenya. Farmer Voice Radio (FVR) was launched in Kenya in 2009. Its main objective was to introduce an agricultural extension model that tested the use of media houses (with a focus on rural and community radio stations) as information resources for farmers with the support of agriculture experts from universities, research institutes, NGOs and the Ministry of Agriculture. Amongst my other responsibilities, I was involved with conducting surveys that assessed the impact of the radio programs across Kenya. This involved questionnaire development and testing, training of enumerators (research assistants), and questionnaire administration logistics. In 2011, I attended a course at the Queensland University of Technology in Brisbane, Australia, funded by the Australian Leadership Award Fellowship program with the theme "Developing a Community Engagement Strategy for Climate Change Adaption and Renewable Energy Policy in Kenya". Lessons learnt during the one month course together with my experiences with farmers inspired me to further my studies on climate change

education and communication with farming communities who are the most vulnerable to climate variability, through the radio. Being female I encouraged the contribution of women farmers who in the African setting, are mostly viewed as silent actors whose voices are often unheard (Manfre, Rubin, Allen, Summerfield, Colverson, & Akeredolu, 2013).

1.6 Overview of methodology and methods

A pragmatic approach was used in data collection and analysis for this study. Pragmatism is mainly pluralistic and oriented towards what works (Creswell, 2014). Pragmatism has "a 'logic of inquiry' that primarily focuses on problem solving and outcomes, allowing one to make use of a myriad of methods for the practical purposes of induction, deduction, and abduction." (Greene & Hall, 2013, p. 131). Multiple sources of evidence are mixed to attain and modify knowledge which in turn informs potential solutions to problems that will help to answer research questions as well as provide a deeper understanding of the problem (Greene & Hall, 2013). A pragmatic approach to choosing the most appropriate method for a study acknowledges that each of the chosen methods has it merits and demerits and no one method is superior to the other.

This study used a mixed methods pre-and post-intervention design and was guided by the researcher's experience. The radio programs developed were the intervention. In mixed methods research, both quantitative and qualitative methods are combined (as opposed to subscribing to only one method) to meaningfully generate information that addresses research questions (Creswell, 2014). A researcher's assumptions (Greene & Hall, 2013), past experiences, understanding and knowledge of a community they have worked in can form a background on which the choice of research methods for a particular study can be made. In this case the researcher used her experience when working with Farmer Voice Radio in determining which method worked best for this study. From my experience while working with farmers, I observed that they often had a lot to say when it came to expressing their thoughts and feelings on agricultural issues. Therefore using quantitative methods alone would have restricted how much they had to share on particular topics, meaning not all their views and experiences would have been included in the surveys. Focus group interviews help to further explain some of the issues the quantitative surveys cannot elaborately address and provide a deeper understanding of the problem. I also observed that the use of quantitative methods alone may not always garner a representative female population. Focus group interviews with women groups helped to include their voices.

Quantitative and qualitative data were collected before and after the intervention. Before the intervention, quantitative and qualitative data were collected simultaneously, where quantitative data were collected through semi-structured surveys and qualitative data were obtained from

focus group and individual interviews with key informants. Qualitative data supported or augmented the quantitative data collected (Creswell & Plano Clark, 2011), enriched findings, and sought to explain observed trends or gaps from the quantitative data. An analysis of the farmers' climate change knowledge from the initial quantitative and qualitative data led to the identification of their information needs. Radio programs that addressed farmers' information needs identified during the analysis were developed with input from climate change experts in Kilifi County. Final quantitative and qualitative data collection and analysis after the intervention enabled an assessment of the impact of climate change messages aired through radio on the farming community in Kilifi County.

1.7 Theoretical perspectives

Theoretical perspectives discussed in this section are further elaborated in section 2.6 of the Literature review chapter.

The impacts of climate change are being felt globally with the frequency of extreme weather events projected to increase in the future (IPCC, 2014). As a result, climate change communication and education efforts are shifting from convincing the public that climate change is happening to persuading them to adopt practical measures to deal with its effects (Nerlich, Koteyko & Brown, 2010). This study is based on climate change education and communication primarily through the radio. There exists a large volume of studies on climate change communication. Theoretical perspectives for planning this study were drawn from extensive literature reviews on climate change communication by Nerlich et al., (2010), Moser (2010), and Wibeck (2014).These authors are in agreement that the development of relevant, practical and impactful messages that aim to communicate and educate the public about climate change and motivate adaptation requires an understanding of: how to effectively communicate climate change, how to foster public engagement in climate change communication, the barriers that may be encountered and how to overcome them.

Education and communication about climate change "is as complex as the science" (Chess & Johnson, 2007, p. 223). There is no one-size fits all solution to effectively communicate climate change in ways that lead to behaviour change and increase the capacity to adapt (Nerlich et al., 2010). Raising awareness or promoting active engagement by providing the public with information about adaptation or mitigation will not necessarily motivate them to act accordingly (Nerlich et al., 2010; Moser 2010). Additionally, some people may be overwhelmed by the magnitude of the problem of climate change. Hence, alarmist messages that emphasise the negative impacts of climate change without offering any solutions may not only result in their engaging in defensive coping strategies, such as avoiding more information about the problem, deflecting the blame to others, or justifying their current unsustainable behaviour (Portney,

2014) but also lead to depression and other psychological problems. Several aspects should therefore be considered when understanding the challenges and opportunities for effective education and communication about climate change. Moser (2010) summarises key aspects of the communication process as: the purpose and scope of the communication, the audience, the framing of the issue (use of language, metaphors and images), the information (message) conveyed, the messengers, the channels (including media and modes) through which the communication occurs and determining whether the communication achieved the intended effect.

Climate change educators and communicators should consider using various communication strategies that engage the audience, by making the issue appealing, interesting and meaningful (Nerlich et al., 2010). Communication strategies could include meaningfully engaging the audience by considering their values, emotions and attitudes; simplifying the technical language used by scientists into locally understandable terms; engaging the audience in a two way dialog; and being solution rather than problem oriented by communicating relevant climate change adaptation and mitigation interventions that have worked (Nerlich et al., (2010). Additionally, identifying the intended audience's information needs as well as their cultural values, beliefs, concerns and attitudes towards climate change, followed by developing messages that address these needs and characteristics can contribute to promoting active engagement. Somerville and Hassol (2011) add that climate change educators and communicators should

> Consider what your audience cares about. Talk more about the local impacts of climate change that are happening now. Connect the dots between climate change and what people are experiencing, such as increases in extreme weather. Try to craft messages that are not only simple but memorable, and repeat them often. Make more effective use of imagery, metaphor, and narrative. In short, be a better storyteller, lead with what you know, and let your passion show (p. 52).

Climate change content should be made locally relevant to the community and should ideally be facilitated by a person trusted by the community. This could include a local scientist, a religious leader, village elder or a government official. In addition, social scientists, communicators and educators should examine and learn from individual or collective experiences in a community which could make a significant contribution to current climate science knowledge. Lastly, messages that emphasise the negative impacts of climate change may increase worry, concern and fear amongst the audience. These types of messages must be accompanied by information that allows the audience to translate their feelings into actions that effectively reduce those impacts (Portney, 2014; Moser, 2010).

In analysing the findings, some limitations of radio and one way forms of communication became more apparent and theoretical perspectives on social and adult learning, particularly as developed by Mezirow (1981; 1994; 1997), emerged as a useful way to frame an analysis and recommendations. Adult learning essentially occurs informally through practical experiences and social interaction with others and it involves individuals attaining information, ideas and skills that inform their knowledge, attitudes, and belief systems and build their capacity for action. Dialogue is significantly important for the facilitation of adult learning. Dialogue gives meaning to experiences (Mezirow, 1991), hence social interactions that allow for dialogue are essential. Dialogue also enables learners to reflect back on prior learning in a social setting to solve problems. The process by which learners define and solve problems helps in learning through reflecting on the content of the problem, the process of solving the problem and the premise of the problem (Mezirow, 1991). Through this reflection adult learners such as farmers are able to undertake thoughtful actions, for example, in adapting to climate change.

1.8 Organisation of the thesis

The remainder of the thesis is organised into five chapters, followed by references and appendices, in the following manner: Chapter two is a review of the literature which explores perceptions of climate change from a global to a local perspective, factors that influence people's perceptions of climate change, agricultural extension service provision in Kenya and the use of radio as an education medium and, finally, theoretical perceptions that guided this study are provided. Chapter three describes the methodology, research design and data collection and analysis procedures used. The study area, sampling size and sampling methods, recruitment of participants, data collection instruments, the development of the radio programs and research procedures are described before and after the intervention. This chapter ends with a description of how the data were analysed, the ethics approval and considerations for this study and the methodological limitation of this study. Chapter four presents results of this study before the intervention, while in chapter five a comparison is made between pre- and post-intervention results. Chapter six discusses key findings from chapters four and five in light of the literature. Chapter seven concludes the thesis and provides recommendations for policy, practice and future research.

Chapter Two: Literature review

2.1 Introduction

This literature review forms a background for this study which sought to investigate the influence of a radio intervention on farmers' perceptions and adoption of climate change practices. Specifically, this study was centred on communicating climate change information including adaptation strategies to farmers in order to increase their adaptive capacity through the use of one media form (i.e. radio), supported by further education through agriculture extension. Hence, this literature review which explores climate change from a global to a local Kenyan perspective has a multidisciplinary approach, drawing on literature from climate change science, climate change communication, adaptation, agriculture extension and media. Drawing on these genres of literature helps to set the context of this study in trying to address the impact of climate change on farmers. This chapter begins with a discussion on the public perceptions of climate change with a focus on global public opinion trends and farmers' perceptions. The second section explores factors that influence public perceptions of climate change, such as culture, socio-demographics and media. The third section discusses climate change adaptation in terms of the types of adaptation, barriers to adaptation and defining adaptation success. The fourth section discusses agriculture extension provision in Kenya and reviews literature on the use of radio as a medium for formal and informal learning. Finally, the fifth section explains the theoretical perspectives, derived from this literature review that guided this study.

2.2 Public perceptions of climate change

2.2.1 Global public opinion trends

Public opinion surveys and polls aim at identifying and improving the understanding of public perceptions of climate change for both scientists and policy makers, in order to generate more informed discussions and action (Bord, Fisher, & O'Connor, 1998). In the literature, the terms "polls" and "surveys" have been used interchangeably (Nisbet & Myers, 2007; Eurobarometer survey, 2011; Pugliese & Ray, 2009; World Bank, 2009) even though they do not have the same meaning. Polls offer simple and speedy ways of gathering data and are mainly used by commercial and media houses. However, polls are frequently not scientifically rigorous because the sample sizes used are usually not representative of the population in question and the poll questions may not be framed appropriately. On the other hand, surveys are academic in nature and use complex statistical techniques to analyse data collected. Schuman (2008) attributes the interchanging of these two terms to the upward social mobility gained by commercial organisations in using the term surveys instead of polls in order to make them more acceptable or credible in the society. In this section, where an interchanging of the terms "polls" and

"surveys" was encountered within the literature, the indicated methods used in the article for data collection and analysis were used to make a distinction.

The *Health of the Planet* survey conducted by George H. Gallup International Institute in 1992 was the first survey to include a large and wide range of countries covering 24 nations (Dunlap, 1993). Results from the face-to-face survey showed that people in both wealthy and poor nations expressed as much concern over the environment and that they were willing to pay higher prices for industry to better protect the environment (Dunlap, Gallup, Alec, 1993). An expanded survey that focused on the lay public's perception of climate change was administered to six of the 24 *Health of the planet* countries, where it was found that those who had limited knowledge about climate change, were concerned but rated other environmental problems such as air and water pollution much higher (Brechin & Bhandari, 2011). In 1997, a mail survey was conducted in the U.S on the public's beliefs, attitudes and behavioural intentions on global warming (Bord et al., 1998). The data, which also compared results from other international studies, found that respondents had limited understanding of global warming and were not very willing to pay/sacrifice to reduce climate change impacts and rated other environmental concerns much higher than climate change.

The trend where climate change was increasingly viewed as a serious problem but other environmental concerns were rated higher by respondents continued into the 21st Century. A Globescan online survey in 2000 revealed a majority of the respondents in 34 countries viewed climate change as a "somewhat" to "serious" problem, with developing countries finding it more serious than developed countries (Leiserowitz, 2007). A re-survey in 2006 by Globescan in 22 of the 34 countries found an increase in the number of respondents indicating climate change was a very serious problem. The International Gallup survey conducted between 2007 and 2008 via telephone and face-to-face interviews in 128 countries revealed that 61% of individuals were aware of global warming. People in developed countries were more aware than those in developing countries, with Africa being the least aware, at 44% (Pugliese & Ray, 2009). The Gallup survey had similar findings to the second *Health of the Planet* and the U.S mail surveys which revealed that the American public was concerned about climate change, but rated other environmental concerns such as pollution much higher. In Europe, the Eurobarometer survey (2011) conducted via face-to-face interviews found that 89% of the respondents from European countries considered climate change a serious problem, with 68% regarding it as very serious. Respondents had a high expectation that Europe will be a low carbon economy by 2050.

However, results from surveys carried out in the same countries over longer periods of time showed the public viewed climate change as less of a serious problem. Surveys by Smith (2010)

from 1993 to 2010, in 33 countries and HSBC (2009) between 2007 and 2009 in 22 countries showed a decrease in the level at which countries perceive climate change as being serious. Smith reported the environment ranked 6th with only 4.7% of respondents showing some concern. Economy (25.5%), health care (22.2%) education (15.6%), poverty (11.6%) and crime (8.6%) were ranked first to fifth. The HSBC online survey reported a decrease in concern on climate change in both the developed (from 29% in 2007 to 25% in 2009) and emerging markets (from 54% in 2007 to 43% in 2009). Some of the possible reasons for the global decline in concern on climate change have been cited as the so-called "climategate" incident (discussed later in section 2.3.3) and other media publicity given to climate change sceptics (Stevenson, Nicholls, Whitehouse, 2012), issue fatigue, politicising of climate change, the public perceiving it as being distant in time and space (Lorenzoni & Pidgeon, 2006), and a decline in economic well-being (Pidgeon, 2010) heightened by the global financial crisis that occurred between 2007 and 2009.

Further investigations revealed that people in high income and big polluting countries viewed climate change as less of a serious problem. Examples are surveys conducted by the Pew Research Center and the World Bank in 2009 in 25 and 15 countries respectively. The World Bank survey that was conducted via telephone, internet, and face-to-face interviews (World Bank, 2009) showed fewer respondents in high income countries perceived climate change as very serious: for example, U.S (31%), Japan (38%), and France (43%). This was also observed with the Pew Research Center Survey (Kohut, Wike, Carriere-Kretschmer, Holzwart, & Poushter, 2009) conducted via telephone and face-to-face interviews where the big polluters U.S (44%), Russia (44%) and China (30%) showed the least concern. Findings from the Yale project on climate change communication, also observed that fewer Americans (since a similar a survey by the Yale project in 2012) are worried about climate change with 14% being very worried and 37% being somewhat worried, further confirms this finding of less concern about climate change in industrialized countries (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013).

A more recent PEW Research Center survey conducted in 40 countries in 2015 via telephone and face-to-face interviews reported 54% of the respondents viewed climate change as a very serious problem (Stokes, Wike, & Carle, 2015). Latin Americans (61%) were found to be the most concerned about climate change followed by Sub Saharan Africans (59%). The U.S (45%) and China (18%) remained among the least concerned about climate change. The PEW research Center survey found that nations with high levels of carbon emissions per capita (such as Australia, Canada, and Russia) were less likely to be very concerned about climate change. Interestingly, a significantly higher proportion of respondents (78% including 71% of Chinese) were willing to support their governments action on climate change by limiting GHG emissions

despite fewer of them reporting to be concerned about it. Despite the publics support from both poor and rich nations to limit GHG emissions, many of those interviewed (54%) were of the opinion that wealthy nations (such as the U.S and Germany) should bear a greater responsibility in addressing climate change. This view was held more strongly by respondents from poor economies (e.g. 64% Ghanains, 73% Filipinos, and 64% Tanzanians) which emit the least amount of GHGs. On the other hand, respondents from wealthy nations were of the opinion that rich and poor nations should equally share the responsibility of combating climate change.

Over the years since the "Climategate" incident, there has been a decrease in the number of people who believe that climate change is solely anthropogenic, but a mixture of human and natural causes. An internet based survey carried out in 2013 showed that out of the 63% of Americans who believe global warming is happening, 49% believe that it is caused mostly by human activities, with 33% attributing it to natural changes in the environment (Leiserowitz et al, 2013). Further to this, an online survey done in Australia in 2010 and 2011 found that only 4% of respondents thought climate change is entirely caused by human activities. A majority (83%) of respondents attributed both human activities and natural processes as the main cause of climate change with 7% attributing it to natural processes (Reser, Bradley, Glendon, Ellul, Callaghan, 2012).

Despite a vast majority of climate change scientists being in agreement that climate change is mostly anthropogenic, the public believe it is both natural and human caused. An analysis of scientific consensus on anthropogenic global warming in peer reviewed scientific literature from 1991 to 2011 found that out of the 33% of papers that expressed a position on anthropogenic global warming, 97% endorsed the view that humans are the cause of global warming (Cook et al., 2013). Further validation was done in a U.S study that investigated the views of reputable U.S climate scientists in 2005 and compared it to the 2007 IPCC physical science report. The U.S study found that there was an agreement on the nature, causes and consequences of climate change, with a majority of the respondents strongly agreeing (49%) and agreeing (39%) that climate change is anthropogenic (Rosenberg, Vedlitz, Cowman, Zahran, 2010).

2.2.2 **Farmers' perceptions of climate change**

Climate change effects will hit farming dependant households the hardest. There are limited studies on farmers' perceptions on climate change worldwide, with most of the studies having been carried out in developing countries, where climate change effects will be felt the most (Barnes & Toma, 2012). In China, a study done across Central North Shaanxi and Ningxia Provinces in 2009 showed that farmers' climate change perceptions were linked to aridity of their county. Seventy three percent of respondents in Yanchi, the most arid county, reported

having observed climatic changes in their lifetime and 45% of these farmers were worried about a perceived increase in drought. In less arid regions, farmers were found to be generally unconcerned about climate change (Sjögersten et al, 2013). A study conducted in both lowland and upland Nepal showed that farmers' perceptions closely matched climatic data. A majority of the farmers interviewed in lowland Nepal indicated that they have personally experienced climate change and have observed erratic rainfall, a decrease in the water level of nearby rivers and wells, as well as an increase in the length of cold waves in the last 14 years. In the uplands, farmers observed a decrease in snowfall, increased winter rain, delay of the onset of frost by two weeks and the emergence of mosquitoes and other insects due to an increase in temperatures, (Manandhar, Vogt, Perret, & Kazama, 2011).

Agricultural activities contribute to the emission of greenhouse gasses, specifically carbon dioxide, methane and nitrous oxide. Agriculture accounts for about 10-12% of the total global anthropogenic GHG emissions (IPCC, 2007). In spite of this, some farmers believe that their farming activities do not contribute to climate change and have diverse perceptions on how climate change will affect their crop quality and yields. In America, farmers in North Carolina who were found to be climate change sceptics had little belief that climate change will have negative effects on their crop yields. Only 36% of the farmers surveyed agreed/strongly agreed that climate change has been scientifically proven, with 47% of farmers surveyed agreeing/strongly agreeing that human activities cause changes in the earth's climate (Rejesus, 2012). A study carried out in Europe (France, Italy, and Germany) on the perceptions of winegrowers of climate change revealed that they have observed a change in climate over the past few decades (Battaglini, Barbeau, Bindi, & Badeck, 2009). A majority of the respondents reported an increase in grape quality. Eighty seven percent of respondents noticed an impact of climate change on pests and diseases and perceived it as a threat to their industry. However, grape yield was not seen to be affected by changes in climate. In Australia a national survey carried out in farms between 2006/2007 found that 66% of agricultural businesses observed a change in climate, where 62% stated that the perceived change had an impact on their holdings. Warmer temperatures (50%), more extreme weather events (74%) and change in rainfall patterns (92%) were the most common perceived changes affecting the holdings (Australia Bureau of Statistics, 2007).

Several studies on farmers' perception on climate change have been done in Africa (Mubaya, Njuki, Mutsvangwa, Mugabe, & Nanja, 2012; Mengistu, 2011; Yaro, 2013; Clarke, Shackleton, & Powell, 2012; Mertz, Mbow, Reenberg, & Diouf, 2009; Nyanga, Johnsen, Aune, & Kalinda, 2011; Tambo & Abdoulaye, 2013; Osbahr, Dorward, Stern, & Cooper, 2011), where sub-Sahara Africa (as well as low lying small island developing states in the Pacific and Indian Oceans, and the Caribbean, Mediterranean and South China Seas) are some of the most

vulnerable regions to climate change. These studies have shown that the majority of African farmers are aware of climate change, but have a limited capacity to deal with its impacts due to challenges such as poor access to credit, high cost of adaptation measures and lack of access to information and extension services (Juana, Kahaka, & Okurut, 2013). Inter-country surveys carried out in Africa, such as the Global Environmental Facility and World Bank funded survey in 11 African countries (Maddison, 2007), showed that a significant number of farmers believed that there has been an overall increase in temperature and a reduction in rainfall. According to this survey, most farmers in Senegal and Kenya believed they had lived through a change in the frequency of droughts. The same study explains from their findings that farmers who are in the best position to gauge if climate change has occurred are those who have the most experience in farming.

The findings that farmers perceived an increase in average temperatures and a decrease in average rainfall have also been reported in other studies carried out in vulnerable regions of Kenya to gauge farmers' perceptions on climate change (Bryan, 2013; Kitinya, Onwonga, Onyango, Mbuvi, & Kironchi, 2012). A study in Laikipia district in Kenya (Ogalleh, Vogl, Eitzinger, Hauser, 2012) found that farmers perceived reduced rainfall and increases in temperatures and frequency of droughts, as well as incidences of animal diseases, frost and hunger. They coped by diversifying the crops they grew, migrating to other areas and selling off their livestock. In another survey, perceptions of Agro-pastroralists' with over 23 years farming experience in seven districts (Arid, Semi-Arid, Temperate and Humid Agro-ecological zones) in Kenya were a decrease in the average amount of rainfall and long term changes in rainfall variability. Respondents reported feed shortages mostly due to drought in the arid and semi-arid zones leading to the death of their herds. Adaptation strategies employed included doing nothing (for farmers in arid areas), migrating, and diversifying or changing livestock feed (Silvestri, Bryan, Ringler, Herrero, & Okoba, 2012).

Farmers' perceptions on the changing climate do not always correlate with long term meteorological data. A study done in semi-arid regions in Kenya showed that farmers' perceptions on rainfall patterns were not supported by observed trends in rainfall data from the study sites (Rao, Ndegwa, Kizito, Oyoo, 2011). One possible explanation for this is that individuals face challenges in detecting climatic changes within weather fluctuations as climatic changes manifest themselves differently in different geographic locations and can appear almost normal based on the length of the comparison period and the individuals' past experiences (Akerlof, Maibach, Fitzgerald, & Cedeno, 2013). Another explanation could be farmers' beliefs and expectations can cause bias in perceptions of climate over time (Kahan, Jenkins-Smith, & Braman, 2010). For example, farmers in Illinois inaccurately recalled temperature and precipitation patterns over the last seven years. Those who believed the climate was changing in

their region recalled temperature and rainfall trends consistent with this expectation and those who did not believe climate change affected their region recalled temperature and rainfall patterns consistent with that belief (Weber & Sonka, 1994).

To sum up, public opinion assessments reported here were all found to be surveys, despite the interchanging of the terms "surveys" and "polls" in some of the articles (Eurobarometer survey 2011, Pugliese and Ray, 2009, World Bank, 2009). Global surveys provide useful data but have little representation of African countries. The criteria used to determine which and how many countries to be included in a given survey is unclear. The difference in wording, sampling methods, and questions makes it difficult to compare survey statistics across years. These discrepancies could have caused the difference noted between respondents from France, Japan and Kenya in both the World Bank and PEW surveys that were both conducted in 2009. The World Bank survey indicated France (43%) and Japan (38%) did not see climate change as a serious problem, but Kenya (75%) perceived it as a serious problem. On the other hand, the PEW survey reported climate change as serious problem for France (68%), Japan (97%), and not for Kenya (48%). However, surveys carried out over many years in the same selected countries, such as by HSBC (2009) and Smith (2010), provide a better picture for comparisons.

Worldwide, there are limited studies of farmers' perceptions of climate change with most studies having been carried out in Africa. Most farmers surveyed in African countries reported having observed increased temperatures and frequency of droughts and reduced rainfall over the years. However, there is more to climate change than observations in change of climatic conditions over a number of years. The surveys especially in Africa did not delve into the farmers' wider understanding of climate change: their beliefs, attitudes and what they thought were its causes. Largely, the surveys have looked at farmers' climate change perceptions, identified some strategies they have put in place in mitigating or adapting to climate change and outlined the challenges they faced. Farmers mostly coped by employing strategies such as diversifying their farming enterprises, changing livestock feed or selling of their livestock. In extreme cases migration was used as an option. Lack of information, the high cost of technology adaptation, lack of financial support and infrastructure, poor extension services and information flow from researchers to farmers were cited as some of the reasons for the limited capacity of farmers to deal with the effects of climate change.

2.3 What influences people's perceptions on climate change?

The previous section of this literature review discussed public perceptions of climate change. This section explores various factors that influences people's perceptions on climate change. Farmers' ability to take up proposed climate change interventions will largely depend on economic, political, social, cultural, educational, and technological factors. These factors in turn

influence public climate change views which vary within and between countries. Scepticism, uncertainty, ambivalence and denial are attitudinal terms used to describe those who hold an opposing view on climate change.

> Scepticism refers to strongly held disbeliefs in or a rejection of the tenets of mainstream climate science, uncertainty refers to a lower subjective sense of conviction or validity as to whether climate change 'really' exists, is caused by human activity, and/or will have major impacts . . . ambivalence . . . is the degree to which an attitude object is evaluated positively and negatively at the same time (Pootinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011, p.1016).

Climate change deniers or contrarians are vocal critics who contest the findings of mainstream scientific studies, receive disproportionally large amounts of media attention and hold a significant influence on ongoing debate about climate change impacts and policy (Anderegg, Prall, Harold, & Schneider, 2010). Climate sceptics hold very different positions and can be distinguished as trend sceptics (who deny there is global warming), attribution sceptics (who accept the global warming trend but see natural causes for this), and impact sceptics (who think global warming is harmless or even beneficial) (Rahmstorf, 2004). Additionally, audiences can be distinguished by how they understand climate change. A Yale University project on climate change communication in 2010 carried out an American national study that distinguished different categories of audiences (called the "Six Americas") as alarmed, concerned, cautious, disengaged, doubtful and dismissive. The alarmed had the highest belief in global warming and were most concerned and motivated; the opposite being true for the dismissive (Leiserowitz & Smith, 2010). Globally, people fall into the various forms of scepticism, attitudinal positions and audience segments and it is important for climate change education and communication efforts to be successful in distinguishing among them in planning such efforts.

2.3.1 **Cultural Influences**

Culture plays a significant role in influencing public opinion on climate change. "Cultural cognition" is "the tendency of individuals to fit their perceptions of risk and related factual beliefs to their shared moral evaluations of putatively dangerous activities" (Kahan et al., 2010, p.148). Culture forms an individual's norms and values and shapes one's mind frame to fit certain cultural beliefs and behaviours which in turn shape an individual's risk perceptions and related beliefs (Fagbohun, 2011). Culture can be defined as "information capable of affecting individuals' behaviour that they acquire from other members of their species through teaching, imitation, and other forms of social transmission." (Richerson & Boyd, 2008, p. 5). Kahan and colleagues state that culture influences

> the interpretation of new ambiguous information about climate change and other risk issues that serve to confirm pre-existing beliefs, hence fostering resistance to attitude

> change or even leading to a greater polarisation of views for those already at the extremes of opinion (as cited in Pidgeon, 2010, p.25).

In Africa, communities successfully use indigenous knowledge in farming and environment conservation (Nyong, Adesina, & Elasha, 2007). Cameroon's first attempt to enact three forest policies and laws were unsuccessful because they did not incorporate the protection, promotion and preservation of traditional knowledge of indigenous people (Fagbohun, 2011). The policies were found to be against the indigenous peoples' culture and beliefs and hence were rejected. In Kenya, cultural and religious beliefs have resulted in the preservation of indigenous forests, knowledge which should be taken into consideration in policy development. The Kaya forests along the Kenyan coast have been protected from illegal logging and encroachment through the culture of the Mijikenda people. The forests are viewed as sacred, holy, and set apart or revered (Nyamweru, 2012; Githitho, n.d.). Taboos and religious beliefs have been used in preserving the forest with dire consequences threatened from the spiritual world to those who break the rules. This means that cutting of trees, grazing of livestock or removing dead logs or twigs is forbidden. However, the forests are being threatened by encroachment as a result of demand for agricultural land and forest products, by a people who lack knowledge and respect for Mijikenda traditional values and beliefs (Githitho, n.d.; Nyamweru, 2012). The Kenyan government stepped in to save the forests in 1992 by recognising the forests as national monuments, where the National Museums of Kenya together with the Mijikenda community were made responsible for their conservation and management. Government efforts have seen 10 of more than 30 Kaya forests covering 15Km^2 along the Kenyan coast inscribed in the list of world heritage sites in 2008 by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), further preserving the forests and cultural sites.

Cultural cognition presents a challenge of communicating climate change to people who align their beliefs to those of their close ties; for example, individuals who place no value or lack understanding of environmental or cultural preservation. Cultural cognition can therefore positively or negatively influence a community's behaviour and perceptions towards climate change. This can in turn affect a community's acceptance or rejection of adaptation and/or mitigation strategies. For instance, the *Fulbe* and *Rimaiibe* live in the same geographical location in Northern Burkina Faso but they reacted differently to adaptation strategies available to them. The *Fulbe* did not embrace livelihood diversification adaptations to reduce their vulnerability to drought, such as labour migration, development work and gardening due to cultural beliefs and practices. On the other hand, the *Rimaiibe* who are located in the same region have used labour migration and diversification of livelihoods to cope with climate change impacts. More research on cultural cognition needs to be carried out as most of the studies have been done on small industrialised *WEIRD* sample sizes with *W*estern, *E*ducated,

*I*ndustrialised, *R*ich and *D*emocratic characteristics (Bender & Beller, 2013; Henrich, Heine, & Norenzayan, 2010). The investigations should establish how cultural cognition plays out in non-western world populations.

2.3.2 **Socio-demographic factors**

Socio-demographic characteristics of individuals such as age, gender, and level of education play a role in influencing public views, attitudes and beliefs on climate change. Whitmarsh (2011) found that age, gender, income, education and urban/rural location were determinants of uncertainty and scepticism, but were found to be mediated by environmental and political values. A national Australian survey examining public risk perceptions, understandings, and responses to climate change and natural disasters, undertaken in 2011, found that respondents who were less than 35 years old rated higher on belief of climate change, climate change concern, risk perception and greater experience with perceived impacts of climate change compared with all other age groups (Reser et al., 2012). Older people are not easily swayed to change their minds or behaviours on climate change as they have mostly identified their trusted sources of information and tend to only trust information sources associated with their cultural, political and/or religious values. Women are perceived to be more pro-environmental than men as they are found to be more emotionally engaged, more capable of establishing a connection between environmental conditions and their values, more concerned about environmental degradation and are more willing to change (Kollmuss & Agyeman, 2002; Whitmarsh, 2011). However, cultural cognition may influence men or women's perception on climate change. The influence of worldviews or culture on gender perceptions on climate change in different communities should be a subject for further research.

With the introduction of environmental courses into various universities curriculum, younger people are found to be less sceptical about climate change. A study done in 2009, covering 1,250 students from 166 universities in 43 countries (including Europe 53%, North America 21%, Australasia 12%, Latin America 9%, Africa 5%,), found that students' views of climate change were fairly accurate. Most of the respondents were between ages 23 to 26 years (59%), followed by 18 to 22 years (32%), with 9% being 27 years or older. Climate change as a topic or subject in teaching programs predominantly featured in North America with 83% followed by Europe with 71% and only 43% in Africa, out of the universities sampled per continent. The study also revealed that of the universities sampled, climate change was mostly taught in natural (73%) and social sciences (68%), and less with Engineering (44%), Humanities (21%), Arts/Design (12%) and sports (4%) (Filho, 2010). This study recommended incorporation of climate change into the education curriculum in all disciplines studied by students, even at the pre-university stage.

Level of education has shown mixed results as an influence on climate change beliefs. Several studies in America have shown that a higher level of education increases the chances of believing that climate change has already begun, but has no effect on Americans' belief on the main cause of recent global warming (McCright & Dunlap, 2011). Some studies have shown that an individual's level of education has no effect on their belief and concern about climate change (O'Connor, Bord, & Fisher, 1999; Wood &Vedlitz 2007; Malka, Krosnick, & Langer, 2009), while other studies have shown a positive effect (Maddison, 2007, Silvestri et al., 2012). McCright & Dunlap, (2011) argue that this difference is likely to be caused by variations in the measures used by researchers for global warming beliefs and concerns during data analysis. Another view from the Yale School of Law cultural cognition study is that individuals align themselves with scientific experts who share their common world views (Kahan et al., 2010). This could explain why as much as there is scientific consensus on climate change, the public despite their level of education take sides by only trusting sources of information that are in line with their world views, discrediting the rest. Additionally, studies that investigated the effect of science literacy on perceived climate change risks found that the perception that the public knows too little science to comprehend climate change evidence is inaccurate (Kahan et al., 2012; Allum, Sturgis, Tabourazi & Brunton-Smith, 2008). Instead they found that individuals with the highest qualification of science literacy were not the most concerned about climate change. Kahan et al., (2012) link this finding to the public conflict of interest between individuals forming beliefs that are in line with those with whom they closely associate and the collective one they all share in making use of the best available science to promote common welfare.

2.3.3 **Media influences**

Media plays an important role, along with other social institutions such as schools and churches, in contributing to the formation (and re-formation) of beliefs and attitudes in any society. Media is a channel through which common concerns and societal problems are aired and debated, resulting in the formation of public opinion, whether positive or negative (Gavin, 2009). Media (newspapers, television and radio) and more recently ICT, including social media, offer a channel for communicating climate change news to the public. Several polls in the U.S. found the main source of climate change information in developed countries to be television and newspapers, while the radio was found to be the principle source of climate change news in rural areas of developing countries (Boykoff & Roberts, 2007).

Despite the channel used, messages conveyed through the media influence the perception of the audience to climate change. In the recent past there have been incidences that have been fuelled by the media in a manner that misrepresents climate change research findings. For example, the

leaked e-mails from the University of East Anglia's Climate Research Unit in November 2009, popularly known as "Climategate," was fuelled by the media, where climate change sceptics claimed that scientists manipulated data to indicate global climate change. This occurred prior to the Copenhagen climate change summit, causing a lot of confusion amongst the public on scientists' stand on climate change. However, subsequent independent investigations by scientific organizations showed that there was no such conspiracy to enhance their data. Results from a study by Whitmarsh, (2011) on sceptism and uncertainty about climate change in the United Kingdom revealed that media communication about climate change is alarmist with the use of dramatic imagery and apocalyptic language. Most participants in the study felt that scientific experts are undecided on whether climate change is anthropogenic or not. In contrast to what many members of the public think, there is almost universal consensus in the scientific community about many aspects of climate change. A publication and citation analysis of climate science experts conducted by Anderegg et al., (2010) showed that 97–98% of climate researchers support the tenets of anthropogenic climate change outlined by the IPCC, and that there are significantly fewer unconvinced climate scientists than convinced.

Popular mass media (newspapers and television) has been accused of unbalanced reporting of climate change issues. The media interpret journalistic balance to mean giving equal coverage or attention to competing perspectives irrespective of the weight of evidence on each side (Storksdieck & Stylinski, 2010). However it seems misleading and biased for the media to have a 'balanced' coverage or debate between climate change scientists who have an overwhelmingly universal consensus on the issue and unscientific figures who are mainly climate change opponents (Stevenson et al., 2012). This unbalanced reporting of climate change by the media could be caused by the use of limited sources of information in reporting, weak scientific understanding of climate change issues by journalists (Storksdieck & Stylinski, 2010) and the media's proclivity to turn issues into controversies and conflicts in order to sell their product or increase their audience.

Limited coverage of important issues such as climate change can also be another form of unbalanced media reporting. A study in Britain between 2001 and 2006 found limited coverage on climate change by the British national press whereas other issues such as health, economy and crime were given higher priority (Gavin, 2009). This finding is common in Africa, and especially Kenya where politics, crime, health, human interest stories and entertainment carry the news of the day. Climate change is given prominence mostly during big world climate change meetings/summits or when the country faces floods, landslides, hurricanes or drought; catastrophes that journalists most often do not attribute to climate change. Imbalanced regional coverage of climate change by the media can result in regional differences in risk perceptions on climate change (Boykoff & Roberts, 2007). A case study that investigated how Conference

of Parties (COP14) and a European summit on climate change were covered by three Middle Eastern and one Danish newspaper showed that there were regional differences in climate change coverage in terms of number of news articles and quality (Eskjaer, 2009). These differences could be traced back to institutional practices, financial resources and interests, and journalistic fields of the different media houses. Media professionals face many challenges in covering climate change topics. These challenges need to be unearthed and addressed so as to achieve better balanced coverage and a better informed public.

2.3.4 **Political, economic and environmental influences**

Political and economic agendas and environmental values influence climate change beliefs. In the United States, climate change began to be strongly contested from the late 1980s especially when the Kyoto Protocol was being considered by the then U.S government (Dunlap & McCright, 2008). Political conservatives who are philosophically rooted in the values that oppose government interventions are commonly critics of climate change (Etkin & Ho, 2007). This finding is supported by McCright and Dunlap's study (2011) where liberals and democrats were found more likely to believe in and be concerned about anthropogenic causes of climate change than conservatives and republicans. Those who gain from the fossil fuel industry as well as car owners are more likely to be climate change sceptics while pro-environmental people are less likely to be sceptical (Poortinga et al., 2011). The fossil fuel industry has been accused of funding some journalists and anti-environmental advocates to deliberately obscure the truth on climate change (Johnson, 2010). On the other hand, scientists have been accused of over exaggerating the effects of climate change in order to become beneficiaries by making profits from mitigation/adaptation projects. This distortion of information in the form of disinformation or denial campaigns aims to slow down the enactment of climate change legislation and cause public confusion by intentionally and skilfully misleading them on climate change (Kolmes, 2011).

Physical cues can influence individual beliefs about global warming as evidenced in a study at the University of Bretagne-Sud in France (Guéguen, 2012).Undergraduate students were asked to answer a series of questions on climate change in different rooms with: a plant with foliage, a plant without foliage, three indoor plants with foliage, three indoor plants without foliage and no plants. Results showed that presence of an indoor plant *without* foliage was associated with an increase in students' beliefs about global warming, but the presence of foliage was associated with no variation in such beliefs. Also, an increase in the number of indoor plants *without* foliage increased the beliefs on global warming. Another study in America showed that exposure to abnormally high or low temperatures had an effect on individuals' attitude to global warming. The study looked at the effect of heat waves (seven consecutive days of temperatures 10^{o}C above normal) on respondents who experienced it three weeks prior to questionnaire

administration and those who did not. Results showed that being exposed to a heat wave increased the number of Americans believing in global warming by 5.0 to 5.9% but this opinion was swiftly wiped out by new weather patterns after the heat wave experience (Egan & Mullin, 2012). This finding is also supported by Donner and McDaniels (2013) in a study on the influence of national temperature fluctuations on climate change opinion polls. The study found that climate variability could be one of the factors causing variability in opinion in the U.S. since 1990. Results from these studies indicate that physical cues and short term climate events such as heat waves, floods, droughts and cold spells can lead the public to believe that climate change is happening. However, short term climate events are not indicators of climate change. The type, frequency, and intensity of climate patterns that persist for an extended period, typically decades or longer are indicators of climate change.

In summary, climate change views vary across and within countries. These views can be influenced by culture, socio demographic factors, media, political and economic agendas and environmental values held by the public. Cultural cognition poses a challenge for climate change educators and communicators in situations where the public align their beliefs to those of their close social, religious and/or political ties who may lack understanding of or devalue environmental issues (Kahan et al, 2010). Socio-demographic factors such as age and level of education influence public perceptions of climate change. Younger people (less than 35 years) were found to be less sceptical about climate change especially with the introduction of environmental courses into universities compared to older people who have mostly identified their trusted sources of information. Level of education has shown mixed results on climate change beliefs, with some studies showing that climate change beliefs are not influenced by an individuals' level of education. Additionally, individuals with the highest qualification of science literacy were found not the most concerned about climate change in spite of the overwhelming consensus on anthropogenic climate change by the scientific community. This could be as a result of the public, despite their level of education taking sides by only trusting sources of information that are in line with their world views, discrediting the rest. Media influences public perceptions of climate change and it has been accused of poor journalistic balance in climate change issues. Weak scientific understanding of climate change issues and use of limited sources of information in reporting have been cited as some of the reasons for the unbalanced reporting.

Political, economic agendas and environmental values held by the public influence public perceptions of climate change. Liberals and democrats are more likely to believe in and be concerned about anthropogenic causes of climate change than conservatives and republicans (McCright & Dunlap, 2011). Moreover, pro-environmental people are less likely to be sceptical, compared to those who gain from the fossil fuel industry and car owners who are

more likely to be climate change sceptics. Physical cues and exposure to different climate events influence public views on climate change, not always accurately. For example, being in a room with plants with no foliage or being exposed to short term climate events such as heat waves could increase the number of public believing in global warming. The public confuse single weather events as evidence of climate change happening. On the contrary, long term climate patterns or trends which show increasing temperatures and climatic changes are the true indicators of climate change.

2.4 Adaptation to climate change: an overview

The early impacts of climate change are already being felt globally and future impacts are projected to affect human and natural systems with largely detrimental consequences for economic and social well-being (Burton, Diringer, & Smith, 2006). Anticipating and adapting to climate change impacts in order to minimise its effects is therefore vital. The long and multidisciplinary history of research on adaptation has resulted in various definitions of the term in the literature by field and in practice (Moser & Ekstrom, 2010). This study adopted the definition by Smit and Pilifosova (2003) who define adaptation as the

> adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability (p. 88).

The IPCC third assessment report (IPCC, 2001) distinguishes several types of adaptation as:

> **Anticipatory Adaptation**—Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
> **Autonomous Adaptation**—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
> **Planned Adaptation**—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.
> **Private Adaptation**—Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.
> **Public Adaptation**—Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.
> **Reactive Adaptation**—Adaptation that takes place after impacts of climate change have been observed. (p.981)

Planned adaptations usually correspond with public/government institutions while autonomous adaptations are usually undertaken by private actors rather than government (Smit & Pilifosova, 2001). Adaptation to climate change is distinguished by its timing, therefore it can either be proactive (anticipatory) or reactive. Unlike reactive adaptation which occurs after the onset of a

climate related event, proactive adaptation occurs before the predicted future event (Grothmann & Patt, 2005). Burton et al., (2006) argue that actions/strategies that lead to proactive adaptation should be given priority to reduce future risks, but should also incorporate reactive approaches to help vulnerable communities recover from climate change impacts. According to Smit and Pilifosova, (2003), proactive adaptation is cheaper and more effective than "forced, last-minute, emergency adaptation or retrofitting" (p. 890) characteristic of reactive adaptation. However, proactive adaptation presents a challenge of adapting to climatic changes forecast but not yet experienced and uncertainties in the extent, timing and distribution of impacts in addressing risks that may occur in the future make the estimation of the appropriate level of investment, and their timing difficult (Burton et al., 2006). On the contrary, reactive adaptation resources can be targeted towards known risks since it is informed by direct experience of the climate change impacts (Burton et al., 2006).

Adaptation measures, initiatives, practices or strategies have been developed to reduce farmers' vulnerability to the impacts of climate change by providing them with a range of options to choose from (Mugi-Ngenga, Mucheru-Muna, Mugwe, Ngetich, Mairura, & Mugendi, 2016; Njeru et al., 2016). A systemic review of literature (63 peer reviewed articles) on climate change adaptation in sub-Saharan Africa found that farmers adapted to climate change by: changing the timing of their planting, planting early maturing crops, diversifying their crops, planting drought tolerant crops, irrigating, diversifying their livelihoods, relying on social structures around them (such as family and friends), migrating, changing the types of foods they ate because they could no longer grow them, reducing food consumption and using indigenous knowledge to cope with the effects of climatic variability (Antwi-Agyei, Dougill, & Stringer, 2014). A community's ability to undertake such actions is largely a function of their adaptive capacity (Burton et al., 2006) which IPCC, (2007) defined as "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (p. 869). Unfortunately, communities with limited adaptive capacities may not reap the potential benefits of adaptation strategies available to them. For example a weather warning system may be of little use to a community with no televisions, radios or mobile phones (Burton et al., 2006).

Assessments of adaptive capacity provide useful information on the types of resources or opportunities available for individual and collective local action or government intervention in building adaptive capacity (Engle, 2011; Jacobs, Nelson, Kuruppu, & Leith, 2015). Adaptation responses have to be matched with local conditions and needs because the nature of risks and the affected livelihood groups differ from one ecosystem to another (Kansiime, 2012). How to sufficiently assess adaptive capacity has remained a challenge to researchers because it is context specific and cannot be measured directly. The latent nature of adaptive capacity (it is

only best measured after its realization within a system) and variation in the methods used for measuring and characterizing it further increase the complexity in assessing it (Engle, 2011). Various frameworks that organize complex information about determinants that contribute to adaptive capacity and the processes through which those determinants interact have been developed by researchers (Jacobs, Nelson, Kuruppu, & Leith, 2015; Williams, Fenton, & Huq, 2015) in a bid to assess adaptive capacity. Identifying determinants that influence people's capacity to adapt and the publics' ability to access and utilize the identified determinants is therefore an important step in assessing adaptive capacity. The determinants of adaptive capacity include factors such as economic resources, available technology (including improved seeds and seasonal forecasting), information and skills, social factors (such as human capital), policies and governance structures, infrastructure, cultural values and equity (IPPC, 2007, Nelson et al., 2010). Social capital and knowledge have also been categorized as determinants of adaptive capacity in the literature. Social capital enhances a community's ability to act collectively through social relationships and close social bonds that enable cooperative action (Jacobs et al., 2015). Knowledge has been associated with many other determinants of adaptive capacity in various research frameworks (Jones, Ludi, & Levine, 2010; Adger, Brooks, Bentham, Agnew, & Eriksen, 2004). This highlights the need to frame adaptive capacity in terms of knowledge as a means of empowering actors to define adaptation on their own terms (Williams, Fenton, & Huq, 2015).

Barriers to adaptation have been defined as 'factors, conditions or obstacles that reduce the effectiveness of adaptation strategies" (Antwi-Agyei et al., 2014, p.2). Moser and Ekstrom (2010) expound this definition to include "obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institutions, etc" (p.2). Barriers to adaptation may be technological, cultural or related to limited resources or economic constraints, other more pressing priorities, and limited knowledge and skills on how to undertake the strategy (Smit & Pilifosova, 2003). Technological barriers present themselves when there are limited technologies available to farmers that would help them adapt to climate change, such as: drought tolerant crops and livestock, modern farm inputs, simple and affordable irrigation systems, formal and informal seed systems, accurate early warning systems for the weather and flood control measures. Culture plays a central role in a community's decision to adapt (as discussed in section 2.3.1) where individual and collective adaptations are guided by what is believable, desirable, feasible, and acceptable (Nazarea-Sandoval, 1995). Financial barriers or economic constraints are an impediment to the adoption of climate change strategies. African farmers have been reported to lack access to credit or financial resources that would help them meet transaction costs associated with adopting various adaptive strategies available to them (Juana et al., 2013).

Lastly, access to climate change information is a powerful tool that can be used to enhance the adoption of adaptive strategies by farmers in Africa (Antwi-Agyei et al., 2014). Farmers need to have the knowledge about adaptation options available to them, the ability to assess them, and the capacity to implement the most appropriate ones.

Overcoming all barriers to adaptation is not possible. Hypothetically speaking, a barrier free process does not guarantee adaptation success (Moser & Ekstrom, 2010). However, it is possible to achieve success of an adaptation strategy but how this success is defined varies in the literature as Adger, Arnell, & Tompkins (2005) elaborate

> the success of an adaptation strategy or adaptation decision depends on how that action meets the objectives of adaptation, and how it affects the ability of others to meet their adaptation goals. Crucially, an action that is successful for one individual, organisation or level of government may not be classed as successful by another. Success therefore depends on scale of implementation and the criteria used to evaluate it at each scale. (p.78)

There are various types of adaptation strategies and a variety of contexts in which they occur, leading to multiple types of adaptation success (USAID, 2014). The Global Environmental Facility (GEF) proposes three factors that can be used to estimate adaptation success

> 1) a project's ability to minimize uncertainty, achieved by using a spectrum of available sources of data; 2) a project's ability to alter communities' long-term perceptions and behavior toward climate change by convincing them of the need to adapt to climate change and giving them the confidence that adaptation activities can succeed; and 3) a project's ability to address the systemic nature of climate change by mainstreaming it into broader political, legal, and regulatory structures (cited in USAID, 2014, p.3).

Osbahr, Twyman, Adger and Thomas (2010) define the process of successful adaptation as one which increases the resilience of a system to climate change shocks and promotes institutions to generate and sustain individual and collective action. Examples of successful adaptation projects include a horticultural project initiated in 1994 in Mcitsheni village in South Africa that involved agricultural extension officers providing credit to small holder farmers in order to help them adapt to a changing regional economy and unreliable rainfall (Osbahr, Twyman, Adger & Thomas (2010). Through this project the members, who were mostly women, diversified risk by varying the crops they grew to include potatoes and selling their vegetables to nearby towns. In 2004, the members requested training in business which resulted in improved marketing strategies and developed mechanisms to access credit and information from extension officers. They also demonstrated local ownership of the project as exemplified by their local decision making about investment options for their financial returns.

Having defined adaptation in the context of this study and discussed the types of adaptation, the strategies African farmers have put in place to adapt to climate change, the barriers to adaptation and definitions of adaptation success in various contexts, the next section provides an overview of agriculture extension and the use of radio in formal and non-formal settings.

2.5 Agricultural extension

2.5.1 An overview and a Kenyan perspective

Agricultural extension services play a vital role in the growth of the agricultural sector by disseminating agricultural knowledge, information and technologies. Agricultural extension services help in linking farmers with other actors in the economy and are a critical change agent in promoting household food security and reducing poverty (Anandajayasekeram, Puskur, Workneh, & Hoekstra, 2008). Purcell and Anderson (1997) define agricultural extension as 'the process of helping farmers to become aware of and adopt improved technology from any source to enhance their production efficiency, income and welfare' (Anandajayasekeram et al, 2008, p. 82). Rivera, Quamar, and Crowder (2001) provide a broader interprettion that includes non-formal agriculturally related adult education for multiple audiences (such as youth and peri-urban farmers) and various purposes (community resource development and agricultural development).

Agriculture extension occurs with farmers who are adult learners whose learning essentially occurs informally through practical experiences and social interactions with others working in their field of agriculture. Adult learning involves individuals attaining information, ideas and skills that inform their knowledge, attitudes, and belief systems and build their capacity for action. Adult learning is more than cognitive processing of new information; it is a multidimensional phenomenon that takes place in various contexts (Merriam, 2010). Adult learning theory was pioneered by Malcolm Knowles who identified six major characteristics of adult learners: Autonomous and self-instructed; accumulated life experiences and knowledge; goal oriented; relevancy oriented; practical and with a need to be respected. However, Pereira and Aherne (2008) argue that Knowles' theory is more of a description of what an adult learner should be like than a theory, and add that adult learners retain the ability to learn with age, where new skills attained follow the learning curve and success at specific skills increase with practice. Adult learning usually occurs in environments where there is limited time to communicate every detail required to successfully implement specific tasks. Educators (extension agents) should therefore incorporate a myriad of strategies to foster adult learning. Strategies used should capture the adult learners' attention enough to encourage them to follow up and be engaged beyond the learning activity or program, and be empowered to implement ideas communicated.

Various agricultural extension methods have been tried by African governments, most of which have been initiated and promoted by the World Bank. In Kenya, extension service provision has evolved from a top down one size fits all approach to a pluralistic, demand driven enterprise. Extension services are pluralistic in being provided by various agents including the government, NGOs, civil society as well as the private sector. The most common extension delivery methods include face-to-face, on-farm demonstrations/trials, agricultural shows, field days and mobile training units for pastoralists. Farmer Field Schools (FFS) are also popular because of their hands-on field-based training where farmers learn practically how to implement a new technology being promoted from start to finish (National Agriculture Sector Extension Policy, 2012). Extension service provision models are mainly composed of delivery of free services to small scale farmers, with partial cost shared between farmers and the government or fully commercial where farmers pay for services provided by mostly the private sector (private companies, cooperatives, NGOs, CBOs).

Kenyan farmers have benefitted from extension services that have increased their farm productivity and profitability and reduced their risks by encouraging them to diversify their sources of income from farming (Brownhill et al., 2016). According to the National Agriculture Sector Extension Policy (2012), Kenyan farmers are classified as small scale (owning 0.2 to 3ha), medium scale (3 to 49 ha) or large scale (50 to 30,000ha), where small scale farmers are the majority. Regardless of their land size, farmers engage in various agricultural enterprises in the various agricultural subsectors which include industrial crops, food crops, horticulture, livestock, fisheries and forestry. The main food crops grown include maize, rice, wheat, sorghum, potato, cassava, beans, and indigenous and exotic vegetables. Industrial crops such as tea, coffee, sugarcane, cotton, sunflower, pyrethrum, barley, sisal and bixa are mainly grown for export. Horticultural crops such as cut flowers, vegetables, fruits, nuts, herbs and spices are grown both for export and domestic consumption. Livestock production includes beef, dairy, sheep, goats, camel, poultry, piggery and emerging livestock such as rabbits and bees. Aquaculture is a developing enterprise in Kenya with fish such as tilapia and catfish being grown commercially. These agricultural enterprises are at risk of climate change impacts especially in the face of Kenya's reduced forest cover that stands at less than the FAO recommended 10% of total land area. Government efforts are geared towards reforestation on both private and government land as a climate change mitigation strategy.

Kenya agricultural extension service provision faces many challenges. These challenges include weaknesses in: establishing research-extension-clientele linkages; packaging and disseminating technologies; recruitment and capacity building of frontline extension workers; and providing stakeholder linkages by creating functional institutional frameworks (National Agriculture Sector Extension Policy, 2012). The pluralistic extension system lacks a regulatory body to

coordinate all the players, resulting in duplication of efforts, wastage of resources and dissemination of conflicting messages. These challenges have resulted in the continuous restructuring and/or formulating of ideal extension models suitable to farmers. The National Agriculture Sector Extension Policy (2012) recognises these gaps and challenges including the decline in agriculture sector performance where reduced performance of public research and extension services was attributed to a decline in funding and the number of extension workers. The policy provides a point of reference for ethics, standards and approaches to all parties involved in agriculture extension service provision and provides a guide on how to strengthen coordination, partnership and collaboration. The policy includes the use of ICT in the development of Agricultural Knowledge Information Systems and acknowledges community based radio stations as one of the channels of increasing farmers' reach.

2.5.2 Use of radio as a medium for education in formal and non-formal settings

This study focused on informal learning with adults. However, a review of the literature on the use of radio in formal settings is provided in order to demonstrate the potential of radio as an educational tool in non-formal settings. Radio has been successfully used in formal learning systems with positive results such as higher levels of student achievement being reported in some of the countries that integrated it into their curricula (Jamison & McAnany, 1978; Nwaerondu & Thompson, 1987; Imhoof, 1983).

2.5.2.1 Radio as an educational medium in formal learning systems

Radio has been described as a dominant, effective and cost effective medium of communication, making it a powerful tool for primary or higher education (Lucas, 1999). Radio, if used effectively, can enhance the quality and relevance of education, reduce educational costs and improve access to education (Jamison & McAnany, 1978). Indeed, radio has enhanced access to education in settings with weak education systems, low teaching staff numbers or qualified staff, remote areas with poor access to schools, disadvantaged children who cannot afford to go to school and in fragile war torn countries (such as Somalia and South Sudan) where school attendance is unsafe (Bakshi & Jha, 2013). Radio has been reported to have high ownership, especially in rural communities, caters for both illiterate and literate populations and, compared to other media, is a cheaper method of reaching a wide audience in a limited period of time (Bakshi, & Jha, 2013; Lucas, 1999).

Globally, many countries have incorporated radio within their education systems via state owned stations with Mathematics and English being the most popular subjects (Bakshi, & Jha, 2013). Australia, Canada and the United States of America are examples of countries that historically have used radio to implement their education curriculum in remote areas. In America integration of radio into the education system begun in the 1920's with "Schools of the

air" programs (Bianchi, 2008), in Canada in 1925 with the broadcast of musical appreciation programmes by the Canadian National Railways radio network and later school broadcasts began at the University of Alberta and the Alberta Department of Education using the facilities of CKUA (a radio station) in Edmonton, starting in 1927 (Buck, 2006). In Australia, shortwave radio broadcasts begun to be delivered to outback students in 1948 and was followed by the development of the "School of the Air" (SOTA) programs from 1951 (Stacey, 2005). In Kenya radio broadcasts to schools began in the 1960's through the Ministry of Education and the Kenyan Institute of Education and were broadcast via the Kenya Broadcasting Corporation (then called Voice of Kenya) with the aim of improving the standard of and access to education (Odera, 2006).

English broadcasts were particularly useful in countries where it was not the first language. Kenya is a multilingual country and English was chosen as the language of instruction in schools. A "Radio Language Arts" project initiated in 1982 with support from the United States Agency for International Development (USAID) successfully tested radio's ability to teach English language skills in schools across Kenya (Imhoof, 1983). This was done after a similar project dubbed "Radio Mathematics" was successfully piloted in Nicaragua to children in their first years of primary school (Imhoof, 1983). Educational radio in these and other countries where it was introduced progressed in different forms, depending on various factors such as evolving educational needs and political and economic environments but the main objective was to complement and improve the existing educational curricular.

Radio is mostly viewed as a one way communication medium. An Interactive Radio Instruction (IRI) model was developed in 1970 in Nicaragua by Stanford University with the primary goal of turning the one-way technology into an interactive tool for learning (Bosch, Rhodes, & Kariuki, 2002). IRI integrates a variety of instructional design contexts which include printed materials, discussion groups and question and answer sessions managed by a facilitator (Sweeny & Parlato, 1982; Nwaeroundu & Thompson, 1987). The short pauses throughout the lessons allow learners to react to questions and participate in exercises through group work, experiments, physical and intellectual activities while the program is on the air, making the program interactive (Bosch et al., 2002). The IRI programming model uses active learning pedagogy where students learn from hands-on activities with mental engagement that keeps them productively involved and focused on learning. The programs are transmitted either through radio or audio cassettes where a teacher or facilitator manages the exercises, discussions and follow up. The "Radio Mathematics" and the "Language Arts" projects in Nicaragua and Kenya respectively used this Model. IRI was found to be effective in Nicaragua with the achievement of significantly higher scores by primary school children who were taught mathematics via radio lessons compared to their counterparts who were taught through regular

face-to-face classroom instruction (Nwaerondu & Thompson, 1987; Imhoof, 1983). In Kenya students after one year of English language instruction by radio made significant gains over conventional classroom students of 50% in listening skills and 25% in reading skills (Imhoof, 1983). The IRI model became popular around the world (including Kenya) with this model being further developed for a variety of other subjects, audiences and learning environments (Anzalone & Bosch, 2007; Berman, 2008).

The use of radio for formal education has its challenges. Competition for revenue from advertisements has pushed out or reduced the time allocated for educational programs within state owned radio stations. Other challenges are related to costs, political goodwill, policies and lack of ownership of the radio projects by the respective governments. The IRI model was not successful in some countries (e.g. Kenya, Nicaragua, Costa Rica, Guatemala) due to high operational costs, lack of local ownership of the project, poor institutionalisation, and changes in policies or political leadership (Anzalone & Bosch, 2007). In Nicaragua the IRI program was abandoned due to the revolution (which occurred between 1978 and 1990), while in Kenya, the government was unprepared to meet the project's recurrent costs. Most of the costs in educational radio arise from engaging qualified staff to design, develop, sequence and present the programs in a manner that meets the educational goals of the respective country. Other costs arise from purchasing radio station airtime to broadcast the programs (Imhoof, 1983; Myers 2008).

By the beginning of the 21st century, the use of radio for formal education had diminished, especially in developed countries due to competition from audio visual media such as the TV and internet (Farenga & Ness, 2015). However, radio still plays an important role in education in remote areas of developed countries as well as in developing countries that are less advanced in ownership and use of television sets and the internet (Farenga & Ness, 2015). It can be argued that educational radio has laid a foundation for the development of educational technologies through television, audio, video conferencing, the internet and other technologies developed to meet educational needs of learners (Chandar & Sharma, 2003). Radio has the power to capture the imagination of the audience by providing a 'theatre of the mind" (Imhoof, 1983, p2). As Lewis (1992) puts it "a child once said he preferred radio over television because the pictures are better" (p.32). Perhaps this could be one of the reasons why the School of the Air in Australia, CKUA radio in Alberta and IRI programs across various countries are still ongoing despite the challenges they have faced.

2.5.2.2 The use of radio in non-formal settings: The case of African rural and community radio

Radio was used to provide advice on health, hygiene and finance mostly to the farming community before many African countries attained independence (Ilboudo, 2003). Most African colonies gained independence in the 1950s and 1960s with the new governments taking over broadcasting services established by colonial authorities (Myers, 2008). This resulted in a monopoly of radio broadcasting services by the African states for nearly three decades (Myers, 2008; Ilboudo, 2003). During this time, the focus of radio programming largely included programs that promoted economic development (including agricultural content). Farm radio broadcasting which is the "system and structure within broadcasting institutions through which agricultural radio programs are produced and disseminated to the general public" (AFRI, 2008, p.12) emerged as an agricultural extension tool that provided relevant agricultural information to rural and remote farming communities (AFRI, 2008). As the population in most African countries increased post-independence, farm radio broadcasting was then used to strengthen agricultural extension services especially in countries with few extension officers (AFRI, 2008).

Liberalisation of radio waves that occurred in many African countries prior to and at the start of the new millennium led to the birth of private broadcasting which greatly enabled the growth of rural radio (Berman, 2008; Myers, 2008). Kenya gained independence in 1963 and Capital FM was the first private radio station to be licenced in 1995 (Minnie & Bussiek, 2011). This was followed by the Kenyan government fully liberalising the radio waves and issuing broadcasting permits and licences to many other private entities (Minnie & Bussiek, 2011). In the 1980s rural radio (in the African context) was used to refer to programs produced in cities by experts and broadcast to people in the rural areas via state owned frequencies (Girard, 2003). Rural radio "is a geographically descriptive term which acts as a powerful metaphor for the developmental process of connecting people together across remote communities so that they can share their knowledge, information and culture." (Chapman, Blench, Kranjac-Berisavljevic, & Zakariah, 2003, p.1). Rural radio has two broadcasting strategies; one where centralised broadcasters produce programs targeting rural audience and the other where decentralised broadcasting stations (which can be commercial, community, government or rural networks) located in rural areas broadcast agricultural information to farmers (Manyonzo, 2009; Ilboudo & Castello, 2003).

Community radio- unlike rural radio- has strong linkages between the community and the station. Community radio stations encourage the active participation of the community in program development and intervene in the community's development issues to correct social and economic marginalisation. Additionally, community radio stations are required to remain politically neutral and non-profit oriented (Manyozo, 2009). According to Manyozo (2009), the

term “community radio” is ambiguous due to the difficulty in describing “community”. Community may be defined from a geographical perspective; however other non-geographically situated forms of communities such as communities of practice or “imagined communities” (e.g. fish farming communities) have been coined. In Kenya the first community radio to go on air was Mangelete Community Radio located in the semi-arid district of Makueni, in 2004 (Minnie & Bussiek, 2011). The station was developed by the Mangelete Community Integrated Development Project and is composed of 33 rural women groups. The women groups were initially radio listening groups with the objective of actively participating in the production of programs that covered nutrition, agriculture, and reproductive health amongst other issues (Minnie & Bussiek, 2011). Since then several other community radio stations have been licenced.

Both community and rural radio aim to inform, educate, and entertain their listeners. Farm Radio Forum which was started in Canada in 1941 is one of the most dominant and widespread examples of the use of educational radio for farming (Manyonzo, 2009). Farm Radio Forum was a radio discussion program that served as a model to many developing countries which subsequently adopted it. The radio forums were composed of small listening and discussion groups that met regularly to listen and discuss specific programs (AFRI, 2008).The lessons learnt from Canada, such as the use of fora, multi-media approaches, printed materials, two-way communication and various production techniques (drama, interview, discussions with experts) were then introduced in India early in 1956, and in Ghana in 1964, with the sponsorship of UNESCO (AFFRI, 2008). In Africa, agricultural programs post-independence covered various topics such as: palm planting and maize spacing (Benin); improved seed varieties, soil management, and cattle rearing (Niger); agricultural mechanisation (Nigeria); and agricultural advice via the Education by Radio program (Kenya) (Ilboudo, 2003). Kenya has recently seen an increase in agricultural content both in rural and community radio using local languages. Mali Shambani (Wealth in the Farm) is an example of an agricultural program that has been on air for a decade. The program was first broadcast in 2006 via the state owned Kenya Broadcasting Cooperation (KBC) and was cited as the most listened to radio program in rural Kenya, after the KBC Kiswahili news in a survey by Steadman group in 2008 (USAID, 2008). The program covers various issues including crop and soil management, animal husbandry weather, food market prices and trends, financing opportunities, and has a live question and answer segment (through calls or text message) with an expert panel. Despite the increase in the number of agricultural programs on the Kenyan air waves, the programs are seldom informed by farmers’ information needs and there is hardly any follow up to establish the impact of the programs on the farming community.

Both rural and community radio stations are not without challenges. The mushrooming of private/commercial radio stations especially in Africa (including Kenya) has greatly reduced the listenership of state owned radio stations which mostly air educational radio programs. Additionally, commercial radio stations attract more listeners compared to state owned stations because they mostly broadcast entertainment content. Community radio stations have an over reliance on donors for capacity building of their staff, purchase of equipment, and paying staff salaries (Kamlongera, 2001; Manyozo, 2007). This dependence on donors to sustain the running of the stations has been attributed to low advertising revenues to the stations (Kamlongera, 2001). These financial constraints have resulted in community radio stations mostly broadcasting live studio-based discussions with experts as opposed to high impact educational broadcasts composed of prepared programs with drama and magazines (Myers, 2008). Both community and rural radio stations suffer from inadequate human capacity. The stations are reported to have low staff numbers resulting in some staff taking up multiple responsibilities. For example, an individual may function as the producer and presenter of a program and double up as a technician when required. High staff turnover-especially with community radio stations-is common as trained personnel who are mostly volunteers leave for salaried opportunities in private and commercial stations (Minnie & Bussiek, 2011). Despite these challenges the radio stations have greatly benefitted from the support of various international organisations such as UNESCO, Farm Radio International (FRI), The World Bank, Bill and Melinda Gates Foundation (BMGF) and Food and Agriculture Organisation (FAO). For example, the FAO has provided support to rural and community radio stations since the 1970s through its Extension, Education and Communication service by offering: capacity building of personnel; support for setting up new stations including designing broadcasting services (e.g. radio Dahomey in Benin in 1960) (Ilboudo, 2003); support to rural networking initiatives; and research and evaluation services mostly in the design and application of methodologies for analysing the content of rural radio programs (Ilboudo & Castello, 2003).

2.5.2.3 Participatory approaches to educational radio in non-formal settings

While most communication and education experts agree that radio can play an important role in bringing about change, the ability to induce such change using radio alone remains controversial. Human interaction is necessary in getting individuals to adopt innovations (Sweeney & Parlato, 1982). Therefore, agricultural radio programing cannot be considered a separate activity from the educational work carried out by extension officers (AFRI, 2008). This realisation has resulted in a shift in broadcasting approaches used by rural and community radio stations from top down to more participatory approaches that encourage dialogue with the audience. This dialogue is aimed at enhancing the audiences' understanding of the concepts being communicated. Studies that examined the use of radio in conjunction with some form of

interpersonal support, such as discussion groups, printed materials or contact with extension workers found them to be very efficient and effective in encouraging dialogue (Cerqueira, et al, 1979; Bordenave, 1977). Other forms of participatory approaches that have enhanced dialogue and discussion between the radio stations and listeners, such as mobile phones, and social media have transformed radio from a one way to a two-way communication medium (Rao, 2015).

Radio can create a participatory learning environment by encouraging feedback from listeners. After a program's broadcast, a telephone number, email or postal address can be provided where listeners can call, send a text message, or write with their queries or comments. Social media (e.g. Facebook and Twitter) can also be used as an avenue to carry on the program discussions off air, after the program broadcast. Live shows on radio promote dialogue by providing listeners with the opportunity to call in directly and talk to the experts on the show. However, these methods of providing feedback are dependent on listeners taking the initiative and are limited in the kind of interactions they make available, with most of them using the question and answer (Q&A) format to provide feedback. Radio can promote social interaction amongst farmers by encouraging them to form radio listening groups. These groups listen to the radio programs together or individually, after which a discussion on the content learnt follows. Radio listening groups enable a very different and more authentic kind of dialogue compared to the other methods of providing feedback mentioned earlier, in that the listening groups offer a deeper and more meaningful engagement between participants on the topic of discussion. Social interaction amongst farmers can also be encouraged through radio stations creating awareness and encouraging farmers to attend social events such as farmer field days, agricultural shows and farmer trainings.

2.5.2.4 Importance of the cultural context in the use of radio as an educational tool

The use of radio as an educational tool in formal and non-formal settings should integrate approaches that combine scientific knowledge with indigenous knowledge to build on local cultural and agro-ecological diversity (Chapman et al, 2003). The traditional African education culture is more oral than written. A well designed educational radio program can capitalise on this oral tradition by preserving the oral heritage of indigenous agricultural practices and incorporating new agricultural information that can be passed along orally, especially for adults (Imhoof, 1983). Creative forms of learning such as stories, folklore, myths, symbols, music dance, proverbs, tongue twisters, and riddles are commonly used. All these creative forms of learning are examples of "Critical thinking activities, encouraging . . . innovative, creative and difficult uses of various symbol systems." (Reagan, 2000, p.34). These methods can be used in climate change education and communication efforts in non-Western communities to draw the learners' attention, create meaning and retention of knowledge.

In order to expand our understanding of adult learning holistically, there is a need to consider different cultural values and epistemological systems. This is especially important in environments where learning occurs with learners having non-Western worldviews. For example, a study on self-directed learning was rejected in Korea because:

> a person becoming independent of his or her parents, teachers or other people, tends to be considered threatening the stability of a community he or she belongs to. The virtue of independence and autonomy is not an indication of a person reaching an idealised adulthood in Korean culture . . . Becoming independent without being interdependent passes for immaturity or self-centeredness (Nah, 1999, p. 18).

In Australia it is argued that Aboriginal literacy programs are not just about being effective in reading, numeracy and writing to gain meaningful employment, rather they are about resymbolising and reinterpreting past experiences and valuing traditions in contemporary times (Merriam, Caffarella, & Baumgartner, 2012). Africa is diverse in culture, language and ethnicity and "Education… cannot be separated from life itself. It is a natural process by which the child gradually acquires skill, knowledge, and attitudes appropriate to life in his or her community" (Reagan, 2000, p.29). In the African context children learn by copying adults in their daily activities. This includes agricultural activities where (indigenous) knowledge is passed down from generation to generation.

Educators using Western or non-Western theories or approaches to learning need to consider learners' emotions which may impede or facilitate learning. To deny emotions is to deny learning. Emotion is both "a motivator and modifier of attitudes and behaviour… by influencing knowledge structure and processes." (Pereira & Aherne, 2008, p.130). For learning to occur, adult learners need to have: the appropriate motive for producing a commitment to and readiness for learning; scaffolding of new concepts and ideas that connects to their existing cognitive schemas or mental models; and feedback including reinforcement of learning as it takes place (Mezirow, 1991; Hansman, 2001). The emphasis of educators should be to develop long term not just immediate retention. Learners should be encouraged to be aware of and express their emotional responses to both climate change and learning situations about climate change. Educators on the other hand can use literature, poetry, art, humour, trilogies, metaphors, and films to strengthen emotional responses to learning.

In summary, agriculture extension service provision in Kenya has evolved from a top down, one size fits all to a more participatory approach. The agricultural sector has faced many challenges in the provision of extension services to farmers including a low number of extension staff. Agriculture extension service provision in Kenya should benefit from the implementation of the National Agriculture Sector Extension Policy (2012) which recognises

the role of radio in providing farmers with relevant and timely information in the face of the negative impact of climate change on their farming. Radio has been successful as an education medium in formal and non-formal settings in many parts of the world. However, for radio to be an effective education medium many factors have to be considered including the cultural perspectives that learners bring to a learning situation, the need for dialogue between the station and the audience and interaction between the audience and a facilitator (in radio listening groups). Radio has a rich history in theory and practice. This history forms a platform upon which climate change educators and communicators can build upon in ways which enhance learning and adoption of practices that would help the public cope with climate change.

2.6 Theoretical perspectives

Theoretical perspectives for this study were drawn from extensive reviews of climate change communication literature with a primary focus on publications by Nerlich et al., (2010) who position "the theory of climate change communication within theoretical developments in the field of science communication"(p.1); Moser (2010) who discusses the challenges of communicating climate change, the key elements of the communication process, and the importance of assessing the effectiveness of communication; and Wibeck (2014) who focuses on how to enhance learning, communication and public engagement, barriers of public engagement and how they may be overcome in non-formal education settings.

Communication is a vital element in promoting effective and successful adaptation strategies. Communication of climate change aims to engage individuals and communities through information dissemination and debate in order to elicit behavioral responses necessary to mitigate and adapt to climatic variability (Moser, 2010). Effective communication between stakeholders can help raise awareness, identify problems, encourage dialogue and influence behavioural change (Moser, 2010; Nerlich et al., 2010). One of the challenges of communicating climate change is related to its complexity and uncertainty because it is not well understood by laypeople and it is never entirely predictable (Moser, 2010). Other challenges include the perception by the public of climate change impacts being distant in time and place; climate change not being directly observable; the delayed or absence of gratification for taking action; the lack of cultural narratives or stories that sustain engagement and motivate interest in climate change issues; the public's political orientation, worldviews and religious views; and the lack of a sense of agency (Moser, 2010; Wibeck, 2014). Agency is an individual's ability to act and includes awareness of options and one's capacity to implement those options (Fleming, Vanclay, Hiller, & Wilson, 2014). It would be difficult to encourage the public to engage in climate change issues unless they believe that they can do something about the problem and that it is worth doing something about (Moser, 2010).

The multidisciplinary nature of climate change poses yet another challenge to climate change communicators and educators. Working across disciplines makes it difficult for experts to listen and talk to each other especially because more than one discipline is required to understand and address environmental sustainability problems such as climate change (Scott & Gough, 2003). Communication between scientists and other communicators, on one hand, and lay people on the other, may need a substantial effort for this exchange to lead to greater understanding and constructive engagement (Moser, 2010). Climate change educators and communicators therefore need to learn how to work across different disciplines and literacies and act as interdisciplinary mediators and co-contributors with experts from other disciplines. Scientists and other communicators also need to familiarise themselves with the scholarship on communication with lay people (Moser, 2010).

There is a widening gap between the scientific knowledge of climate change (including adaptation and mitigation strategies) and the public's understanding of that knowledge (Weber & Stern, 2011). Climate change educators and communicators have over the years endeavoured to "fill" this gap to support/facilitate learning by using different strategies and approaches (including the mass media) some of which may or may not have worked. As a result there has been a rethinking of how to effectively communicate climate change by communicators and educators (Nerlich et al., 2010). The simple import-output model of information dissemination and acquisition of knowledge has been superseded in recent decades by more sophisticated understandings and theories of learning of science. Many scientists subscribed to the "Public understanding of science model" and the "information deficit model" which both assume that the provision of more scientific information to laypeople will result in their acceptance of scientific and technological advancements and result in a greater convergence between the knowledge and attitudes of laypeople and experts; and that the public knows far too little science to act and providing this information will move them into action (Nerlich et al., 2010; Moser 2010). These simplistic views of audiences by scientists have in many cases been replaced in recent times with approaches based on how to better engage with the public so that they are motivated to actively learn and take action on climate change. As a result, there has been a shift in focus over the years by social scientists and climate change communicators and educators from how the public understand climate change to how to engage the public with the issue both in terms of personally connecting with climate change issues and climate policy deliberations (Wibeck, 2014).

The key elements of communication that aim to engage the public on climate change issues should include the purpose and scope of the communication. Moser (2010) summaries the purpose and scope of the communication as: to inform and educate individuals about climate change, to achieve some type and level of social engagement and action, and to bring about

changes in behaviour. Public engagement on climate change issues generally involves the audience, the messenger (person conveying the message) and the message (Moser, 2010). Recommendations on each of these three dimensions have been put forward by a number of climate change communication scholars. Climate change educators and communicators should strive to make the *message* relevant, consistent, appealing, and meaningful to the audience by using clear and simple metaphors embedded in stories with imagery and humour to maintain the attention of the audience (Nerlich et al., 2010; Moser 2010). Cultural narratives, which are important in making climate change meaningful and sustain engagement by motivating interest, especially with laypeople, should be used (Wibeck, 2014). The message should also contain the specific steps the audience can take to make a difference (Nerlich et al., 2010). Thus, the message should focus on climate change solutions rather than problems and showcase success stories of how ordinary people have taken action on climate change. To promote a sense of agency and control, the message should encourage people to join community projects that focus on mitigating or adapting to climate change (Wibeck, 2014).

The *audience* is comprised of people who possess different cultural values and beliefs, language, fears, hopes attitudes, concerns, and knowledge of climate change. The message should therefore be context specific, communicated in a language that speaks to the audience, connect with the cultural values and beliefs of the audience, and consider the level at which the audience can engage with the issue. The *messenger* plays an integral part in framing the way in which the climate change story is told and establishes its credibility. The messenger should tell the story in a way that engages the audience, enables them make sense of the problem and moves them to action (Moser, 2010). Ideally, communication should be a two way interaction between the information source and receivers. The messenger should therefore endeavour to engage the audience in dialogue or participatory communication which Nair and White (1993) (as cited in Jacobson and Kolluri,1999) define as 'the opening of dialogue, source and receiver interacting continuously, thinking constructively about the situation, identifying developmental needs and problems, deciding what is needed to improve the situation, and acting upon it' (p.272).

Thompson and Schweizer (2008) summarise these concepts as follows (as cited in Nerlich et al., 2010, p.105):

> **1.** Know your audience and select a credible messenger for that audience.
> **2.** Know what type of claim, argument you are asserting and why it is appropriate for your audience.
> **3.** Connect your message to cultural values and beliefs; people react to traditions, experiences and shared values—not abstract concepts and scientific data.
> **4.** Make the message meaningful; appeal to values that are meaningful for your audience. For example, speak in spiritual language and parables when targeting a conservative Christian audience.

> **5.** Lead with your strongest argument or your most confident point.
> **6.** Make the message empowering; tell your audience what specific actions they can take to make a difference.
> **7.** Link to global patterns and collective action; promote a 'systems' perspective of the problem and of potential solutions.
> **8.** Partner with other organizations, key players, leaders, employees, rock bands, and neighbors.
> **9.** Start from the inside—get your organization's top leaders involved, inspire action internally first, then communicate about it.
> **10.** Communicate about actions and remember that actions and events are an effective mode of communication.

The public is not homogeneous. It is comprised of communities whose members share perceptions of risk, values, beliefs, understandings, concerns, and emotional responses to climate change (Wibeck, 2014), but these perceptions may vary across communities. Nerlich et al., (2010) therefore emphasise the importance of establishing the public's existing perceptions about climate change. They argue that this can be used to tailor communication initiatives before starting any local communication activities. Knowing the public's perceptions of climate change prior to the development of a communication initiative provides evidence of what the public already know and believe about the issue and facilitates better communication between all parties involved. Moser (2010) recommends a follow up evaluation study to establish whether the goals of the communication activity were met and if not why. What worked and what did not need to be carefully examined in order to improve future climate change communication and engagement activities and could offer valuable practical and theoretical insights (Moser, 2010).

Lastly, alarmist messages and images on the current and IPCC predicted future impacts of climate change are likely to evoke feelings of fear and hopelessness amongst the public (Wibeck, 2014). Communicators need to foster hope by providing

> a realistic assessment of the threat or diagnosis, a sense of personal control over their circumstances, a clear goal, an understanding of the strategies to reach that goal (including the personal setbacks along the way), a sense of support and frequent feedback that allows them to see that they are moving in the right direction. (Moser, 2008, p.73).

Giving hope is about climate change communicators and educators creating awareness of innovative adaptation strategies (success stories) that have worked in other communities to empower them to take action (Stevenson et al.,2012; Wibeck, 2014). This can be achieved through creating awareness of local community-based adaptation strategies that have been successful in enabling communities to enhance their adaptive capacities and empowering them to increase their resilience to climate change impacts (Yatich, 2011). A Kenyan example can be

given of the pastoralist community in Kaikor, Turkana North. Their livelihood, which has been threatened by continuous drought spells due to climate change, entails walking long distances in search of pasture and water for their livestock. The droughts have resulted in the loss of human and livestock life due to hunger and malnutrition. The Kenya Red Cross Kenyans for Kenya (K4K) project has promoted growing of food crops and fruits through irrigation in this region. Water is pumped into storage tanks using solar pumps from boreholes, making it accessible for domestic, agricultural (small scale irrigation and kitchen gardens) and livestock use (Kenya Red Cross resilience program, n.d.). This success story provides hope to other drought stricken communities, not only in Kenya but regionally.

In summary, effective climate change education and communication strategies are a vital catalyst in facilitating and promoting the adaptation and mitigation of climate change interventions by the public. The considerations for effective education and communication discussed in this section provide possible plans of action to facilitate the education and communication of climate change information through radio. Radio is an educative vehicle that is viewed as a one-way communication medium, where information is relayed in a short period of time. The fact that radio is not visual poses a challenge of communicating practices which could better be explained practically. The considerations discussed in this section (such as: the use of imagery, metaphors, and cultural narratives; audience interaction with the station through call ins and social media; and monitoring and evaluation of the radio programs) seek to address these challenges by providing potential strategies that can be used by radio producers during program production or by other communicators including agriculture extension agents involved beyond a program broadcast.

2.7 Conclusion

This literature review provides a context for the research study and remainder of the thesis. A background on public perceptions of climate change and the factors that influence their perceptions was provided. This was followed by an overview of adaptation to climate change, agricultural extension provision in Kenya including the use of radio in formal and non-formal settings and the theoretical perspectives that grounded this study. Previous surveys have investigated the public's understanding, beliefs, values and attitudes towards climate change. Largely, the surveys have looked at climate change perceptions, identified some strategies that farmers have put in place in mitigating climate change impacts and outlined challenges farmers faced. Additional research is needed to investigate farmers' beliefs, concerns and attitude towards climate change from an African context. How to communicate climate change information and educate farmers about appropriate interventions for adaptation that address their information needs as well as the channels to be used (e.g. media) within a cultural context should also be studied.

The future impacts of climate change will be felt globally, but will be tilted towards the world's poorest nations which have the least economic, institutional, educational, scientific and technical capacity to deal with its adverse effects. This calls for enhanced climate change education and communication in a simplified language and manner understandable to different social and cultural groups in order to increase their adaptive capacity. Climate change interventions being introduced should be relevant, practical and have an immediate use for the audience. Climate change education and communication is a continuous process since some of the impacts of climate change are predicted to occur many years in the future. Climate change educators and communicators therefore need to remain active and responsive by being attentive to and using their creativity, innovativeness and their experiences to advance communication and education strategies and theories that will be relevant to various learners, culture and agencies with time.

Chapter Three: Methodology

3.1 Introduction

Chapter one provided a background for this study by introducing the problem of climate change for African farmers and the research questions that guided this study. Chapter two reviewed the relevant literature and explained the theoretical framework which drew upon perspectives from climate change communication literature used in designing the radio intervention. This chapter describes the methodology, research design and specific methods of data collection and analysis used for this study. The study area is described first, followed by an overview of the research design, the sampling size and methods, and the procedures used in the recruitment of participants. This is followed by a description of instruments and procedures used for data collection and design of the radio intervention in relation to the research questions. Last, data analysis and ethical considerations and clearance for this study are provided. Data collection for this study was conducted between February and October 2014.

3.2 Study area

This study was carried out in Kilifi County which is one of the six counties located along the Kenyan coast (Appendix A). Kilifi County is made up of the former Kilifi and Malindi districts and has seven constituencies (Table 3.1).

Table 3.1: Kilifi County population and area per constituency

Constituency	Population Census (2009)	Number of HH*	Area (Km^2)**
Kilifi North Constituency	207,587	37,266	530.30
Rabai Constituency	113,622	27,479	205.9
Kaloleni Constituency	139,302	15,213	686.4
Magarini Constituency	177,241	23,321	6,979.4
Kilifi South Constituency	171,607	37,008	400.6
Malindi Constituency	162,712	39,934	627.2
Ganze Constituency	137,664	19,543	2,941.6
Total	**1,109,735**	**199,764**	**12,371.4**

*Both rural and urban Households
** Excludes land occupied by the Arubuko Sokoke forest and the Indian ocean

Source: Kenya National Bureau of statistics (2009); Kilifi County Integrated Development Plan (2013)

This County is mainly inhabited by the Mijikenda, who comprise nine distinct Bantu speaking ethnic groups believed to have migrated to the land they occupy in the early 16th Century from

Somalia (UNESCO, 2008). Kilifi County has two main rainy seasons; long rains from April to July and short rains from October to December. The soil in this County is composed of various combinations of sand, silt, clay and loam with varying salinity and fertility (Jaetzol & Schmidt, 1983). The main crops grown in the County include maize, cassava, cowpeas, green grams, bananas, coconut, sisal, cashew nuts, citrus fruits and mangoes (Kilifi County Integrated Development Plan, 2013; Gachanja, 2007).

Kilifi County has five agro-ecological zones (Table 3.2) called coastal lowlands (CL) (Jaetzol & Schmidt, 1983). The agro-ecological zones are gradients of agricultural productivity distinguished by climatic, topographic and soil characteristics, running inland from the coast (Tumusiime, De Groote, Vitale, & Adam, 2010). The agro-ecological zones are classified by their probability of meeting the climatic requirements (temperature and rainfall) of the main crops that can be grown in a particular zone (yield potential) in relation to the topographic and soil characteristics of the zone (Jaetzol & Schmidt, 1983). Coconut cassava zone (CL3) has the highest agricultural potential in the County. This zone is suitable for dairy farming as well as growing crops such as mangoes, citrus, coconuts, cashew nuts and vegetables. Cashew nut-cassava zone (CL4) has medium agriculture potential with the same crops grown as CL3. The coconut-cashew nut-cassava zone (CL3-CL4) is the smallest of the five agro-ecological zones and is described as medium potential due to its salinity, low soil fertility and poor drainage. This zone has the potential for crops grown in CL3 and CL4. Livestock-millet zone (CL5) has short to medium cropping seasons suitable for dry land farming and livestock dairy ranching, while lowland ranching zone (CL6) is mainly suitable for ranching, beekeeping, wildlife and mining. This study covered all the five agro-ecological zones mentioned.

Table 3.2: Agro-ecological zones (AEZ) attributes for Kilifi County

AEZ	Annual Average Temp (^{o}C)	Altitude (M above sea level)	Annual Average Rainfall (mm)
CL3	24	1-450	1300
CL4	24	1-300	900
CL3-CL4	27	300-310	900
CL5	26	1-300	700-900
CL6	27	90-300	350-700

Source: Kilifi County Integrated Development Plan (2013); Jaetzold and Schmidt (1983)

3.3 Overview of the research design

In this study, a radio program intervention was tested to assess its influence on the way farmers' perceive climate change and appropriate adaptation responses. Four types of data collection

were employed: surveys with farmers, focus groups interviews, key informant interviews and interviews with climate change experts. Quantitative and qualitative data were collected before and after the intervention. Data collection prior to the intervention included all four types whereas after the intervention only surveys and focus group interviews were conducted with the same farmers surveyed or interviewed before the intervention. All the pre-intervention surveys and interviews informed the content for the radio program intervention.

3.3.1 Mixed methods design

This study used a mixed methods pre-post intervention design. This choice in design was informed by my pragmatic worldview discussed in Chapter One. Worldviews are a set of beliefs and assumptions that underpin approaches that guide inquiries (Creswell, 2014; Creswell & Plano Clark, 2011). Philosophical worldviews influence the practice of research and help to explain why a particular research design was chosen by a researcher. According to Creswell (2014) a pragmatic worldview arises from "actions, situations and consequences" (p. 39) and a concern for the use of all approaches available to understand what would work best in solving a problem. In this case, I was drawn by the situation in Kilifi County where agriculture is the main source of livelihood for a majority of the population, yet climatic variability coupled with the high levels of poverty make their farming difficult. My pragmatic worldview offered me the freedom to choose the "methods, techniques and procedures" (Creswell, 2014, p.39) that would best address this situation. In this case, I used a mixed methods pre-post intervention design where I combined both quantitative and qualitative data.

Mixed methods research integrates components of quantitative and qualitative designs and methods in a single study or a series of studies in order to understand a research problem (Johnson et al., 2007). Quantitative and qualitative designs have their own strengths and weaknesses (Table 3.3). Mixed methods research combines the strengths of both quantitative and qualitative research to address their respective weaknesses. The collection of both quantitative and qualitative data can provide a more complete picture and better understanding of the research questions compared with using either one of the methods alone (Pidgeon, 2010). Other advantages of mixed methods research include

> the potential to offer more comprehensive understanding of a complex process, including the convergence, corroboration, expansion, and elaboration of findings (Greene, Caracelli, & Graham, 1989). The weaknesses of quantitative and qualitative research can be offset by the strengths of both—words can add meaning to numbers and numbers can add precision to words (Johnson & Onwuegbuzie, 2004). (Suter, 2005, p. 370).

In this study using the mixed methods approach enabled triangulation of results from both quantitative and qualitative data. Triangulation seeks convergence, corroboration and correspondence of both the quantitative and qualitative data (Tashakkori &Teddlie, 2010).

Table3.3: Some strengths and weaknesses of quantitative and qualitative research designs

Quantitative	**Qualitative**
Strengths • Used for studying a large population • Can be used to generalize a research finding when it has been replicated on many different populations and subpopulations • Provides precise quantitative numerical data that can be used to make quantitative predictions • The research results are relatively independent of the researcher	**Strengths** • Useful in studying a small number of cases in depth • Provides individual case information • Can describe in great detail, phenomena as they are situated and embedded in local contexts • It provides a deep understanding of peoples personal experiences of phenomena
Weaknesses • The researchers' categories used in the study may not reflect the local understanding • The researchers' theories used in the study may not reflect the local understanding • The findings may be too general to be directly applied to the local situations and context	**Weaknesses** • The findings produced may not be generalized to the rest of the population or different settings • It is difficult to make quantitative predictions • It is more difficult to test hypothesis and theories

Source: Johnson and Onwuegbuzie (2004)

Additionally, a mixed method approach can show the extent to which a particular treatment or intervention will work in a particular study sample (Creswell, 2012). In this case, an assessment was made to determine how the radio program intervention had influenced farmers in Kilifi County to implement climate change adaptation practices. Mixed methods research has many designs such as the convergent parallel design, explanatory sequential design, exploratory sequential design, embedded design, transformative design and the multiphase design (Hesse-Biber, 2010). These designs are differentiated by the timing of methods, how the methods are mixed or integrated, and the priority given to the methods (Creswell &Plano Clark, 2014). This study used a mixed methods pre-post-intervention design approach where the convergent parallel design was used for data collection and analysis (Figure 3.1A).

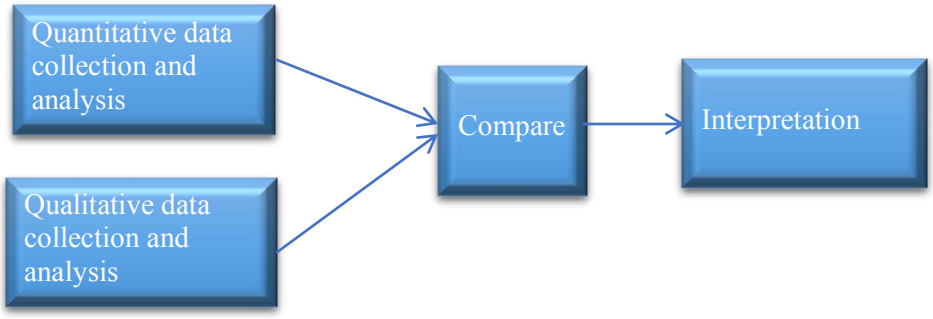


Figure 3.1A: The steps of the convergent mixed methods design (Creswell, 2014)

The steps in Figure 3.1A were modified for this study as indicated in Figure 3.1B where the radio was the intervention.

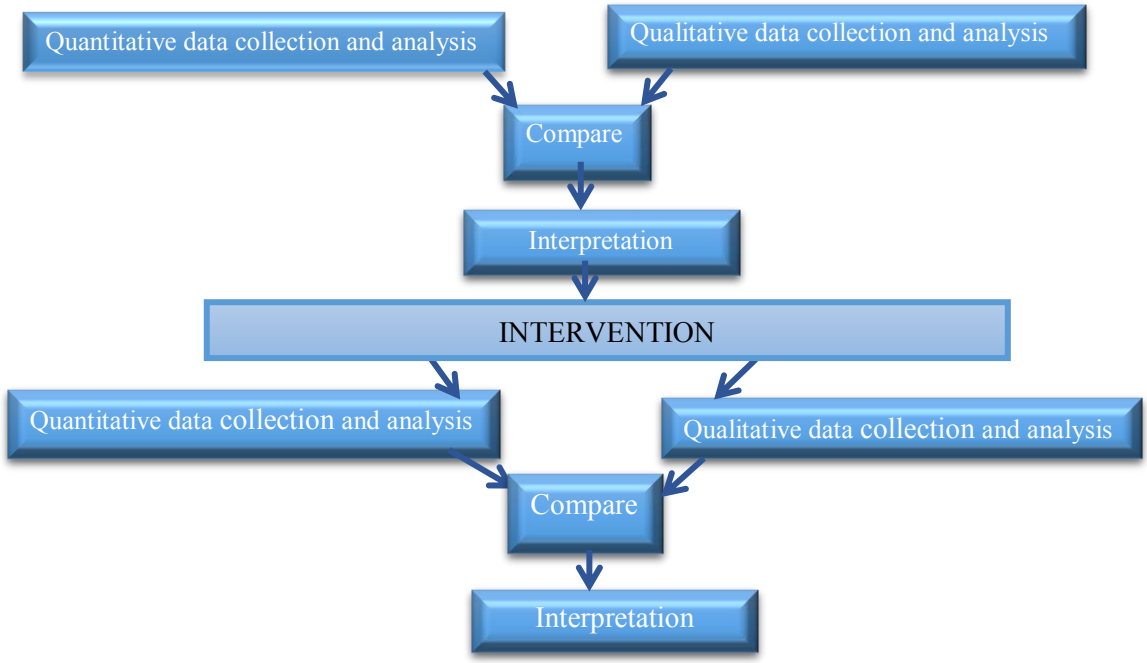


Figure 3.1B: Adapted model of the convergent mixed methods design

The convergent parallel design helps in developing a more complete understanding of the research problem by using different but complementary data on the same topic (Creswell & Plano Clark, 2014). I used this design because it brings together the different strengths and weaknesses of quantitative and qualitative methods and it allows for triangulation of methods by comparing quantitative statistical results with the qualitative findings for corroboration and validation purposes. In this design, the quantitative and qualitative data are collected and analysed in a single phase (or at the same time). The quantitative and qualitative data are given equal priority and analysed separately (independently). This allows the researcher to carry out a compare and contrast analysis within the quantitative and qualitative data sets. However, it is important to note that by the different purpose and nature of the qualitative and quantitative data

there may be aspects of each that reveal that the data are unique and cannot be compared. The two types of data are then mixed during the overall interpretation of results where the researcher looks for convergence, divergence, contradictions or relationships of the two types of data, where appropriate (Creswell, 2012).

Quantitative and qualitative data were collected simultaneously during the pre- and post-intervention phases of the research. The quantitative and qualitative data and their analysis before the intervention revealed farmers' understandings and perceptions of climate change as well as their experiences and challenges with implementing adaptive practices. Quantitative and qualitative data collection and analysis after the intervention enabled an assessment of the impact of the climate change messages (information and ideas) aired through radio on the farming community in Kilifi County.

3.4 Sample size and sampling method

3.4.1 Sample size calculation

Participants of this study were rural farmers aged 18 years and above, who owned or had access to a radio. According to the Kenya Bureau of Statistics (2009) there are 355,310 people who are over 18 years of age living in Kilifi County. Additionally, there are 127,790 rural households in the County.

The sample size for farmers to be included in the survey was calculated using the following equation (Yamane, 1967), where n is the sample size required, N is the population size, and e is the sampling error (0.05).

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

Using the equation, the number of farmers for this study came to 399. This was rounded off to 400 farmers. This number was increased by 42 farmers (six per constituency) so as to take care of the possibility of any farmers dropping out of this study after recruitment. The total number of farmers was therefore 442. Proportionate-to-population size methods were used to allocate the sample size (442 farmers) to each constituency.

3.4.2 Sampling method and procedure

Administrative boundaries in Kenya have the following structure:

→ County
→ Sub-County (constituencies)
→ Wards (sub-locations)
→ Villages

The researcher chose to collect data from all seven constituencies in order to make the total sample representative and descriptive of the unequal distribution of the population across the County. The primary sampling unit (PSU) for this study was Kilifi County. The secondary sampling unit (SSU) were the sub-locations which were randomly selected within the County (Appendix B). To determine the number of SSUs to be selected in each constituency, a 'sample take' was used based on a minimum of five and a maximum of 10 interviews per SSU. The number of SSUs required per constituency was determined by dividing the 'sample take' by the sample allocation at the County level (PSUs) (Ipsos, 2013).

Multi-stage sampling techniques were used in selecting households and farms (Appendix A). Stratification sampling was used to reduce the chances of having a disproportionately large (or small) number of the sample units selected from a sub-population that is considered significant for the analysis. In particular, stratification sampling was undertaken on the basis of administrative boundaries, land size holdings, and farming systems. This enabled the selected areas sampled (stratum) to be internally homogenous and externally heterogeneous and ensured that the selected farmers who were sampled were well spread across the important population sub-groups mentioned.

Selection of households for the administration of semi-structured surveys was done randomly. To determine the sample interval (distance in households to be sampled between each selected household), a landmark such as a church or school was identified. The left hand rule was applied where the interviewer proceeded to the starting household from the landmark. The first house to be sampled was determined by the date. For example if the day was 21 March, the starting household was house number three [2+1]. Again, using the left hand rule the interviewer skipped four houses calling on every fifth household (Ipsos, 2013). During the pre-intervention survey the next closest household was visited if the house was found to be permanently vacant, the occupants declined to be interviewed or if several attempts to interview an adult in the household were unsuccessful (Centers for Disease Control and Prevention, 2008).

3.5 Recruitment of participants and their composition

3.5.1 Recruitment of participants

Farmer groups recruited for focus group interviews were randomly selected from a list of farmer groups registered with the Kenya National Farmers Federation (KENAFF) in Kilifi County. The groups selected represented the seven constituencies in the County. Farmer groups were mainly composed of women groups and groups with mixed age and gender. Focus group interviews were composed of four to eight members who were randomly selected from the

groups they belonged to. The same farmer groups who were interviewed during the pre-intervention survey were interviewed again in the post intervention survey.

Climate change experts and key informants were purposefully selected by the researcher. The purpose of climate change experts was to provide answers or content that addressed farmers information needs identified during the pre-intervention surveys and focus group interviews. These answers were audio recorded by the radio producers (or researcher in some instances) to generate content for the production of radio programs. Experts selected for the interviews were knowledgeable in the field of climate change and related with climate change issues at the local level. Climate change experts were selected from government and non-governmental institutions dealing with climate change issues in Kilifi. Climate change experts also included farmers who had implemented adaptive practices and were willing to share their experiences and knowledge with other farmers over the radio about the practices. Requests to conduct face-to-face interviews with the climate change experts were done via email and telephone calls. Key informants, who included a chief, an assistant chief, a village elder, and agricultural extension officers, were people who had lived in the area for more than 20 years, occupied formal positions of authority and had observed climatic changes over the years. Their purpose was to provide a deeper and wider perspective of how the climate has been changing in Kilifi County, the indicators of this change and how the community and the organisations they represented had responded to this change.

Participants who agreed to take part in the semi-structured surveys or focus groups, key informants and expert interviews were provided with an information sheet that explained the objectives of the research (Appendix C) which they retained for their reference. A verbal informed consent form (Appendix D) was used for the semi-structured surveys and focus group interviews where a recording of the farmer's agreement to be interviewed was made. Signed consent forms (Appendix E) were used for interviews with key informants and climate change experts.

3.5.2 Composition of participants by surveys, focus group interviews, climate change experts and key informants

After the pre-intervention survey, seven out of 442 questionnaires were excluded from this study since they had missing data or contradictory responses rendering them unreliable, bringing the total to 435. Fourteen out of the 435 potential farmers to be re-interviewed in the post-intervention survey were not re-interviewed for various reasons including death, sickness, relocation or they declined to be re-interviewed. In order to achieve direct statistical comparisons between the pre- and post-intervention phases of this study, these 14 pre-

intervention respondents were subsequently removed from the pre-intervention data bringing the total number of farmers included in the data analysis to 421 (Table 3.4).

Table 3.4: Number of farmers included in the surveys per constituency

No	Constituencies in Kilifi County	Number of farmers (pre- and post-intervention)
1	Malindi	**56**
2	Kilifi North	68
3	Kilifi south	74
4	Rabai	51
5	Magarini	56
6	Ganze	56
7	Kaloleni	60
	Total	**421**

Table 3.5A lists the gender, affiliation and location of the climate change experts and key informants interviewed for this study. It is acknowledged that there are not many females in Kilifi County with expertise in climate change; hence nearly all of the climate change experts were male. Table 3.5B provides a breakdown of the number, gender and the range in age of farmers in each of the 11 farmer focus groups. To improve participation of women, three out of the 11focus group interviews were held with women groups (Atwi-Agyei et al., 2014).

Table 3.5A: Number of climate change experts and key informants

Category	Gender	No of representatives per institution/livelihood		Location
Climate change experts	Eight males Two females	-Kenya Forestry Research Institute (KEFRI)	1	Gede Mombasa Mtwapa Kilifi
		-Kenya Meteorological Department (KMD)	1	
		-Kenya Marine and Fisheries Research Institute (KEMFRI)	1	
		- Ministry of Agriculture (MoA)	4	
		Kenya Agriculture and Livestock Research Organization (KALRO)	1	
		Farming	2	
Key informants	One female Four males	Chief	1	Ganze Malindi Chonyi Mtwapa Mawesa
		Assistant chief	1	
		Village elder	1	
		KALRO	1	
		Kenya National Agriculture Farmers Federation (KENAFF)	1	

Table 3.5B: Number of participants in focus group interviews (FGI)

Category	Gender						Age (range in years)	*Group type	Consti-tuency	Sub-loction
	Pre-intervention			Post-intervention						
FGIs	F	M	Total	F	M	Total				
Group 1	4	0	**4**	4	0	**4**	37-40	1	Ganze	Ganze
Group 2	7	1	**8**	7	1	**8**	35-80	1	Kaloleni	Kaloleni
Group 3	4	4	**8**	4	1	**5**	35-59	2	Magarini	Magarini
Group 4	8	0	**8**	8	0	**8**	30-60	2	Kilifi North	Tezo
Group 5	3	4	**7**	3	0	**3**	40-60	2	Rabai	Rabai
Group 6	2	5	**7**	2	2	**4**	24-59	2	Kilifi South	Chonyi
Group 7	3	5	**8**	3	4	**7**	30-65	2	Ganze	Sokoke
Group 8	4	3	**7**	4	0	**4**	25-50	2	Malindi	Malindi
Group 9	3	5	**8**	1	4	**5**	35-48	2	Kilifi North	Watamu
Group 10	4	2	**6**	2	2	**4**	24 -64	2	Rabai	Ribe
Group 11	6	1	**7**	4	1	**5**	32-70	1	Kilifi South	Junju
Total	**48**	**30**	**78**	**39**	**18**	**57**				

*Group type: 1=Women group, 2=Mixed gender

3.6 Data collection instruments

Data collection instruments for this study included semi-structured surveys and semi-structured interviews with a list of key questions, pictures, video and audio recordings. The use of semi-structured surveys administered by the research team - as opposed to self-administered questionnaires - was necessary because of the low literacy levels of farmers in the selected community (Kenya National Bureau of Statistics & Society for International Development, 2013). Most farmers in the rural areas were not able to read or write and were therefore not able to self-administer the questionnaires. This meant that the semi-structured surveys had to be administered to each of the randomly selected farmers face-to-face. Open-ended questions in the survey were audio recorded for documentation and reference during qualitative data analysis. Video recordings of focus group interviews were taken in order to accurately record multiple contributions by an individual within each interview for transcribing purposes; a task that would be challenging if only audio recordings were used. Audio recordings of face-to-face interviews with experts was done for reference and to allow for high quality recordings that could be used as content for developing radio programs, with the experts' consent. Pictures of adaptive practices implemented by farmers were taken for documentation purposes.

The semi-structured interviews were composed of a list of questions used to guide the face-to-face interviews key informants and focus group interviews with farmers but I had the flexibility to ask follow-up or alternative questions in order to elicit a better understanding of the participants' knowledge and perspectives on local climate change issues. All interview schedules used in this study were translated to Kiswahili, the language used during the interviews. The Kiswahili version of the interview schedules were translated back to English to check if the original meaning of the questions had been retained. Revisions were made where necessary.

3.6.1 Survey instrument

Questions in this survey instrument were adapted from a previous survey by Reser et al., (2012). The survey instrument (Appendix F) had the following sections with examples of some of the questions asked in each section shown below:

- **Household socio-demographics:** age, gender, marital status, level of education, income, years lived in the area and size of farm
- **Climate change beliefs, attitudes, and emotions:** Questions asked in this section included: "What do you think would be the most serious problem facing the world in the future if nothing is done to stop it?", "What would you say is the cause of climate change?", "How concerned if at all are you about climate change?", "How does climate change make you feel?"
- **Extension support:** "What are the sources of your extension?", "Do you attend farmer field days?", "How do you receive weather updates?", "What interventions have you adopted in order to cope with the effects of climate change?"
- **Media:** "How much do you feel you know about climate change?", "How much more information do you feel you need to know about climate change?", "How often do you use day to day media coverage to inform your own views on climate change and other environmental issues?", "How much agreement do you think there is amongst scientist that climate change is happening?"
- **Awareness and utilisation of ICT-Radio, mobile phones, internet:** "Which one of the following communication methods do you use?", "Who normally listens to the radio in your household?", "Have you adopted any agricultural practice due to information that you first heard on radio?"

The pre- and post-intervention survey instruments were similar. The only differences between the instruments were: (1) the post-intervention survey instrument (Appendix G) did not have questions on household socio demographics because these details remained the same for the households visited, and (2) the post-intervention survey had a section that assessed whether the

farmers had listened to the programs, if they had adopted any climate change practices that they had heard in the programs, what challenges they faced while implementing the practices, and if they had received any climate change information other than what was broadcast in the climate change programs aired.

3.6.2 Focus group interview instrument

Focus group interviews provided qualitative data that was used for corroborating, validating or explaining quantitative data from the survey. The focus group interview schedule (Appendix H) was therefore composed of questions derived from the semi-structured survey. The researcher took note of the number of females and males in the group, the groups range in age and how many years the group members had lived in the area.

The same instrument was used for the post-intervention survey but with an additional section that asked if the farmers had listened to the programs, if they had adopted any adaptive practices that they had heard in the programs, what challenges they faced while implementing the practices and if they had received any climate change information other than what was broadcast in the climate change programs (Appendix I).

3.6.3 Key informant instrument

The key informant interview schedule (Appendix J) included some of these questions: Do you believe climate change is happening? What are the causes of climate change? What are the indicators of climate change in Kilifi County? What are the effects of climate change to the community? What are the existing adaptive practices that can be utilized by farmers? What challenges do farmers face in adopting these practices? What has been (or is) the role of media in educating and communicating climate change issues? What activities are you or your organization undertaking in order to create awareness on climate change within the community?

3.7 Research procedures

The following procedures were used to address the first three research questions prior to the intervention:

i. What are Kenyan farmers' perceptions of climate change and its causes?

ii. What beliefs and emotions influence Kenyan farmers' responses to climate change?

iii. What strategies do farmers report as having put in place in adapting to climate change?

A quantitative pre-intervention survey was conducted using a semi-structured survey instrument in randomly selected households and farm parcels in Kilifi County. The semi-structured survey instrument was pre-tested with 17 randomly selected farmers to establish its flow and clarity of questions. The survey instrument was then reviewed and revised as found necessary to address

problems identified during the pre-test, such as repetition of questions and missing choice of answers. An example of this was farmers' response to the question "what do you think is the cause of climate change?" During the pre-test, some farmers responded "an act of God". This response was not amongst the choice of answers in the survey instrument and was therefore included in the final survey to be administered to farmers. Five enumerators were recruited for data collection due to the large number of households to be sampled in the surveys. These enumerators (three males, two females) had a minimum of high school education and a maximum of a university degree. Fluency in the local language (Kiswahili), familiarity with Kigiriama (a vernacular language), and knowledge of the survey area and customs were some of the desired attributes sought during the recruitment of enumerators. A-two day training course was provided to the enumerators to ensure that they understood the questions in the questionnaires, the process of obtaining consent from farmers and the household selection procedures. Qualitative data were collected by myself from focus group interviews and interviews with key informants.

A field guide nominated by KENAFF was used for every constituency we visited. The guides were people well known within the community and were knowledgeable of the administrative boundaries of the sub-counties and wards. In every administrative location we visited, we called in on chiefs of the various locations to inform them of our presence in their area of jurisdiction and provided them with a brief overview of the research. The guides also acted as translators in instances where the respondents could only speak Kigiriama.

The following procedures were used to address the last two research questions after the intervention:

iv. How does radio as a channel for disseminating climate change messages impact on farmers' perceptions of and response to climate change?

v. What challenges do farmers face in implementing climate change interventions that are aired on radio?

Farmers' information needs identified from the pre-intervention surveys, focus group interviews and interviews with key informants informed the development of radio programs. Information needs were identified by analysing (refer to Chapter four, section 4.5) questions that gauged farmers' understanding of climate change. These included questions such as:

- What would you say is the cause of climate change?
- How much have you personally experienced the effects of climate change?
- How has climate change affected your farming?
- How much do you feel you know about climate change?

- How much more information do you feel you need?
- What more information do you require?

The radio intervention

A total of 16 programs were developed (Appendix K) in Kiswahili and broadcast by Pwani FM; one of the state owned stations of the Kenya Broadcasting Corporation (KBC), whose frequencies are restricted to the Coastal region. Radio producers at Pwani FM developed the radio programs from interviews conducted with climate change experts that addressed farmers' identified information needs. This involved frequent consultations with the researcher. The programs were in a drama format mixed with humour and proverbs to catch and retain the listeners' attention. The drama involved a farmer, his wife and nephew seeking climate change information from experts across the County (see Appendix L for a translated transcript of two of the programs). The voices of farmers sharing their experiences on climate change and what they have done about it as well as the voices of climate change experts were incorporated. The programs were intended to capture the adult learners' attention, encourage them to follow up and be engaged beyond the program to implement climate change interventions that were communicated.

Pwani FM which has a wide coverage in Kilifi County provided free airtime for this study under a Memorandum of Understanding with Kilimo Media International. The free airtime was composed of five-minute programs. The programs were aired at 7.50am from Monday to Saturday. Programs aired on Mondays and Tuesdays were repeated from Wednesday to Saturday. However, this schedule was not always followed due to occurrences beyond the producer's control. Once the 16 programs had been aired, the whole set was repeated once. The programs were aired from May to September 2014.

The mobile contacts of farmers who were sampled in the pre-intervention survey were entered into a database using Microsoft Excel. These farmers were requested and reminded to tune in and listen to the climate change programs, through a short message service (sms) notification a day before the programs were aired and throughout the research period. This was done through FrontlineSMS (http://www.frontlinesms.com), an open source software used to send and receive bulk mobile text messages. Farmers who participated in this study were also provided with a program schedule so that they could tune in to listen to the programs when aired. A mobile number was provided at the end of each program to allow feedback (comments and questions) from farmers on programs aired.

The post-intervention survey and focus group interviews were aimed at investigating how the programs aired impacted on farmers' understanding and response to climate change and the

challenges they faced when implementing the aired adaptive practices. They were conducted (from the end of September to mid-October 2014) with the same farmers and groups who were sampled in the pre- intervention stage of this study.

Data collection tools as per research questions are summarized in Table 3.6.

Table 3.6: Data collections tools per research question before and after the radio intervention

World view: Pragmatism		
Research design: Mixed methods pre-and post-intervention		
Mixed methods design: Convergent parallel design		
Research questions	**Quantitative data***	**Qualitative data****
	Data collection instruments	
i) What are Kenyan farmers' perceptions of climate change and its causes?	-Semi-structured interviews	Focus group interviews, open ended questions in the semi-structured interviews, individual interviews with key informants and climate change experts -semi-structured questionnaire -audio and video recorder
ii) What beliefs and emotions influence Kenyan farmers' responses to climate change?		
iii) What strategies do farmers report as having put in place in adapting to climate change?		
INTERVENTION: Radio programs		
iv) How does radio as a channel for disseminating climate change messages impact on farmers' perceptions of and response to climate change?	-Semi-structured interviews -Photographs	Focus group interviews, open ended questions in the semi-structured interviews, -semi-structured questionnaire -audio and video recorder
v) What challenges do farmers face in implementing adaptive practices aired on radio?		

* Quantitative data were collected by the researcher and five enumerators
** Qualitative data were collected by the researcher

3.8 Data analysis

Quantitative data collected from the pre- and post-intervention surveys were entered in Microsoft Excel 2010 and analyzed using the IBM statistical package for social scientists (SPSS V22). The quantitative data were checked for normality of distribution using frequency plots and histograms. Statistical tests such as means, frequency counts, percentages, Chi square, one sample t-test and ANOVA were performed. Two sample z-test and paired-sample T tests were performed to determine whether there was a statistical significant difference between pre- and

post-intervention results. All significant differences are declared at 5% level, unless stated otherwise.

Qualitative data from open ended questions in the surveys, recordings from focus group interviews and interviews with key informants were transcribed in Kiswahili and Kigiriama. The transcripts were then translated into English. Transcribing and translating of the transcripts was done by a professional due to the large amount of qualitative data. I crosschecked the transcribed and translated data for consistency and accuracy and made revisions where necessary. Transcripts translated from Kigiriama to English were crosschecked with an independent Giriama speaking person since I am unfamiliar with the language. Words or phrases which did not have an English equivalent or were problematic to translate were left in the local language. The process of crosschecking the data enabled me to familiarise myself with the data. Once I had crosschecked all the data, I reread it once more this time making some general notes on what I found interesting, unusual or significant.

The transcribed data in the form of text were imported into QSR NVivo10. The data were thematically coded using an inductive approach. A theme captures important aspects about the data in relation to specific research questions and represents a level of patterned response or meaning within the data (Gray, 2014). The process of inductive analysis involved "discovering patterns, themes, and categories" (Paton, 2002, p.453) in my data. This meant that the themes were data driven i.e. they emerged from my data (Gray, 2014). Thematic analysis begun with the generation of initial descriptive codes. In NVivo, a node (parent node) is used to represent a "code, theme or idea about the data" (Gray, 2014, p.625). Coding took place in two stages. In the first stage, I read the transcripts line by line, highlighting segments of information that related to an idea and assigned them into nodes. At this stage labels assigned to nodes were descriptive and no inference on the data was made. Sub-themes that emerged as I continued to code the data that related to the parent node were added under the respective node as a "child node". In the second stage, the descriptive labels assigned to parent nodes were redefined into more meaningful terms to form broad themes. Themes that were similar to each other were grouped together and redundant ones were eliminated. During the coding process, an independent researcher was invited to crosscheck my coding (Crabtree & Miller, 1999). This involved the independent researcher coding randomly selected texts. The results were compared, where irregularities were discussed and adjustments made in some instances.

The Kiswahili version of the transcripts was mainly used for the analysis in order to avoid losing the authenticity of the farmers' perspectives in the recorded interviews through interpretation bias during translation (Markle, 2011). The English version was maintained for cross referencing. Results from the quantitative and qualitative data analysis were interpreted

together, where one reinforced or complemented the other (Creswell, 2012). Qualitative data provided a deeper understanding of knowledge of and perspectives on climate change, and insights into any discrepancies or unexpected relationships observed in the quantitative data collected.

3.9 Ethics approval and considerations

Ethics approval (No: H5387) to conduct this research was granted from James Cook University Human Research Ethics Committee on 22 January 2014. Additional approval (Permit No: NACOSTI/P/13/9638/447) to conduct this study in Kenya was granted by the Kenyan government through the National Commission for Science Technology and Innovation on 5th December 2013. Further ethics approval (ERC/PhD/003/2013) was obtained from Pwani University which is a member of the Ethics Review Committee in Kenya on 8 November 2013 (see Appendix M for copies of approval letters). This study was categorised as a low/negligible risk application and focused on adults who were 18 years old and above. Consent was obtained from participants before they took part in this study. Participants were informed that:

- their identity throughout the research will remain anonymous,
- taking part in this study was entirely voluntary and that they could withdraw from the research at any time,
- interviews and discussions will focus on climate change and farming practices and will not touch on topics such as politics, religion or land issues which are considered sensitive.

3.10 Limitations of the study

The first limitation of this study concerns the study area. Since this research was undertaken at the coastal region of Kenya which is unique in its agro-ecology, its people and culture, it is not recommended to extrapolate the findings of this study to the rest of Kenya. The second set of limitations either applied to the radio intervention or emerged after the intervention. They are therefore reported at the end of Chapter seven (in the Conclusion chapter).

Chapter Four: Kilifi farmers' perceptions and responses to climate change

4.1 Introduction

This study sought to improve farmers' adaptive capacity through a radio intervention. This chapter presents results that address the first objective of this study which was to identify Kenyan farmers' perceptions of and responses to the impact of climate change. Data was collected before and after the radio intervention. However, this chapter only reports findings before the intervention. Data analysis before the radio intervention reveals the impact of climate change on farmers, and their responses in dealing with this impact as a means of enhancing their adaptive capacity. The second objective of this study was to develop and air radio programs that communicated climate change information to farmers. The process by which farmers' climate change information needs informed the radio programs were generated is explained at the end of this chapter. Pre-intervention findings presented in this chapter address the following first three research questions which guided the data collection and analysis:

i. What are Kenyan farmers' perceptions of climate change and its causes?
ii. What beliefs and emotions influence Kenyan farmers' responses to climate change?
iii. What strategies do farmers report as having put in place in adapting to climate change?

This chapter is divided into four sections. The first section provides some background information on the focus groups. The second section reports baseline data at the pre-intervention phase of this study on farmers': socio-demographic characteristics, climate change beliefs and emotions about the impact of climate change on their farming, and their use of or access to Information Communication Technology (ICT) and agricultural extension services. The third section reports the practices that farmers adopted to cope with climate change, including their use of indigenous knowledge to predict weather and to cope with climatic variability. Finally, the fourth section describes the procedures that led to the identification of farmers' climate change information needs and the subsequent generation of radio programs that addressed their information needs.

4.2 Background of focus group

This section provides a brief description of the farming activities undertaken by the various groups. Participants of the Focus Group Interviews (FGIs) were drawn from their larger groups (refer to Chapter three, section 3.5.1 for how the larger groups were identified). Unless otherwise stated, all members of the FGIs had lived in Kilifi County since they were born (refer to table 3.5B in Chapter three for their range in age) and the primary reason for the members joining/forming the groups was to raise their standard of living through farming and to meet the food needs of their families. Additionally, all members of the FGIs reported that they had experienced climate change apart from group six.

Group 1: The members of this group came together to improve their livelihoods through farming cassava, but they later diversified to growing other crops. The members of this group had lived in the area for a range of 13 to 40 years. They kept bees and cows and grew cassava, cow peas, oats, maize and African Bird Eye (ABE) chilli under contract farming with a privately owned food company. They received extension support from a Community Based Organisation (CBO) to grow and process their cassava. The chair of the group was very active in promoting the growing of ABE chili in this area (Plates 4.1 and 4.2).

Plate 4.1:ABE chili growing under a simple drip irrigation system

Plate 4.2: Harvested ABE chili drying in the sun

Group 2: This is predominantly a women group with 36 women and seven men. This group was composed of two separate groups that came together to grow the ABE chili under contract farming with the same food company as in group one:

> **Chair of group:** it is true our group has more women than men because in our Mijikenda culture the women are in charge of farming activities in the homesteads while men deal with other businesses.

This company recently recognized the group as the best ABE chili growers in the location. The group also grew tomatoes, cassava, and maize. They recently obtained funds from a farmers' association to put up a mill for their cassava.

Group 3: This FGI was composed of two farmer groups: one women group and another mixed gender group. Other than farming, the women group ran small businesses such as maize mills. The income generated from their businesses helped them buy food and pay for the education of their children because the women believed that they cannot expect their husbands to meet all the financial obligations of their households. They saved money through "merry go rounds" (an informal saving scheme between friends) and took loans to improve their lives. The mixed

gender group was formed as a result of agribusiness training that the farmers attended individually. There they learnt that coming together as a group would make training easier for the facilitators. They were also taught about gender equality and as a result they incorporated some women into their group. Farming is the only source of livelihood for the group members:

> **Male group member:** Farming is in our blood, we are not employed. We depend on agriculture and it helps us in our lives.

Both groups kept cows, goats, and chicken and grew maize, green grams, cowpeas, beans, pigeon peas, melons and cucumber.

Group 4: This was a mixed gender self-help group that was formed to improve the livelihoods of their members through farming. However, the men were not available to attend the FGI. The group grew cassava, maize, green grams and Cowpeas. This group reported that it received good extension support from the Ministry of Agriculture whom they said were their role models in farming. In turn this group alleged that they were role models to other farmers who looked up to them to know various things including the onset of the rainy season:

> **Female group member:** even many who are not group members look at us to see when we start planting. When they see we have begun they know the rainy season has started.

Group 5: This group was formed with a purpose of applying for funds from government and non-governmental organisations to fund their farming as a group. This group practiced irrigated farming for their vegetables such as okra and chili and grew maize, cassava, mangoes and pawpaw. They also kept cows, chicken, pigs, goats and bees. The group had a Eucalyptus tree plantation and had been trained by the Kenya Forest Research Institute (KEFRI) on how to vegetatively propagate Eucalyptus trees. They were seeking funds from the government to promote some of their group activities.

Group 6: Most of the members of this FGI were born and have lived in the area all their lives apart from one member who moved to the area one year ago. This group was formed with the sole purpose of growing crops via drip irrigation on about 60 acres of land with water sourced from a dam (Plates 4.3 and 4.4). This was made possible through funding from an NGO working in the area. This group grew cabbage, tomato, cowpeas, kale, okra, watermelon, eggplant and green maize for commercial purposes.

Plate 4.3: Green maize under drip irrigation

Plate 4.4: Dam with diesel operated water pump

Group 7: This group was formed to primarily rear goats and grow cassava. The cassava which was drought tolerant was sourced from Kenya Agriculture Livestock Research Organisation (KALRO). They plan on raising funds to buy a mill for their cassava. The group also reared chicken and had a tree nursery. However, they complained of lack of water for their seedlings.

Group 8: This was a group of peri urban farmers who came together to share ideas on how to sustain their families through peri urban farming. All the members had lived in the area for less than 10 years. They had kitchen gardens for subsistence farming and also rented land elsewhere to grow crops. In addition they ran small businesses or sought employment to complement their income from farming. They grew cassava, maize, coconuts and cowpeas.

Group 9: This group was formed to offer social support to people suffering from life threatening or terminal illnesses. The members were encouraged to grow and eat healthy foods to help manage the illnesses. The group had a mixture of members comprising those who had lived in the area for more than 17 years and others for less than 10 years. Their land sizes varied with some only having kitchen gardens and renting land a few kilometres away to farm, while others owned the land they farmed. They grew crops such as vegetables, coconut, mangoes, cashew nut, maize and cassava.

Group 10: This group was registered as a water project for irrigating agricultural crops. This group grew pepper, Amaranth and kept chicken. They had a water project which they used to grow Amaranth as a group. The group received good extension support from the Ministry of Agriculture but they complained that they had insufficient water to continue with farming as a group. They would like the government to dig them a borehole or a water pan.

Group 11: This was a women's group with one male member who has been their secretary since its formation. This group was registered in 1984 as a savings and credit group. Most of the group members are old and not very active in farming. The youngest member is the group's secretary who is 32 years old. They have encouraged younger members to join their group but

they say not many youth are willing to join an old women's group. Individually the members grow cassava, maize, groundnuts, coconut, macadamia, mangoes, cowpeas and pawpaw which they sell at their jointly owned stall. They also sell water which comes from the city council. Since the water supply in their area is irregular, they store it in a tank for sale to residents. They receive extension support from the Ministry of Agriculture and a Community Based Organisation (CBO). They have a greenhouse donated to them by the CBO which they have not put to use as yet (Plate 4.5). They were advised against using tap water in the greenhouse due to the presence of chlorine in the tap water. The NGO had threatened to take the greenhouse to another group but as they say "Luckily the officer who was to carry out the move was transferred to another location and we thank God." They plan on harvesting water from the greenhouse and runoff from the roads to irrigate tomatoes in the greenhouse. In the meantime the group is saving money for this endeavour through a merry go round.

Plate 4.5: Some of the group members in front of their greenhouse

4.3 Pre-intervention survey results

This section presents results from questions covered only in the pre-intervention survey. This baseline data was collected in order to identify the farmers' socio-demographic characteristics, and their use of ICT as well as agricultural extension services in informing their farming activities. Some of this information was useful in developing radio programs as will be illustrated in section 4.5. Ninety one percent of the farmers reported that they had not been surveyed in the last two years. This indicates that the farmers represented in this study are unlikely to have suffered from survey fatigue which usually occurs as a result of individuals taking part in too many surveys in a given year. Socio-demographic data in this study were compared to the Kilifi County Integrated Plan (KCIP, 2013) data and the Kenya National Bureau of Statistics (KNBS, 2009) census data as well as related literature.

4.3.1 Household socio demographics

The gender disparity of the farmers interviewed for the pre-intervention survey was very minimal (49.9% male and 50.1% female). This ratio is comparable to the KNBS (2009) census data [as reported in the KCIP, (2013)] which found the male to female ratio as 1:1.07. Forty two percent of the farmers interviewed were the head of the household, the majority of whom were men (82%). Farmers interviewed who were not the head of the household were either the wives of the head of the household (53%), the children of the head of the household (27%) or had another familial relationship to the household head such as niece or nephew (20%). The Mijikenda usually live together with their extended families. It is therefore not unusual to find other extended family members in their homesteads. Approximately half (50%) of the farmers' ages fell between 25 and 44 years old (Figure 4.1). Slight differences are found when this data is compared to the 2009 census data which puts the youthful population of Kilifi county (20 to 34 years) at 21%, and that of the older generation (>65 years) at 3.6% (KCIP, 2013).

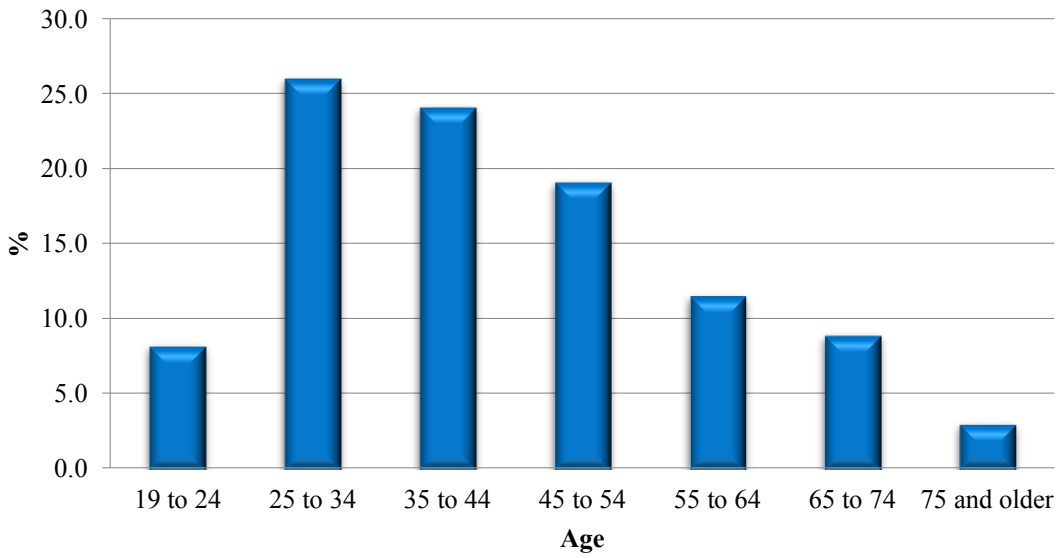


Figure 4.1: Age distribution of the respondents

The highest level of education was primary education (58%) followed by no formal education (22%) (Figure 4.2). Men were found to have higher levels of education than women. The 2009 census data reports that only 13% of Kilifi residents have secondary level of education and above, 52% have primary education and 36% have no formal education (Kenya National Bureau of Statistics & Society for International Development, 2013). Differences between results from this study and findings in the KNBS census data for age and level of education could possibly be explained by the time difference between the 2009 census and data collection for this study (2014), the fact that the focus of this study was for a rural population that was 18 years old and above and the introduction of free primary education by the Kenyan government in 2003 which has seen an increase in enrolment of primary school going children.

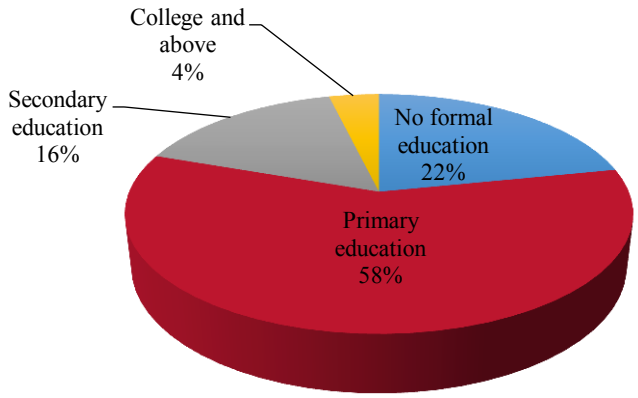


Figure 4.2: Farmers' level of education

According to the KCIP, (2013), the rural population which makes up 63% of the county's population is relatively youthful with 47% of the population falling below 15 years of age.

A majority of the farmers (78%) were married/living with their partners, 10% were widowed, 9% were single/never married and 3% were divorced/separated. The level of poverty was high amongst farmers interviewed with a majority (59%) reporting to earn less than $67 per month, and 28% of the farmers reporting to earn between $68 and $133. Only one percent of farmers reported to earn between $400 and $600 per month. Nationally, 45% of the Kenyan population lives below the poverty line (Kenya National Bureau of Statistics & Society for International Development, 2013). Kilifi County is one of the poorest counties in Kenya with an absolute poverty level of 71.7% (Kenya National Bureau of Statistics & Society for International Development, 2013). The KCIP (2013) attributes the high poverty levels in Kilifi County to frequent natural disasters, inadequate infrastructure, high illiteracy and an excessive dependence on a narrow range of cash crops as a source of income.

The largest number of the respondents had lived in the area between only one to 10 years (22%) or for over 50 years (21%) (Table 4.1).

Table 4.1: Number of years lived by farmers in Kilifi County

Years lived	%
1 to 10 years	22
11 to 20 years	18
21 to 30 years	16
31 to 40 years	18
41 to 50 years	5
Over 50 years	21

Farming decisions were reportedly made by the husband (49%), other family members such as children, nieces and nephews (18%), both the husband and wife (17%) and the wife (11%). A majority (91%) of the farmers owned the land they occupied, with only 8% renting. However, according to the KCIP (2013) 11% of the residents of Kilifi County are landless and as a result being squatters on private land. Almost half the farmers interviewed owned more than one acre to five acres of land (49%), followed by more than five to 10 acres and more than half an acre to one acre (15% respectively). Only 4% of the farmers owned 15 acres of land or more. A majority (59%) of the farmers devoted between one to five acres of their land to farming. The staple food for nearly all the farmers was maize (98%). Other crops grown included: cassava (19%); green grams (14%); indigenous vegetables (10%); coconuts (8%); beans (6%) and sweet potatoes (6%). Activities undertaken during the year by farmers to earn a living included subsistence farming (48%), dryland farming (17%), and sale of value added farm produce such as cooking oil and soap made from coconuts (15%). Very few farmers practiced commercial farming (8%), irrigated farming (3%) and market gardening (1%).

4.3.2 **Climate change beliefs, attitudes and emotions**

Most farmers when asked what they thought would be the most serious problem facing the world in the future if nothing is done to stop it indicated environmental disasters i.e. drought, floods and cyclones (33%), followed by poverty and hunger (27%) then by education (11%). A majority of the farmers believed that the climate was changing in Kenya (99%) and the world (82%) with 15% not knowing if the climate was changing in the world. Farmers indicated that they had personally experienced the effects of climate change a great deal (65%) and to a moderate amount (26%). When asked when, if at all, they thought Kenya will start feeling the effects of climate change, the vast majority of farmers (87%) indicated that they were already feeling the effects with very few (8%) indicating that they will feel the effects in more than 10 years. Given the choice to rate the condition of the natural environment in Kilifi as excellent, good, fair, poor or very poor, almost half of the farmers rated it as fair for both Kilifi (47%) and Kenya (44%). A vast majority of farmers thought that if nothing is done to reduce climate change in the future, it will be a very serious problem in Kenya (94%) and in the world (79%).

4.3.3 **Farmers' beliefs on the causes of and their concern about climate change**

Farmers believed that climate change was entirely caused by human activities (45%), followed by an act of God (34%) (Figure 4.3).

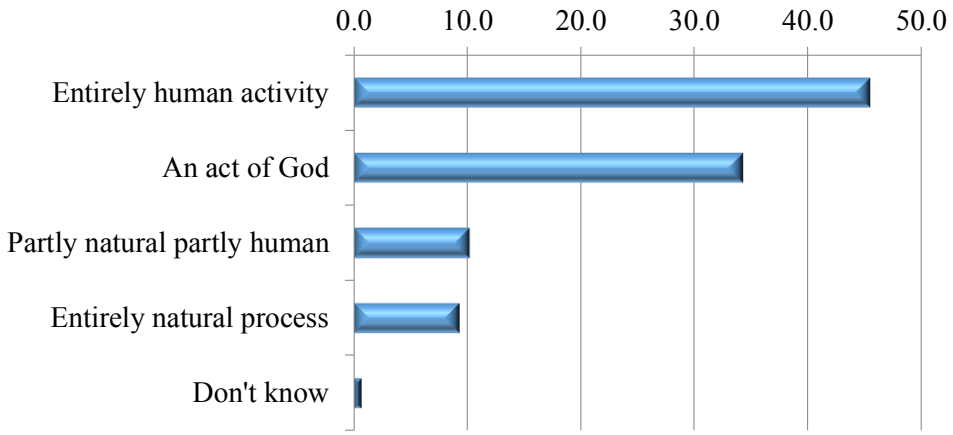


Figure 4.3: Farmers beliefs on the causes and their concern about climate change

Gender influenced (X^2 (5)=23.474, n=421, p<.05) what farmers thought were the causes of climate change where most female farmers thought that climate change was an act of God (44%) and most males thought it was entirely caused by human activities (54%). This finding could be attributed to the low level of education reported earlier for women compared to men. ANOVA (one way) showed that the level of education was found to have a significant effect (F= (3, 417) =10.36, p<.001) on what farmers thought were the causes of climate change where most farmers who thought it was caused by God (57%; M=3.793, SD=1.6344) had no formal education, while those who thought it was entirely human activity had college education and above (63%; M=2.625, SD=1.0247). Note a greater mean signifies a lower level of education. Age was also found to affect what farmers thought were the causes of climate change (X^2(15) =55.219, n=421, p<.05) and how concerned they were about it (X^2(12) =22.849, n=421, p=.029) (Table 4.2 and 4.3 respectively). Farmers between 35 to 54 years of age were more inclined to think that climate change is caused by "entirely human activity" (51%) or "An act of God" (29%). Additionally farmers who were between the age of 35 to 54 were "very concerned" about climate change (75%) compared to farmers who were 75 years and over (50%). Other studies have found similar results (Knez, Thorsson, & Eliasson, 2013; Reser et al., 2012; Searle & Gow, 2010). Unlike younger people who not surprisingly possess a greater fear for the future, older people are least concerned (Searle & Gow, 2010). A survey by IPSOS MORI carried out in Britain (cited in Haq, Brown, & Hards, 2010) that explored how the older generation can be better engaged in climate change issues, found that respondents aged over 55 years and over, felt that they will not be affected by climate change; they mostly "strongly agreed" or "tended to agree" that it is hard to take action on climate change; and they thought that they are unable to make a personal difference with regards to climate change.

Table 4.2: Age and farmers' beliefs on the causes of climate change

	Causes of climate change						
Age	Entirely natural process	Entirely human activity	Partly natural partly human	An act of God	Don't know	Other	Total
19 to 34	12.6(18)	44.1(63)	9.1(13)	34.3(49)	0.0(0)	0.0(0)	100(143)
35 to 54	7.7(14)	50.8(92)	11.6(21)	29.3(53)	0.6(1)	0.0(0)	100(181)
55 to 74	7.1(6)	38.8(33)	9.4(8)	43.5(37)	1.2(1)	0.0(0)	100(85)
75 years and above	8.3(1)	25.0(3)	8.3(1)	41.7(5)	8.3(1)	8.3(1)	100(12)
Total	9.3(39)	45.4(191)	10.2(43)	34.2(144)	0.7(3)	0.2(1)	100(421)

Numbers in parenthesis represent the frequency of respondents in each category

Table 4.3: Age and farmers' level of concern about climate change

	How concerned about climate change					
Age	**Very concerned**	**Fairly concerned**	**Not very concerned**	**Not at all concerned**	**Don't know**	**Total**
19 to 34	58.0(83)	22.4(32)	4.2(6)	2.1(3)	13.3(19)	100.0(143)
35 to 54	74.6(135)	14.9(27)	1.7(3)	1.1(2)	7.7(14)	100.0(181)
55 to 74	72.9(62)	14.1(12)	3.5(3)	1.2(1)	8.2(7)	100.0(85)
75 years & above	50.0(6)	8.3(1)	0.0 (0)	8.3(1)	33.3 (4)	100.0(12)
Total	67.9(286)	17.1(72)	2.9(12)	1.7(7)	10.5(44)	100.0(421)

Numbers in parenthesis represent the frequency of respondents in each category

Gender influenced farmers' concern about climate change ($X^2(4) = 11.798$, n=421, p=.019), where more men (75%) were found to be "very concerned" about climate change than women (60%). Additionally, more men were found to be more pro-environmental than women (Table 4.4). These results contradict findings by McCright (2010) who found that women express slightly greater concern about climate change than men. People with pro-environmental beliefs, regardless of their gender, have been found to be more concerned about climate change than those with none (Searle & Gow, 2010). However, women are perceived to be more pro-environmental and more concerned about environmental degradation then men (Whitmarsh, 2011; Kollmuss & Agyeman, 2002) because they provide for their families by extracting environmental services which are susceptible to the changing climate (Crona & Wutich, 2013).

Table 4.4: Farmers reported pro-environmental behaviours by gender in the last five years

Pro environmental behaviour		Men % Yes	Women % Yes	Men % No	Women % No
i.	Taken part in an environment event	24	21	76	79
ii.	Given money to a group that aims to protect the environment	9	8	91	92
iii.	Taken part in a conservation activity	74	57	26	43

The findings that more men in this study were concerned about climate change, and reported to have experienced noteworthy changes to the environment which they thought was a result of climate (reported later in section 4.3.3.2) change than females could possibly explain why more male farmers were found to be more engaged in pro-environmental behaviours than female farmers. Individuals who have been reported to have direct experience of climatic events that may be linked to climate change are more likely to be concerned about it (Spence et al., 2011).

Although slightly less than a majority of the farmers in the survey and FGIs thought that climate change is caused entirely by human activities, all key informants thought climate change is caused by human activities (e.g. factories and deforestation). The first major human related cause of climate change noted by both the farmer focus group and key informant interviews was cutting down of trees (for firewood, timber, charcoal and to create land for farming):

> **Female farmer, Ribe FGI:** a long time ago cutting down of trees was not allowed, but nowadays people do it. In the past our elders used to say there were customs that prohibited the cutting down of trees….nowadays we do not follow our customs, we make charcoal and sell firewood.

> **Male key informant, KALRO:** the population has been cutting trees for farming and the issue of planting trees has been limited to crop trees…Surprisingly trees like cashew nuts that were mainly for cashew nuts have been turned to produce timber even coconut was not meant for timber … coconut is [now] a cheap source for timber. The mature coconut- even frames for doors for windows it does well, but it was not initially meant for timber…mango was not for fuel or charcoal, nor for timber, it was not for that purpose. Now they have turned it for those things.

The second major human related cause of climate change, according to farmers interviewed, was factories. The main factories located in areas where this study was undertaken were for the production of cement and salt. All FGIs where these factories were located (Rabai, Magarini and Kaloleni) complained about the negative effects of the factories to the environment and their health. The mining factories were accused of releasing a lot of dust into the atmosphere causing a reduction of yields from coconuts, death of livestock, and an increase in Tuberculosis (TB):

> **Male farmer, FGI, Rabai**: Even our livestock are dying especially now in this area because of this dust.
>
> **Female farmer, FGI, Rabai**: the dust falls on the trees, grass then the cows eat the grass. We are troubled.
>
> **Female farmer, FGI, Rabai**: many people have been affected in this area due to TB…because of this dust.

The farmers together with an NGO are urging the factories to invest in dust and fumes arrestors. On the other hand, the salt factories which are mainly located along the shores of the Indian Ocean in Magarini were accused of causing reduced rainfall in the area as well as health problems such as TB and eye problems:

> **Male farmer, FGI, Magarini:** climate change is caused by these factories. The salt factories damage the environment. In the past years we had two rainy seasons-the long and short rains. Now we only have the long rains and it gets dry.
>
> **Male farmer, FGI, Magarini**: Our poverty is caused by climate change because if we didn't have it things would be different. Now we are not even sure of the onset of the rains because of the lack of trees. Near the salt factories it rains by luck-just once and it's over…climate change and the factories have put us in a difficult situation.

Poor government policies and corruption were the third most nominated major human related contributors to climate change by farmers in the FGIs. For example, farmers in the Rabai FGI alleged that "Forest land is allocated to individuals for farming by politicians" and "the government reacts to situations …no planning". They also blamed the government for not monitoring factories claiming that "factories are started without any policies as long as they pay taxes." They recommended that "there should be laws about pollution and the amount of carbon dioxide emitted into the atmosphere. But the government has no policies. They do not forecast into the future. The common man is suffering." The FGI in Watamu shared a similar opinion:

> **Male farmer, FGI, Watamu:** the forest was cut by those protecting it. One hundred years are not enough to restore the forest to what it was, and this [forest destruction] was done over a period of two or three years and it has caused damage for good.

However, a key informant (an assistant chief) stated that the government is working towards protecting the environment:

> **Male key informant, Mawesa:** There are laws provided in our constitution and implemented by NEMA [National Environmental Management Authority] that control pollution by factories and even people cutting down trees. The government is doing something.

Other than human activities, farmers in FGIs thought that God is the cause of climate change. This finding is similar to findings from the survey data. Farmers may have attributed the causes of climate change to God because most farmers could not understand why the rainy seasons had become unpredictable. A male farmer in the Chonyi FGI posited "In general God knows what He is doing because a long time ago it used to rain in March but this has changed." Another female farmer from Ganze thought "I see climate change has confused everyone because everything we try is unsuccessful. I can't say its humans I think it is God." The view that climate change was a result of God punishing people for their sins was mostly held by farmers, but not key informants:

> **Male farmer, FGI, Sokoke:** in the present time we are living, the world has a lot of sin and a lack of discipline. There are lots of murders here in Giriama and even other areas in Kenya. This shedding of blood has led us to be cursed. If in the days of Cain and Abel the land was cursed because of one person….now do the math…multiply to the whole world…how much more would the curse be?

> **Male key informant, KALRO:** [climate change is] not caused by God. When Adam was created he was given the mandate to go and multiply and fill the earth and there is a clause there-subdue it. Subdue it means…control it. So the human population has multiplied, yes, but has not taken the deserved care of the environment that was entrusted to them. So God cannot be the cause. Man was told to subdue that is to control but then they are using it without any control, and that control was to use it sustainably. And that is where the human race has erred. They cannot go back to God [blame God].

A few farmers from the FGIs thought that the ozone layer was the cause of climate change with one farmer (Rabai FGI) referring to it as a "mattress up in the sky". A farmer in the Kaloleni FGI believed that "what used to protect us from the sun was the ozone layer. The sun could not pass directly to the soil…but it burst…so the sun is so hot even the clouds cannot form rain."

A very large majority of the farmers in the survey thought that climate change was a "very serious" (79%) and "somewhat serious" (14%) problem **right now** but fewer farmers were "very" (68%) or "fairly" (17%) concerned about it. Some farmers may have been less concerned about climate change because the survey was conducted at a time believed to be the onset of the long rains (in March). Therefore climate change may not have been viewed as posing an immediate threat to their farming activities even though they were uncertain of the duration and intensity of the impending rains. This view was most evident among farmers in the Chonyi FGI. One participant said "the change in weather is not bad and if it continues this way this year will be good." Another member added "this year the rains have started early. Last year the rains started on 15th of March and this year on 4th of March" to which another member added "the rains have come early and it reminds us of things that used to happen in the past where it rained in March".

Farmers in the survey were asked what in their opinion the risk of climate change exerting a significant impact on the categories listed in Table 4.5 was. The vast majority (>88%) of the farmers responses ranged between high risk and medium risk for all categories asked, with future generations (90%) followed by environment (71%) viewed as highest risk.

Table 4.5: Farmers' risk perceptions on the impacts of climate change

	You personally	Your family	Community	Public health	Economic development	Environment	Future generations
High risk	**61.3**	**64.6**	**58.8**	**54.2**	**56.3**	**70.8**	**90.3**
Medium risk	28.3	25.7	31.2	34.0	34.0	20.9	5.5
Low risk	5.7	5.2	6.7	7.8	5.7	5.0	1.7
Very low risk	1.9	1.9	1.2	1.2	2.1	1.4	0.2
No risk	2.6	2.6	2.1	2.1	1.4	1.4	1.9
Don't know	0.2	0.0	0.0	0.7	0.5	0.5	0.5

4.3.3.1 Psychological impact of climate change on farmers

Farmers in the surveys were asked how climate change made them feel. A majority of them indicated that they felt despair (23%), irritated (17%), confused (16 %), angry (13%) and hopeful (10%). Farmers in FGIs who also reported to feel hopeful viewed climate change as an opportunity:

> **Male farmer, FGI, Chonyi:** Somebody's garbage is somebody's treasure [sic]. Climate change is an opportunity to me that can be used in a positive way…to my benefit. For example when it's dry…if I use irrigation like we are now using we are assured of a good harvest…and I can use that to boost my income. So climate change raises an opportunity for my investment.

Farmers strongly agreed (48%) and tended to agree (28%) that they felt uneasy and apprehensive about what might happen in the near future due to the impacts of climate change. They also strongly agreed (64%) and tended to agree (23%) that they sometimes felt a sense of loss because climate change impacts were becoming apparent in their area. According to the FGIs the biggest climate change impacts were reduced crop yields on the same acreage of land (reported by 66% of farmers in the surveys), especially for mangoes, coconuts, cashew nuts and maize which are their cash crops and staple food. Farmers in the FGI in Kaloleni said they "used to get about 100 coconuts from one tree [per year] but now whatever you do you cannot harvest that many." The second biggest impact was poor/unreliable sources of water because the rivers had dried up. This meant that they sometimes had to walk long distances in search of water. The unreliable source of water was related to the change in the onset of rains and unpredictable rainfall. The onset of the rains raised a lot of uncertainty amongst the farmers in that they felt apprehensive because they didn't know if the rains will bring them good yields or if they will disappear when the crops are in the middle of their growing cycle:

> **Female farmer, FGI, Tezo:** Farming is like taking a chance all the time. There is no time you will be able to say the long rains have started for sure.

> **Female farmer, FGI, Rabai:** Some people have already planted with this little rain. If the rains do not continue the maize will die and it will be a loss to the farmer…the rainfall pattern is unpredictable it is not how it used to be a long time ago. Right now there is a danger that farmers have planted and the seeds may rot in the soil because of very little rain.

> **Male key informant, KENAFF:** it has become hotter…some of the water bodies that used to be permanent are no longer there for instance in Malindi town…there was a small lake that was called Furunzi which is now gone forever it has become a dry area.

> Children below 10 years old have never seen the lake…and if you ask them why the place is called Furunzi they have no idea. There used to be Lake Jilore a very important habitat for hippos, crocodiles and other…animals. People used to fish there…but it is gone forever …even the seasonal rivers that used to dry for a month or two every year are now drier and only have water when it starts raining and when it stops it's no more.

Farmers in the FGIs indicated that they had received food aid during long droughts from the Kenyan government and other NGOs. During such times the price of food increased, there was hunger and no water for both themselves and their livestock:

> **Male key informant, Chief:** the community cannot time their planting well. There are times they prepare to plant and it doesn't rain. So the effects are hunger and poverty. They use whatever money they get to buy food at the expense of other pressing needs.

The farmers lack money to pay school fees for their children who eventually drop out of school. Getting hired as a farm hand to supplement income becomes impossible because with the drought, no one is hiring:

> **Female Key informant, village elder:** you must work to get food and here there is no work…you know I can hire a farm hand to cultivate my farm…but if there is drought like there was last year…there is no work.

In this state of despair, some farmers (Sokoke, Ganze FGI) opt to go into forests to illegally burn charcoal so as to make ends meet.

4.3.3.2 Farmers' perceptions of climatic trends

Eighty four percent of farmers indicated that they had experienced noteworthy changes or events in the natural environment over the last ten years which they thought were due to climate change. Gender ($X^2(1) = 16.482$, n=421, $p<0.05$) and age ($X^2(3) = 8.452$, n=421, $p<0.05$) were found to have a significant effect on farmers' perception of noteworthy changes or events in the natural environment that they thought were due to climate change. A majority of the farmers who had experienced noteworthy changes or events in the natural environment were male (91%). Additionally, as the farmers' age increased, so did their likelihood of experiencing noteworthy changes in the environment (Figure 4.4). Yet as stated earlier, as the age of the farmers increased their concern about climate change decreased.

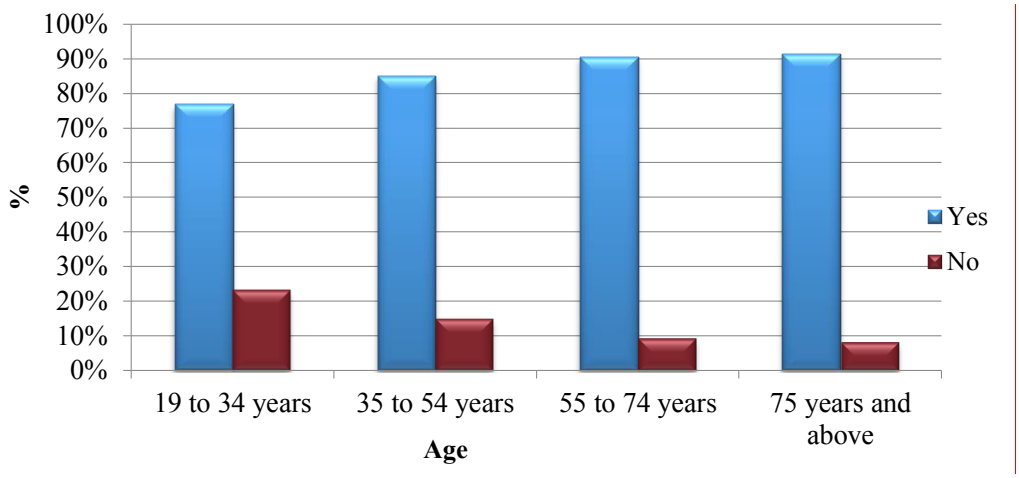


Figure 4.4: Farmers' experience of noteworthy climate change events over the last 10 years with age

Most farmers in the surveys indicated they had experienced floods (46%), followed by drought (33%), while 17% said they did not know of any significant event in the last 10 years (Figure 4.5). These findings are similar to results from other studies conducted in other parts of Kenya where farmers reported to have experienced droughts and floods more frequently (Bryan et al, 2013; Kitinya, Onwonga, Onyango, Mbuvi, & Kironchi, 2012; Mubaya, Njuki, Mutsvangwa, Mugabe, & Nanja, 2012; Maddison, 2007; Ogalleh, Vogl, Eitzinger, Hauser, 2012). Kenya is described as being prone to cyclic droughts with major ones occurring every 10 years and minor ones every three to four years (Downing, Gitu, & Kamau, 1989; Republic of Kenya, 2013).

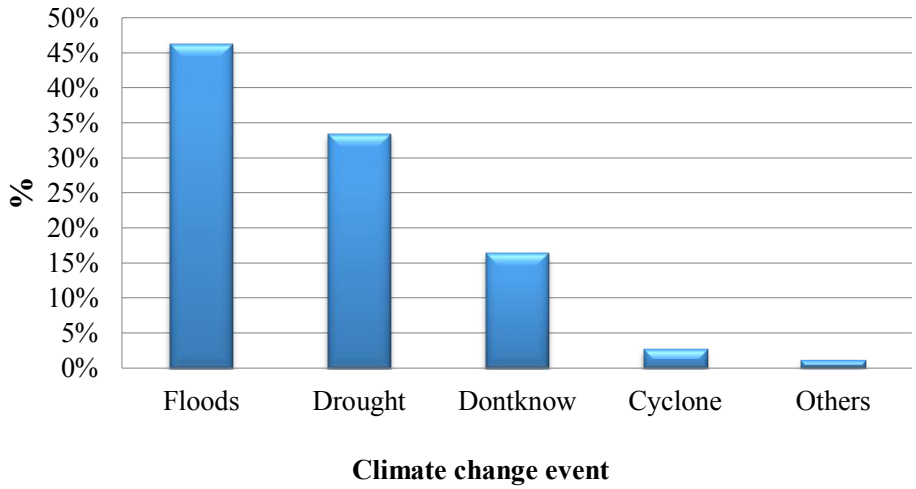


Figure 4.5: Climate change events observed by farmers between 2004 and 2014

Most farmers in the survey cited that there were droughts in 2012 and 2013 and floods in 2013 (Figures 4.6A & 4.6B). Twenty four percent of the farmers did not recall the year in which the noteworthy changes or events in the natural environment over the last 10 years occurred. It is interesting to note that some farmers perceived droughts and floods in the same year.

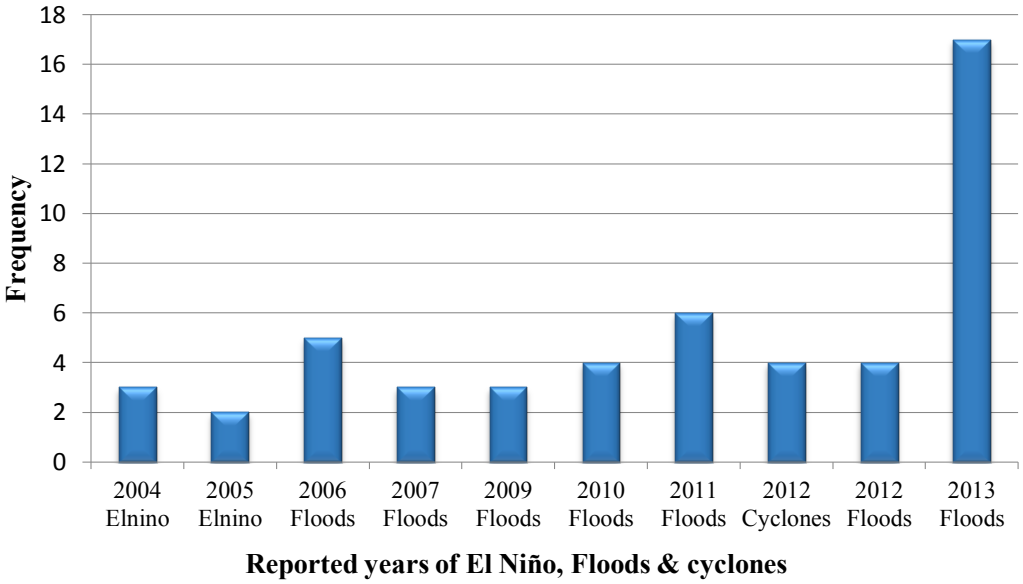


Figure 4.6A: How farmers recalled years of floods, El Niño and cyclones

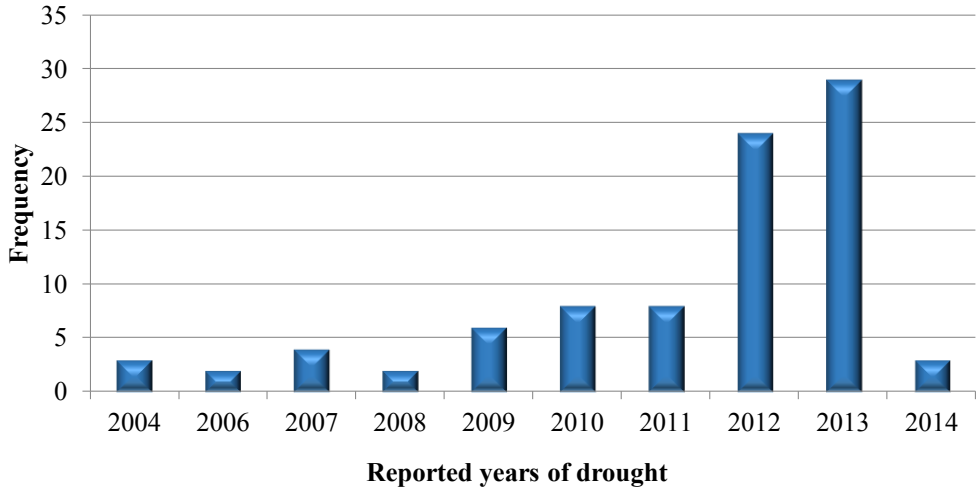
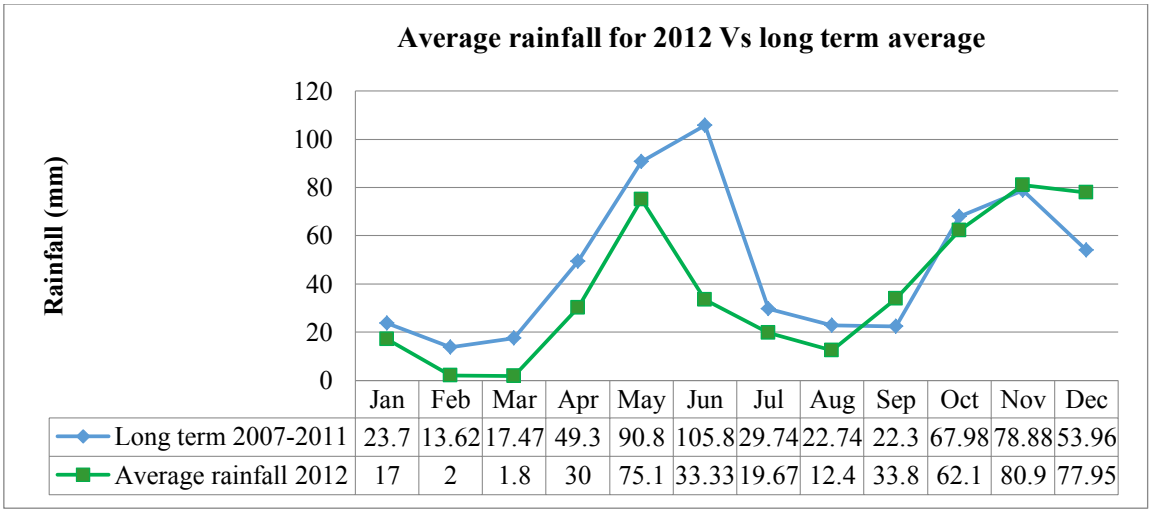


Figure 4.6B: How farmers recalled years of drought

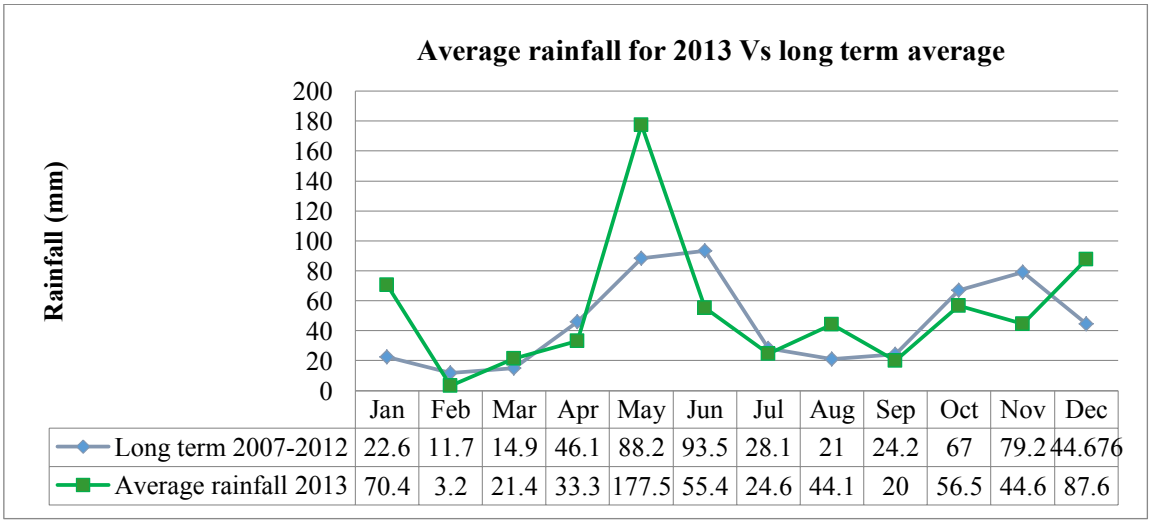
Comparison between how farmers recalled past climatic events and data from the Kenyan Meteorological Department-Kilifi County

How farmers recalled past weather events is compared with meteorological data in order to gauge if their perceptions correspond with historical climatic data. Unfortunately, farmers' reports on climatic events in the last 10 years cannot be compared to meteorological data owing to the lack of reliable meteorological data from the Kenya Meteorological Department in Kilifi County (KCIP, 2013) on the years in which drought and floods occurred in the County. However, the National Drought Management Authority (which was established in 2011) provides data for comparisons for the years 2012 to 2014. (Figures 4.7A, 4.7B & 4.7C). This data provides a background of the climatic trends and weather events that occurred prior to and during my data collection in Kilifi.



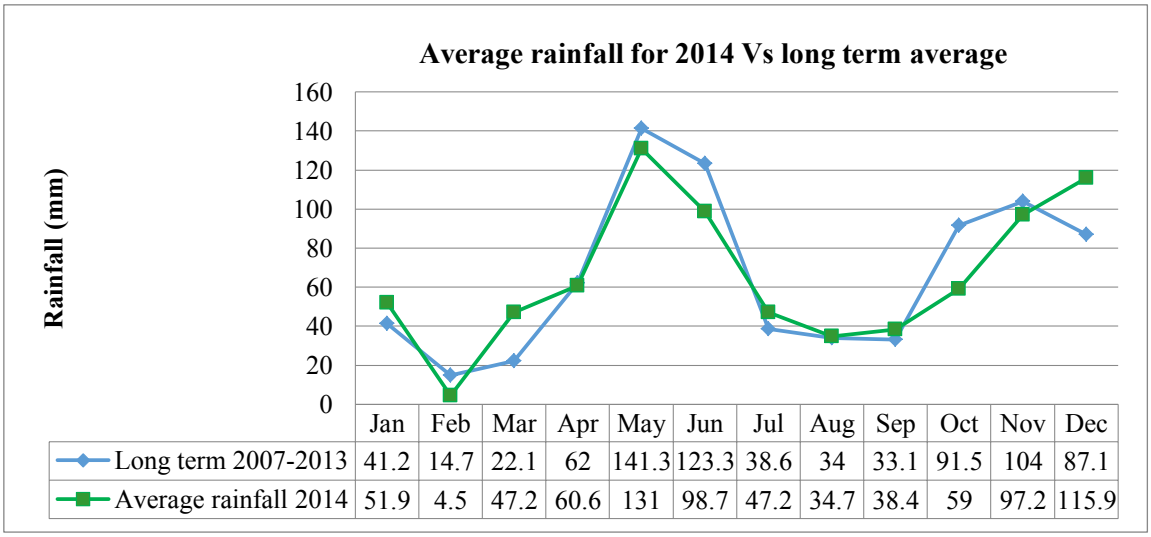
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Long term 2007-2011	23.7	13.62	17.47	49.3	90.8	105.8	29.74	22.74	22.3	67.98	78.88	53.96
Average rainfall 2012	17	2	1.8	30	75.1	33.33	19.67	12.4	33.8	62.1	80.9	77.95

Figure 4.7A: Average rainfall for Kilifi County in 2012



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Long term 2007-2012	22.6	11.7	14.9	46.1	88.2	93.5	28.1	21	24.2	67	79.2	44.676
Average rainfall 2013	70.4	3.2	21.4	33.3	177.5	55.4	24.6	44.1	20	56.5	44.6	87.6

Figure 4.7B: Average rainfall for Kilifi County in 2013



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Long term 2007-2013	41.2	14.7	22.1	62	141.3	123.3	38.6	34	33.1	91.5	104	87.1
Average rainfall 2014	51.9	4.5	47.2	60.6	131	98.7	47.2	34.7	38.4	59	97.2	115.9

Figure 4.7C: Average rainfall for Kilifi County in 2014

Source: NDMA from 12 rain gauges at their various sites

It is important to note that Kilifi County generally follows the following seasonal calendar (Plate 4.6).

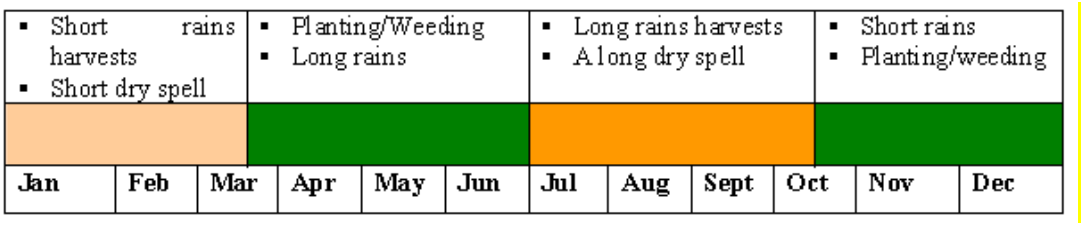


Plate 4.6: Seasonal calendar for Kilifi County

Source: National Drought Management Authority (2012)

Some farmers in this study reported to have experienced droughts, floods and cyclones in 2012. Meteorological data from the NDMA for 2012 indicates that farmers experienced reduced yields due to the late onset and early cessation of the long rains. February and March were particularly dry months receiving an average of 2mm and 1.8mm of rainfall respectively. This resulted in households being in dire need of food due to poor harvests. Generally, the rains in 2012 were below the long term average (historical average of rain over an extended period of time) from January to August of 2012. However, there was a peak in rainfall in the month of May causing floods mostly in Magarini after the river Sabaki burst its banks displacing more than 3000 people and cutting off road networks (Mynews24, 2012 http://m.news24.com/Kenya/MyNews24/Magarini-flood-victims-get-relief-food-20120515). It is evident that farmers concluded there were both drought and floods in 2012 based on these events. A literature search did not provide any information on a cyclone occurrence in 2012 and it is not clear why some farmers cited this occurrence.

Farmers also indicated that they experienced drought and floods in 2013. Meteorological data from the NDMA for the year 2013 shows there was a higher than normal rainfall compared to the long term average in May. As a result, the Galana/Sabaki river burst its banks leading to flash floods in Chonyi, Magarini, Bahari and Kikambala that caused the displacement of 2,417 households and destruction of 6,000 acres of maize in Malindi and Magarini (Kilifi Long Rains Assessment report, 2013). Later in the year, a false start of the short rains in October was observed, which was followed by an overall depressed and unevenly distributed rainfall in most parts of the County that impacted negatively on farmers' yields (NDMA, 2013; Rembold et al., 2014). The dry conditions continued into January and February 2014. This means that farmers experienced insufficient rains and dry conditions from October 2013 to about March of the following year. The NDMA reported many households were forced to buy food supplies due to the poor crop yields in 2013.

At the start of this study in March 2014, NDMA reported an increase in the amount of rainfall (from 4.51mm in February to 47.18mm in March 2014) but not significant for planting. Most of the households started preparing their land as they waited for the long rains to start. The amount of rainfall received from April to June 2014 was good; however the temporal distribution was reported to be poor in some areas such as Magarini (NDMA, 2014). The decrease in the amount of rainfall in July had a good impact on maize which were tussling and was good for planting green grams. August and September recorded minimal rainfall which was normal for that period of the year (NDMA, 2014). The amount of rainfall increased in October, when the second phase of data collection begun.

Information about the characteristics of growing seasons in relation to rainfall patterns is vital in helping small scale farmers (especially those who rely on rain fed agriculture) make informed decisions for successful and profitable farming (Ngetich et al., 2014; Kisaka, Mucheru-Muna, Ngetich, Mugwe, Mugendi, & Mairura, 2015). Hence, the analysis of the distribution of rainfall between and within seasons as well as the onset and cessation of rainy seasons by meteorologists for specific ecological zones contributes to an understanding of the crops length of growing period and indirectly indicates the climatic suitability of crops (Ngetich et al., 2014) to the specific zones.

A few farmers (25%) recalled events that occurred more than the requested 10 years ago. The El Niño that occurred in 1997/1998 was the most mentioned event possibly because it caused significant damage to the farmers' property. Many farmers indicated that the El Niño caused a massive loss of lives, housing, crops and livestock. The road network was disrupted because bridges were washed away

> **Male key informant, Chief**: the event that I remember occurred more than 10 years ago; the 1997 El Niño. The floods caused some rivers to change their course…up to today. The area that the river passed on the way to the ocean is dry. People farm there and it used to have mangrove trees which died.

According to a report on the resilience of coastal systems and humans in the Western Indian Ocean by the International Union for Conservation of Nature (IUCN) and other partners, the worst floods in Kenya were recorded in 1961/1962 and 1997/1998 (Samoilys et al., 2015). The later was the El Niño rains that affected the whole Western Indian Ocean (WIO) region (Samoilys et al., 2015). The El Niño rain is associated with the El Niño weather phenomenon that spans the Indo-Pacific Oceans and is predicted to increase in frequency in the future due to global warming (Samoilys et al, 2015).

These findings (apart from cyclones) are consistent with what some farmers in the surveys and focus groups reported. Climate change is a difficult phenomenon to detect and track based on personal experience because it is a statistical phenomenon that is described as systematic changes in weather conditions over a long period of time (Weber, 2010). Farmers' experience with climatic events significantly affects their recall and expectation of droughts where farmers easily recall more recent or extreme events (Diggs, 1991).

4.3.4 Use of ICT (Radio and mobile phones)

All farmers who participated in this study indicated they owned a radio or had access to one (mostly their neighbours). Nearly all farmers (91%) reported that they listened to Pwani FM. A majority of the farmers in the survey (68%) indicated that one of their radios was portable enough to be taken to the field for listening. Farmers in the FGIs however revealed that they do not usually carry their portable radios to the farms and that they are sometimes too busy to listen to the radio. Radios in the households were reported to be primarily controlled mostly by all family members at times (56%) followed by male adults (33%). When asked if they had adopted any agricultural practice they had heard on the radio, 35% of the farmers' said yes (one or two practices), 26% said no (no practice), 21% said yes (many practices) while 18% said no but they plan to. In summary, a slight majority (56%) indicated adopting at least one practice heard on the radio. Most farmers (86%) did not contribute to agricultural programs they heard on radio by calling or sending text messages to the radio station. Some of the reasons for this included lack of: money to buy airtime; a mobile phone; time and interest as well as constant congestion in the communication lines. Others said they did not know the radio station's number or expressed fear of being heard on radio. Nearly all farmers did not receive (96%) agricultural information on their cell phones, with only 3% reporting they regularly received and 1% occasionally received such information on cell phones.

The vast majority of farmers received weather updates via the radio (92%) with other methods (7%) such as the television, agricultural officers, neighbours and friends being used. Two thirds (68%) of the farmers indicated that they found weather updates reliable. However, it was evident that some farmers in the FGIs were sceptical about weather updates on the radio:

> **Female farmer, FGI, Tezo:** We listen to the radio but what they forecast does not happen. They announce it will be a heavy or light rain but it doesn't rain.

> **Male farmer, FGI, Watamu:** I believe the media and newspapers when they say it will rain. But they do not tell us the duration and intensity. It may be a lot but for a short period, they have therefore not helped us.

Most farmers reported that they found agricultural radio programs very useful (60%) or occasionally useful (26%) and not useful (14%). Most farmers (73%) either "strongly agreed" or "agreed" that current agriculture radio programs met their agricultural needs, while 21% "neither agreed nor disagreed". When farmers were asked how closely they followed the news about the environment these days, 27% indicated "always", 20% "very frequently" and 35% "occasionally". The highest percentage of the farmers (44%) did not know how much agreement there was amongst scientists that climate change is happening, with 23% indicating that some scientists agree, 15% indicating that nearly all scientists agree and 9% indicating there was no agreement amongst scientists. Farmers found "a great amount" (28%), "some" (38%), and "little amount" (15%) of the information provided in the news about climate change as accurate. The preferred language for listening to the radio was Kiswahili (78%) and local dialect (16%), with only 6% preferring English.

4.3.5 **Extension support**

When asked how much extension support they got, half the farmers said they got occasional and effective (41%) or frequently and effective support (9%) support, while the other half indicated they received no extension support (36%) or only occasional and not effective support (13%) . This low extension support could partly be attributed to most farmers living over 30 kilometres away from sources of extension support such as universities (62% of respondents), research institutes (56%) and meteorological centres (58%):

> **Male farmer, FGI, Magarini**: they [extension officers] come but they are not enough. The officer may have to travel from Mbugoni to Tana River. How many farms can he cover even if he has a motorbike? So we have them but they are very few. We need more agricultural officers.

> **Key informant, KENAFF**: In those years when the government had funds we had extension services where extension officers would actually visit almost every farm. Today they say the policy is to give services on demand and very few farmers have got the mechanism to demand for services so they stick to the old ways [of farming] and they are not good enough.

Farmers in FGIs revealed mixed perceptions about the extension support they received, suggesting that such support varied by locality. Some of the farmers in the Rabai and Chonyi FGIs claimed that the extension officers did not visit them individually to provide advisory services. However other groups such as the Ribe, Sokoke, Tezo, Malindi, Junju and Magarini were content with the extension support they received. They were of the opinion that it was easier to receive extension support as groups rather than individually. Some farmers reported

visiting research institutes such as KALRO or attending meetings called by their chiefs where agricultural extension officers were usually given a chance to talk to the farmers. These views were corroborated by key informants:

> **Male key informant, Assistant chief:** As an organization our work is to coordinate government business. So we organize meetings twice a month where we meet citizens to educate them especially about the time to prepare their farms, how to prepare them, the appropriate seeds to use, the planting techniques, the type of pesticides to use during planting and weeding…we [give] them relief seeds [free seeds given to farmers by the government], fertilizers and many more. We don't give them pesticides but we give them seeds yet they are not enough for all farmers but we give what we have and vegetables seeds as well.

> **Male key informant, KALRO:** at my level we are extension officers usually the basic forum to educate our farmers are baraza [chief gatherings]. So we get baraza programs from the administrators and we plan to be with them during the barazas…with regards to the group approach we don't advocate people farming together. Group approach is where farmers meet and are taught. It could be in a centralised demonstration plot or on one of the farmer's farm. Those are learning centres and we don't advocate the learning centres to be the farmers' activity places. This is a place where farmers are trained on a technology and replicate the same on their farms.

The radio was the most popular means of obtaining agricultural information followed by conversation with friends (Table 4.6).

Table 4.6: Sources used by farmers to obtain agricultural information (%)

	Radio	TV	News paper	Lectures	Social networking sites	Government sources	Conversation with friends
Never	8.6	74.8	77.2	76.5	98.5	64.1	28.0
Once or twice	23.8	9.0	15.0	12.6	1.0	22.1	29.0
More than twice	67.6	16.2	7.8	10.9	0.5	13.8	43.0

Farmers reported not belonging to any groups or organizations (35%), while others belonged to savings groups (26%), village Farmer Field Schools (23%), religious organizations (13%) and community radio listening groups (1%). A majority of the farmers (53%) attended farmer field days and 61% reported not having demonstration plots in their area.

4.4 Practices farmers adopted to cope with climate change

Survey data showed that water and soil conservation techniques, switching to non-farming activities and biogas (a gas produced from anaerobically processing animal waste used mainly for cooking in rural households) were some of the least used practices (Table 4.7). Biogas was the least used probably due to its high cost of installation.

Table 4.7: Practices farmers in the survey reported to use to cope with climate change

Practice	%
Mixed cropping	21
Agroforestry	18
Planting/keeping drought tolerant crops and livestock	18
Doing nothing	11
Changing planting/harvesting dates	11
Water harvesting	10
Irrigation	6
Water and soil conservation techniques	4
Switching to non-farming activities	0.9
Biogas	0.1

All the practices in Table 4.7 were used by farmers in the survey as a climate change adaptation measure, with mixed cropping, agroforestry and planting drought tolerant crops or keeping drought tolerant livestock being the most common climate change adaptation practices. The most common adaptive practice reported by farmers across all FGIs was planting trees as an adaptation rather than a mitigation measure. Farmers believed that planting trees would solve the problem of recurring droughts.

> **Male farmer, FGI, Watamu:** we have to have trees that act as windbreakers so that the wind does not blow the clouds away.
>
> **Female farmer, FGI, Malindi**: if people plant trees the rains may come.
>
> **Male farmer, FGI, Malindi**: you know the rains are brought by trees. So the primary factor that can at least help is planting trees.
>
> **Male farmer, FGI, Chonyi:** the rain clouds cannot pass direct [sic] over us if there are trees but if there are no trees the rain clouds are pushed very far away by the wind to where there are trees because here there are no trees…but if there were trees the clouds would not pass over, they will be caught [by the trees] and it will rain.

Male Key informant, Assistant chief: there are farmers who plant trees so as to bring back the rain. This is what they are doing up to now.

According to the farmers in the FGIs, it appears that trees act as a magnet for rain clouds. The second most frequently used intervention by farmers in the FGIs was planting of drought tolerant crops such as chilli, fruits (i.e. oranges, mangoes, coconuts) cassava, bambara groundnut, tamarind, millet, as well as improved maize varieties (Pwani Hybrids) such as PH1, PH4 and PH5. The third most commonly used intervention was diversification where besides growing crops, farmers kept livestock, while a few also kept businesses:

Male farmer, FGI, Malindi: you know business and farming go hand in hand. You cannot depend on farming its seasonal you must have something else so that you can survive. You can find someone who is employed, farming and doing business.

The greatest challenge farmers in the surveys reported to face when adopting climate change practices was poor access to water followed by lack of access to financial resources (Table 4.8).

Table 4.8: Challenges faced by farmers when adopting climate change practices

Challenges	%
Poor access to water	26.9
Lack of access to financial resources	23.2
Poor access to farming inputs	14.4
Not enough extension information	12.1
High cost of adaptation	12.1
Lack of labour	6.0
Shortage of land	5.3

Lack of access to financial resources sometimes resulted in farmers using the slash and burn method to clear their land, a method that is not recommended by key informants:

Male key informant, KENAFF: we have slash and burning for preparation of land for farming that is done by more than 90% percent… The slash and burn method just prepares a big chunks of land in a short time….though it doesn't give them the maximum land they would have wanted. It's still their method of choice because not many farmers will afford to invest their time and money to do the modern way.

Male key informant, KALRO: Also there has been this poor land husbandry [practices] farmers leave unnecessary stumps with thorns so every year it means they must cut the thorns and burn them and so they take it as a cultural method of land preparation which is not good.

Interestingly, no significant relationship ($X^2(5) = 2.173$, n=421, p=.825) was found between farmers' reports of adopting a climate change practice and their beliefs about the causes of climate change (Table 4.9). This means farmers' beliefs on the causes of climate change did not influence their adoption of climate change practices. However, farmers having experienced noteworthy changes in the natural environment which they thought was as a result of climate change had a significant effect ($X^2(1) = 10.673$, n=421, p=0.001) on their adoption of climate change practices (Table 4.10).

Table 4.9: Farmers' adoption of adaptive practices and their beliefs about the causes of climate change

	Causes of climate change						
Adopted?	**Entirely natural process**	**Entirely human activity**	**Partly natural partly human**	**An act of God**	**Don't know**	**Other**	**Total**
Yes	76.9(30)	83.8(160)	81.4(35)	80.6(116)	100.0(3)	100.0(1)	81.9(345)
No	23.1(9)	16.2(31)	18.6(8)	19.4%(28)	0.0(0)	0.0%(0)	18.1(76)
Total	100.0(39)	100.0(191)	100.0(43)	100.0(144)	100.0(3)	100.0(1)	100.0(421)

Numbers in parenthesis represent the frequency of respondents in each category

Table 4.10: Farmers' experience of noteworthy changes in the natural environment and their adoption of adaptive practices

	Experienced noteworthy changes		
Adopted?	**Yes**	**No**	**Total**
Yes	84.7(298)	68.1(47)	81.9(345)
No	15.3(54)	31.9(22)	18.1(76)
Total	100.0(352)	100.0(69)	100.0(421)

Numbers in parenthesis represent the frequency of respondents in each category

4.4.1 Farmers' reported use of indigenous knowledge to predict weather and to cope with the effects of climate change

Use of indigenous knowledge to predict change in weather patterns

Sixty two percent of the respondents reported to use indigenous knowledge to predict weather. Some of the farmers in both the survey and focus group interviews used animal behaviour to predict changing weather patterns. The most commonly used animals were birds and more specifically, ducks. Farmers stated that if they saw ducks running around, flapping their wings and bathing in the sand it was a sign that the rains were near. A male farmer in Magarini stated "I have ducks and I can never sell all of them no matter how much hunger there is because they are my signal for the onset of the rainy season." The second most commonly used birds were black birds called "Mario" in Giriama (Abdim Stork, *Ciconia abdmii*). When they saw the Mario birds circling in groups high up in the sky, they would know that the rains were near. The other commonly used animal was the cow. If they were seen running fast "like they are being chased by someone" and playfully jumping around with their tails raised "as if performing a dance" then the rains were near. Many white butterflies seen moving from South to North then on their return were multi-coloured like they had been "decorated" were also described as signs of the onset of the rainy season. A female farmer in Chonyi explained "You see those butterflies they have gone to get the rain. They have gone that way [South] to get the rain and when they come back they will have changed colour." Other animal signs were the appearing of ants with some of them carrying their eggs or frogs croaking.

Observing tree behaviour was the second most commonly used method of predicting the onset of the rainy season in both the surveys and FGIs. Most farmers said that if they saw the mango (*Mangifera indica*) and tamarind (*Tamarindus indica*) trees flowering, it was a sure sign that the rains were about to start. Another reported sign that marked the onset of the rains were trees growing new leaves, especially after a dry season. The most commonly observed tree was the Baobab tree (*Adansonia digitata*), followed by the "Mvule" (*Milicia excelsa*), then by "Mbambakofi" (*Afzeira cuanzensis*). The third most common method used by farmers was looking out for "many dark clouds gathering" that appeared "heavy", "reddish" and "stood like a rock". The wind was the fourth most frequently used method to predict the onset of the rains. Strong winds that "lifted leaves up to the sky" or change in wind direction that blew towards the ocean were identified signs. A less commonly used method was counting of the months in a year. Farmers knew that the long rains "Mwaka" would start at the beginning of March and the short rains "Vuli" would start around October. It is possible that this method was less popular because the seasons have become unpredictable. Most of the farmers indicated that they got this traditional knowledge from their fathers, grandfathers or elders within their communities.

There was no significant difference ($X^2(3) = 1.569$, n=421, p=.667) between age and use of indigenous knowledge to predict weather. This means that young people are just as likely to use indigenous methods to predict change in weather patterns as older people. However some farmers from both the survey and FGIs observed that the use of indigenous knowledge to predict the onset of the rainy season was slowly dying:

> **Male farmer, survey data, Chonyi:** Most old men have died, those left behind are the youth and they do not practice these things. They use modern methods.

Other farmers stated that the trees they relied on for signs that would help them predict change in weather patterns have since been cut down. Some farmers were cautious about using the signs from nature to predict the onset of the rainy season. This is because even though the signs pointed towards the onset of the rainy season it was not always the case; for example, the wind often blew the rain clouds away.

Use of indigenous knowledge to cope with the effects of climate change

Only 15% of respondents used indigenous knowledge to cope with the effects of climate change. Some of these farmers relied on rainmakers to "induce" rain during prolonged dry spells. Elderly rainmakers gathered at sacred places such as forests called Kayas or some rocks or caves where they performed rituals that brought rain. However most of these farmers indicated that the practice is slowly dying:

> **Male farmer, survey, Junju:** it used to get to a point where people lost hope that it would rain. When the old men saw this they would join hands with the Kaya elders and go to pray for the rains in the big forest called Kaya. In a short period of time, it would rain. But these days they do not do it.

> M**ale farmer FGI, Watamu**: The work that the rainmakers do now is not what they used to do a long time ago…a long time ago they were highly regarded individuals in the society. But now they have changed … to become a rainmaker they must offer a sacrifice.

> **Male farmer, FGI, Kaloleni:** People used to go to the Kaya forest but they no longer do so because if they did they would be branded as witchdoctors and they could be killed.

The use of rainmakers was therefore likened to the use of witchcraft and as a result there were reports of killings of witchdoctors within the community. These killings had even caught the

attention of the media. This situation, together with the cutting down of some of the Kaya forests, had led to the decline in the use of rainmakers:

> **Female, FGI, Kaloleni:** there were big trees in those areas [Kaya forests] in times of drought they [elders] would go to pray there and emerged soaked in rain. It rained even before they got to their homes. Now humans have cleared the whole forest and left the sacred place wide open.

The second most commonly used indigenous practice that was reported to cope with the effects of climate change was the use of water conservation techniques such as digging infiltration trenches to trap rain water and fetching water from rivers and wells. Most farmers complained of poor access to water for their farming and use in their homesteads because they mainly relied on rain fed agriculture. Consequently, they would be forced to buy water to irrigate their crops during the dry spell but this was an expensive venture and some would give up and let their crops dry:

> **Female farmer, Survey, Ganze:** If it hasn't rained I can water the plants but if I see that I am making a loss due to the high cost of water I sometimes just abandon them.

> **Male farmer, survey, Ganze:** using some of the indigenous methods depends on your financial capability. Sometimes we just watch our plants die because we cannot afford to water them, it is too expensive. When the maize die we feed them to the cows.

Diversification was also another commonly used traditional method of coping with the effects of climate change. Farmers from the surveys indicated that they grew crops and kept livestock such as chicken, goats and bees whose meat and honey they sold especially during the dry spell. They also made coconut oil and traditional mats for sale. Farmers in the surveys and FGIs also indicated that they diversified the types of crops they grew to include trees such as coconuts and mangoes and drought tolerant crops such as cowpeas, sorghum, cassava, sesame, "Mawele", "Tendezwa", and stored them for the dry season.

> **Male, Survey, Magarini**: we diversify our crops so that we do not just have one type of crop but many types some of which my fail and others succeed because there are some crops that have a short growing period like 45 days like Okra and beans and others that take a long time like maize … even when we harvest we store the harvest

However the FGIs had mixed reactions to the use of indigenous methods to cope with climate change.

Male farmer, FGI, Chonyi: the use of traditional seeds is fading because they are not certified. You have a 50/50 chance of failing or succeeding.

Female farmer, FGI, Tezo: the indigenous maize seeds have their advantage because they are not easily attacked by pests.

Female farmer, FGI, Junju: we plant traditional maize varieties like Mzihana and Kanjerenjere…they grow well even without manure or Bulldock [a pesticide] but the modern varieties if you do not put manure you will not harvest anything. They are attacked by pests.

Farmers in surveys, FGIs and key informants reported storing their harvests for future use using indigenous methods such as sun drying of tubers (e.g. cassava), grains (e.g. maize) and vegetables (e.g. Cowpeas). These dried grains were stored in a "lutsaga" which is a traditional store built above their cooking stoves. The smoke was said to kill pests, eliminating the use of pesticides during preservation of the food. Another method used by farmers in the Ganze FGI involved arranging maize and Neem tree (*Azadirachta indica*) leaves in alternative layers on the "lutsaga". The Neem tree is known to have insect repellent properties. If the seeds were to be used for planting in the next season, they were mixed with chili or ash to keep pests away before putting them in an air tight container (as reported by farmers in the Chonyi, Magarini FGIs and key informants). Farmers in Sokoke and Ribe FGIs left their cassava in the fields even after they were ready for harvesting as a way of preserving them.

4.5 Generation of programs from farmers' climate change information needs

Responses to various questions in the survey (Table 4.11) and FGIs were analysed to generate farmers' information needs with the aim of addressing them through radio programs. Additionally when farmers were asked what more information they required (FGIs and open ended question in the survey), most of them indicated that they would like to learn about "modern ways of farming" which included information about how to access extension services. Others nominated better rainfall updates and forecasts that advise them on the timing of the planting and harvesting seasons, and the causes and effects of climate change.

Female, survey, Ganze: I would like to know now that the climate is so harsh, will it improve or it will continue being hard or will it get better in the future. I would also like to know, now that the rains have reduced in quantity and the climate is bad causing a reduction in our maize yields, which crops can we plant that can give better yields … We also need to know which seeds can withstand drought and also grow within a very short time in our area.

Female, survey, Magarini: You can say it will rain in March then you plant but the rains do not come till April and others will not plant till May. So I want to know the cause of this.

Male, Survey, Malindi: Because of climate change and the fact that I have not been educated in agriculture, I would like the government to release its agricultural officers in large numbers to assist because we are experiencing climate change and we don't know what to do to our crops. So I would like the government to put some effort in bringing us the agricultural officers.

Male, survey, Watamu: Like now it has not rained and it looks like the rains will be late and I have planted my maize and the rains will not extend just because they were late. So the long rains have been shortened. We need to get fast growing seeds that are drought tolerant. If we don't get them, we will continue planting the old type.

Male, survey, Magarini: as farmers, we are really bothered by climate change because …we are not sure when to prepare land, plant and harvest so as to get a good yield. The dry spells are longer than the rainy days …if we can get educated on the best time to plant even our yields will be good.

Female farmer, FGI, Sokoke: maybe there are other things we do not know that cause climate change other than cutting of trees?

Female farmer, FGI, Watamu: maybe there are farmers who are more serious [in farming] than us or maybe they saw the climate is changing and they did some research and implemented some things because they got some results. We would also like to hear their solutions so that we can see if they will be of use to us.

Male farmer, FGI, Chonyi: with this climate change if we can be informed that the rains will be a lot or there will be floods or drought we can be able to prepare ourselves early.

Table 4.11: Information needs analysis from survey data

Question	Summary of responses	Deductions	Knowledge gaps
Q. 21How has climate change affected your farming?	Farmers indicated that climate change has affected their farming by: - causing a reduction in their crop and animal yields (66%) - causing them to change their planting and harvesting dates (19%) - causing them to abandon some farming enterprises (9%) and - causing them to change the crops or livestock they kept (6%).	How can farmers increase their yields given the effects of climate change?	-climate change adaptation strategies
Q.37. How much do you feel you know about climate change?	Farmers felt they knew very little (44%), a fair amount (37%), nothing (11% and a lot (7%) about climate change.	Farmers needed information on the causes and effects of climate change (even though their beliefs on what they thought were the causes of climate change did not influence their adoption of climate change practices) because this is information they requested. Farmers also required information on the adaptation measures they can put in place to cope with the effects of climate change	-what is climate change, its causes and effects - adaptation strategies that farmers can use -how to access timely and accurate weather updates -how to access extension services
38. How much more information do you feel you need about climate change?	Farmers felt they needed a lot of information (61%), some more information (29%), a little more information (5%) and 6% felt they do not need any more climate change information		
Q.38 (b) What more climate change information do you require?	-what is climate change, its causes and effects -strategies that would help adapt to and mitigate climate change -more timely and accurate weather updates -how to access extension services		
Q.55 What challenges did you faced while adopting the interventions mentioned?	Farmers cited poor access to water (27%), lack of access to financial resources (23%), poor access to farm inputs (14%), high cost of adaptation measures (12%) and not enough extension information to implement a practice (12%) as challenges faced when adopting interventions.	Farmers' challenges provide an opportunity for climate change education and communication	-water harvesting -access to financial resources -access to agricultural extension services

Below is a summary of the identified information needs categorised by themes from the survey and FGIs that provided a context for the development of radio programs.

Climate change background

- What is climate change?
- What are the causes of climate change?
- What are the effects of climate change on farming and the environment?

Strategies that farmers can implement in order to cope with the frequent dry spells and unpredictable rains and to increase their crop yields

- What types of seeds match farmers' agro-ecological zones?
- What early maturing and drought tolerant crops can farmers plant?
- What water harvesting techniques and irrigation systems can farmers use?
- What water and soil conservation techniques can farmers implement?
- How can farmers access financial resources for their farming?

Weather

- Why has the weather changed to an unpredictable onset and duration of rainy seasons?
- Why are weather updates sometimes inaccurate?
- What are the climatic predictions for the future?
- How can farmers get weather updates per season?

Extension services

- How can farmers access agricultural extension services?

The following is a summary of the program content aired to address the farmers identified information needs (Table 4.12). A total of 16 programs (which were five minutes each) were developed with climate change experts from various institutions in Kilifi County (see Appendix K for the specific programs and transmission dates).

Table 4.12: A summary of the program content categorised by theme

Causes and effects of climate change *(Experts: Ministry of Agriculture, Kenya Marine and Fisheries Research Institute)*
– What is climate change and what are its causes?
– How to deal with the effects of climate change?

Adaptive strategies ***(Experts: Kenya Agriculture and Livestock Research Organisation, Kenya Forestry Research Institute, Ministry of Agriculture, Farmer in Voi)***

- Planting drought tolerant crops:
  - Planting and eating drought tolerant crops such as oats, sweet potatoes, cow peas, and pigeon peas (or selling them to buy maize - their staple food, in places where maize varieties grown are susceptible to drought)
  - Planting indigenous maize varieties such as "Kanjerenjere", "Mzihana" that are drought tolerant alongside improved maize varieties
  - Planting drought tolerant cassava varieties such as "Tajirika", "Nzalauka", "Shishibe", "Siri" bred by KALRO
  - Using shoots "matagaa" rather than cuttings "vipandikizi" to plant cassava as a means of shortening the growing period and increasing the number of tubers
  - Planting both early and late maturing cowpeas
- Soil and water conservation:
  - Using a "moist garden"-pits lined with polyurethene sheets to grow vegetables
  - Using zai pits- planting maize in 2ft wide pits filled with organic matter to conserve moisture
  - Digging infiltration ditches "kaselenga" along which vegetables are grown
  - Stopping the use of slash and burn methods for land preparation
- Increasing trees on farms:
  - Planting trees on farms such as "Mizambarau" (Guinea waterberry), Tamarind, Baobab
  - Planting trees in a wood lot, mixed with crops or along fences
  - Allocating 10% of farm land to planting of trees
  - Stopping deforestation
- Water harvesting:
  - Using coconut leaves to harvest rain water into a container
  - Harvesting water from rooftops or from an iron sheet
  - Harvesting water into a plastic lined water pan
  - Digging wells
- Reducing soil erosion on your farm by:
  - gathering all plant residues and putting them along soil erosion control gullies rather than burning them
  - planting grass such as "makarikari"
  - using "fanya juu" system

- using manure

Accessing financial resources: (*Experts: Ministry of Agriculture, farmer in Rabai*)

- Getting loans from the banks, cooperatives, merry go rounds as well as government sources such as the "Uwezo fund" and "Njaa marufuku Kenya"
- Joining groups as a means of accessing loans

- Others
  - Storing seeds in village seed banks for use by future generations
  - Planting traditional crops from KALRO or from village seed banks (domestication of wild crop species)
  - Planting sorghum for sale to beverage making companies

Weather/climate (*Expert: Meteorological Department*)

- Why the weather has changed causing delayed rainy seasons and a change in the duration of rainy seasons
- Why weather updates are sometimes inaccurate
- Predictions for future climatic conditions
- How to get rainfall updates per cropping season

Extension support (*Expert: Meteorological Department, Kenya Agriculture and Livestock Research Organisation, Ministry of Agriculture*)

- Using meteorological data from the radio and the meteorological department
- Joining farmer groups so as to get fast and easy access to agriculture extension officers
- Seeking the services of agriculture extension officers instead of waiting for them to come to your farm

4.6 Summary of Key Findings

Nearly all farmers in this study believed that the climate was changing in Kenya (99%), with a vast majority (87%) indicating that they were already feeling the effects of climate change on their livelihoods (e.g., reduced crop yields) from severe weather events, such as droughts and floods. Farmers also reported that their exposure to the impact of climate change resulted in feelings of despair, irritation, confusion and anger. Farmers believed climate change was caused by entirely human activities (45%), an act of God (34%), partly natural, partly human causes (10%), and natural causes (9%). Human activities included cutting down of trees, emissions from factories, poor government policies and corruption. Gender influenced what farmers thought were the causes of climate change as well as their concern about climate change. Most males thought that climate change was entirely caused by human activities (54%) an act of God was the most frequently nominated cause by females (44%); and more men (75%) were found to be "very concerned" about climate change than women (60%).

All farmers (in the survey and FGIs) who participated in this study indicated they owned a radio or had access to one. Very few farmers reported receiving frequent and effective agricultural extension support (9%), with a majority (77%) reporting occasional and effective support or none at all. Despite this, farmers reported using adaptive practices to cope with climatic variability such as mixed cropping (21%), Agroforestry (18%) and planting/keeping drought tolerant crops and livestock (18%). Poor access to water (27%), lack of access to financial resources (23%) and poor access to farming inputs (14%) were nominated as the major challenges they faced when implementing the adaptive practices. No significant relationship was found between farmers' reports of adopting a climate change practice and their beliefs about the causes of climate change.

Sixty two percent of the respondents reported using indigenous knowledge such as animal and tree behaviour to predict weather. However some farmers from both the survey and FGIs observed that the use of indigenous knowledge to predict the onset of the rainy season was slowly dying because some of the trees they relied on for signs that would help them predict change in weather patterns have since been cut down. Another reason offered was that climatic variability made the use of indigenous knowledge to predict weather unreliable. A few (15%) of the farmers in the survey claimed using indigenous knowledge of soil and water conservation and storing of harvests to cope with the effects of climate change. Farmers also reported using rainmakers to "induce" rain during prolonged dry spells.

An analysis of farmers information needs revealed that they required information on the following questions: What is climate change? What are the causes of climate change and its effects? What climate change adaptive practices can they adopt? How can they access timely and accurate weather updates? How can they better access agricultural extension services? Radio programs that addressed these information needs were then developed with the input of climate change experts within Kilifi County.

Chapter Five: The influence of the radio intervention on farmers' perceptions of and adaptation to climate change

5.1 Introduction

This chapter reports findings that address the last objective of this study which is to evaluate the impact of the radio intervention on farmers' responses to climate change. The radio intervention was composed of programs designed to communicate information on adaptive strategies that would help farmers increase their capacity to respond to climate change. An evaluation of the impact of the radio intervention reveals how the intervention helped farmers improve their adaptive capacity. Consequently, this chapter compares findings between the pre- and post-intervention phases of this study in order to establish how the radio intervention influenced farmers' perceptions of and adaptation to climate change. Challenges that emerge with farmers' access to and use of the radio intervention provide a basis for offering recommendations on possible ways of addressing the identified challenges and limitations of the radio intervention.

The findings presented in this chapter address the following last two research questions which guided the data collection and analysis:

iv. How does radio as a channel for disseminating climate change messages impact on farmers' perceptions of and response to climate change?

v. What challenges do farmers face in implementing climate change interventions that are aired on radio?

Data analysis for this section was completed only with farmers who reported listening to the radio programs (n=137). All percentages reported in this chapter refer to comparisons between pre- and post-intervention results in that order. The first section compares farmers' beliefs, perceptions, and experience with climate change before and after the intervention. The next section presents findings on how farmers interacted with and utilized the radio intervention; what adaptation practices they implemented; the challenges they faced and how they rated the radio programs. Finally, a conclusion which provides a summary of the major findings in this study is presented.

5.2 Change in farmers' beliefs, level of concern, and perceptions of climate change

5.2.1 Farmers' beliefs about climate change

When farmers were asked "What do you think would be the most serious problem facing the world in the future if nothing is done to stop it?" the proportion of farmers who indicated "Environmental disasters (i.e. drought and floods)" reduced from 29% in the pre-intervention to 23% in the post-intervention survey but this finding was not significant (z=0.97, p=.33). However, the percentage of farmers who indicated "poverty/hunger" was the most serious problem increased from 30% to 37% respectively, although this finding was also not significant

(z= -1.28, *p*=.20). Similar results were found with the FGIs where hunger was most frequently mentioned as the most serious problem followed by drought. The proportion of farmers who believed that the climate was changing in Kenya remained the same (99%) before and after the intervention. However, the percentage of farmers who believed that the climate was changing in the world increased from 83% to 87% but this finding again was not significant (z= -1.01, *p*=.31).

In responses relating to what farmers believed were the causes of climate change, no significant difference (z= 1.22, *p*=.22) was found between pre- and post-intervention measures for "Entirely caused by human activity" but the percentage reduced from 48% to 41%. However, a significant increase from 9% to 29% (z= -4.31, *p*=.01) was found for those who believed that it is caused by "Partly natural process and partly human activities". No significant difference (z=1.82, *p*=.067) was found for the response that climate change is caused by "An act of God" with the percentage reducing from 29% to 20% respectively. The same trend was also observed in the FGIs where fewer farmers believed God is the cause of climate change with most believing that it is caused by human related activities such as deforestation and factories.

5.2.2 Farmers' experience and level of concern about climate change

There was an increase in the percentage of farmers who reported that they were already feeling the effects of climate change in Kenya even though there was no significant difference (z= -1.30, *p*=.19) between pre (85%) and post (91%) intervention results. Interestingly, given the choices "A great deal", "A moderate amount", "A little" and "Not at all", farmers who reported personally experiencing climate change "a great deal" significantly (z=3.29, *p*=.001) declined from 66% to 47%, while those who reported to have experienced it "a moderate amount" significantly (z= -3.44, *p*<.001) increased from 24% to 44% respectively. This means that some farmers moved from reportedly experiencing climate change "a great deal" to "a moderate amount". Despite this change, generally, the level of concern about climate change increased from the pre- to post- intervention phases of this study. There was a slight increase in the number of farmers who were "very concerned" about climate change with the percentages increasing from 67% to 70% although this finding was not significant (z= -0.89, *p*=.37), and similarly, the number who were "fairly concerned" about climate change increased from 19% to 23% but this finding was also not significant (z= -0.65, *p*=.52).

The proportion of farmers who thought that climate change is a "very serious" problem **right now** in Kenya, surprisingly significantly (Z=5.66, *p*<.001) decreased from 80% to 47% respectively. Correspondingly, the proportion of farmers who thought climate change was a "somewhat serious" problem significantly (z= -5.93, *p*<.001) increased from 10% to 42%. When farmers were asked how serious they thought climate change will be for Kenya and the

world in the future if nothing is done to reduce it, the number of farmers who thought it would be "very serious" significantly (z=2.95, p=.0032) reduced from 95% to 84%, but significantly (z= -2.79, p=.0053) increased for "somewhat serious" from 3% to 11% respectively, for Kenya. The same trend was observed with respect to the world, where the proportion of farmers who thought it would be "very serious" reduced from 80% to 76% respectively (z=0.73, p=.47) but increased from 7% to13% for "somewhat serious" (z= -1.82, p=.069) although these findings were not significant.

The findings that fewer farmers reported to experience climate change "a great deal" and viewed it as not a "very serious" problem after the intervention could be explained by farmers in the FGIs revealing that the long rains which started in March 2014 (after the pre-intervention data collection) were good with some recounting a good harvest.

> **Female farmer, Ribe:** They said it will rain in March and true [to their words] the rains started in March. When it started people thought it would not last, but it did. It forced some people to plant while it was raining.
>
> **Male farmer, Sokoke:** Some started [planting] in March, others in April and May. Others continued because the rains have not stopped. This year they [extension officers] have said that the rain will not stop. It will continue…and we saw it was true and we continued planting.
>
> **Female farmer, Ganze:** We have gone for three consecutive years without getting food from our fields. We cultivate but we do not get anything. In this fourth year we have got some food that can last us…even a month. Now we are rushing to plant with this rain so as to get a harvest that will last us a few months…the hunger has reduced but in the years to come if drought persist it will be a big problem.
>
> **Female farmer, Tezo:** For now the weather is good. We have planted cassava … How we planted this year is not like last year…the rains this year have rained well and we hope that if it continues this way our crops will grow well.

5.2.3 Farmers' perceptions of natural disasters and weather events

More farmers post-intervention thought that natural disasters are happening more often than they used to and humans are significantly contributing to it, with the percentage increasing from 43% to 61% (z= -2.90, p=.0037). Those who did not think that natural disasters are happening more often than they used to, reduced significantly (z=3.22, p=.0013) from 22% to 8% (Figure 5.1).

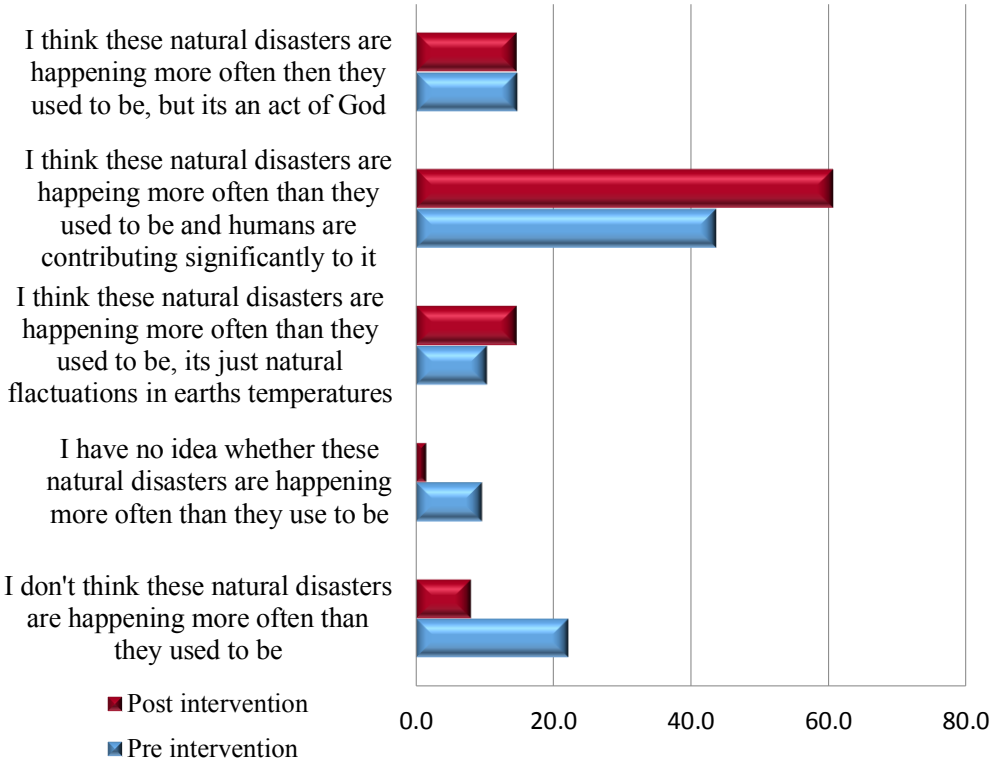


Figure 5.1: Farmers' thoughts about how often natural disasters are happening

Given the options "Very much", "Often", "Sometimes", "Rarely", and "Not at all", most farmers "often" and "sometimes" thought that climate change was influencing the frequency and intensity of weather events such as floods and droughts in Kilifi County, with fewer farmers indicating "Very much" after the intervention. The percentage of farmers who indicated "very much" significantly ($z=2.13$, $p=.033$) decreased from 37% to 23%, while for those who indicated "often" and "Sometimes" increased from 28% to 41% ($z= -2.56$, $p=.010$) and 22% to 31% ($z= -1.94$, $p=.052$n.s) respectively. This shift in responses from "Very much" to "often" and "sometimes" could also be explained by farmers reporting that the long rains were good (as indicated in section 5.2.2).

5.2.4 Farmers' attitudes and behavior towards climate change

Farmers were given the options indicated in Table 5.1 while responding to the question "To what extent do each of the statements describe your response to the threat of climate change after listening to the radio programs?" Generally, a bigger change in proportion (from pre- to post-intervention) was observed with farmers who "Tended to agree" with the bolded statements in Table 5.1 compared to those who "Strongly agreed", with the proportion in the latter decreasing post-intervention in some instances.

Table 5.1: Farmers' responses to the threat of climate change after listening to the radio programs

	Pre (%)	Post (%)	z	*p*
I can personally help to reduce climate change by changing my behaviour				
Strongly agree	50.7	57.7	-0.73	0.47
Tend to agree	25.0	36.9	-1.85	0.064
Neither agree/disagree	3.7	1.5	1.15	0.25
Tend to disagree	3.7	0.8	1.65	0.099
Strongly disagree	13.2	1.5	3.72	0.0002*
Don't know	3.7	1.5	1.15	0.25
My actions to reduce the effects of climate change in my community will encourage others to reduce the effects of global warming through their own actions				
Strongly agree	57.7	52.3	1.33	0.18
Tend to agree	21.9	40.8	-3.022	0.00025*
Neither agree/disagree	5.8	0.0	2.87	0.0041*
Tend to disagree	1.5	0.8	0.58	0.56
Strongly disagree	8.8	3.8	1.75	0.080
Don't know	4.4	2.3	1.017	0.31
I feel uneasy and apprehensive about what might happen in the near future due to the impacts of climate change				
Strongly agree	48.2	21.5	4.84	0*
Tend to agree	26.3	46.2	-3.04	0.0024*
Neither agree/disagree	3.6	7.7	-1.33	0.18
Tend to disagree	3.6	10.8	3.092	0.002*
Strongly disagree	10.9	11.5	0	1
Don't know	7.3	2.3	1.99	0.047*
I feel a sense of loss because climate change impacts are becoming apparent in my local area				
Strongly agree	66.4	27.7	6.66	0*
Tend to agree	17.5	40.8	-3.9	0.001*
Neither agree/disagree	4.4	6.9	-0.80	0.42
Tend to disagree	1.5	12.3	-3.41	0.00064*
Strongly disagree	8.0	11.5	-0.82	0.41
Don't know	2.2	0.8	1.0074	0.31

*$p<.05$

The proportion of farmers who "strongly agreed" and "tended to agree" that **it is hard to imagine individuals like myself can make a difference with respect to a global phenomenon such as climate change** significantly declined (z=4.7, $p<.001$) from 26% to 5% and 19% to 8% (z=2.86, $p=.0042$), respectively, while those who "strongly disagreed" and "tended to disagree" with this statement increased from 27% to 31% (z=-0.676, p=.5n.s) and 16% to 29% (z=-2.48, $p=.013$) respectively. The proportion of farmers who "strongly agreed" that they had **seriously thought of alternative places to live because of the increasingly evident impacts of climate change** significantly decreased (z=2.47, $p=.014$) from 14% to 5%

respectively. However, those who "strongly disagreed" also significantly (z=2.28, *p*=.023) declined from 78% to 69% respectively.

Most of the farmers tended to agree with the following statements (Table 5.2) which were only asked during the post-intervention phase of this study in order to assess their behavioral adaptation to climate change (Reser, 2012) after the intervention:

Table 5.2: Change in farmers' thoughts and actions about climate change

Statements	Strongly agree (%)	Tend to agree (%)	Neither agree/ disagree (%)	Tend to disagree (%)	Strongly disagree (%)	Don't know (%)
I have changed the way I think about the seriousness of environmental problems	45.4	**50.0**	2.3	1.5	0.8	0.0
I increasingly find myself more likely to attend to media reports, articles and discussions about the nature or impacts of climate change	33.8	**53.1**	11.5	0.0	1.5	0.0
I have often discussed my thoughts and feelings about climate change with others over the past several months	37.2	**47.3**	6.2	4.7	4.7	0.0
I tend to think differently these days about what is acceptable and sustainable and not acceptable with respect to my farming practices	39.2	**40.8**	13.8	1.5	0.8	3.8

5.2.5 Farmers' perceptions of climate change impacts

The proportion of farmers who "strongly agreed" that **climate change will mostly affect areas that are far away from here** significantly decreased (z=4.23, *p*<.001) from 45% to 21% respectively while those who tended to disagree with this statement significantly increased (z=-4.3421, *p*<.01) from 5% to 25%. There was also a significant (z=3.0674, *p*=.0021) decrease in the number of farmers who "strongly agreed" that **climate change is likely to have a big impact on farmers** from 80% to 66%, with an insignificant increase in the proportion of farmers who "tended to agree" (z= -2.021, *p*=.043) from 18% to 29% respectively. Farmers were asked to rate the risk of climate change exerting a significant impact on several factors listed in Table 5.3. Even though the proportion of farmers who rated the risk of climate change exerting a significant impact on various aspects as "High risk" declined after the intervention, their proportion still remained high (>50%).

Table 5.3: Farmers rating of the risk of climate change on various factors

Aspects	Category	Pre (%)	Post (%)	z	*p*
You personally	High risk	63.5	50.4	2.2	0.028*
	Medium risk	25.5	40.9	-2.69	0.0071*
	Low risk	8.0	7.3	0.23	0.81
	No risk	2.9	1.5	0.83	0.41
Your family	High risk	68.6	50.4	3.077	0.0021*
	Medium risk	23.4	40.9	-3.11	0.0019*
	Low risk	5.8	7.3	-0.49	0.62
	No risk	2.2	1.5	0.45	0.65
Your community	High risk	66.4	53.3	2.22	0.026*
	medium risk	26.3	36.5	-1.82	0.069
	Low risk	5.8	8.8	-0.93	0.35
	Very low risk	0.0	0.7	-1.0018	0.32
	No risk	1.5	0.7	0.58	0.56
Public health	High risk	59.9	51.1	1.4587	0.014*
	Medium risk	29.2	35.0	-1.035	0.30
	Low risk	9.5	12.4	-0.7739	0.44
	Very low risk	0.0	0.7	-1.0018	0.32
	No risk	1.5	0.7	0.5805	0.56
Economic develop	High risk	63.5	51.8	1.9563	0.05
	Medium risk	28.5	34.3	-1.04	0.03*
	Low risk	7.3	13.1	-1.5956	0.11
	No risk	0.7	0.7	0	1
Future generations	High risk	91.2	76.6	3.3	0.001*
	Medium risk	5.8	13.9	-2.2297	0.026*
	Low risk	2.2	6.6	-1.7713	0.077
	No risk	0.7	2.9	-1.3541	0.18
Their environment	High risk	67.9	54.0	0.3528	0.019
	medium risk	23.4	32.1	-1.62	0.11
	Low risk	6.6	13.1	-1.8243	0.069
	No risk	1.5	0.7	0.5805	0.56
	Don't know	0.7	0	1.0018	0.32

*$p<.05$

5.2.6 Farmers' level of trust in government, scientists and media on climate change and environmental issues

The proportion of farmers who "strongly agreed" that **they trusted the Kenyan government to take appropriate action against climate change** significantly (z=3.17, p=.0015) declined from 34% to 18%. In contrast, the proportion of farmers who "tended to agree" with this statement significantly (z= -2.0829, p=.03752) increased from 26% to 39% respectively, while farmers who "neither agreed nor disagreed" with this statement also significantly (z= -3.1786, p=.0015) increased from 10% to 26% respectively. This means that a majority of the farmers (65%) "tended to agree" and "neither agreed nor disagreed" with the statement. A possible

explanation for the decline in the proportion of farmers who "strongly agreed" with the statement is provided later in this section.

Farmers' level of trust in what scientists, the media and government said about the environment increased significantly for scientists (pre M=0.0925, SD 1.0784, post M=0.0557, SD=0.6501, t(135)=3.529, p=0.001), and media (pre M=0.0859, SD= 1.0056, post M=0.0533, SD=0.6238, t(136)=3.521, p=0.001), but not significantly for government (pre M=0.0963, SD=1.1267, post M=0.0709, SD=0.8298, t(136)=1.685, p=0.094). Note that a greater mean signifies a lower level of trust (Figure 5.2)

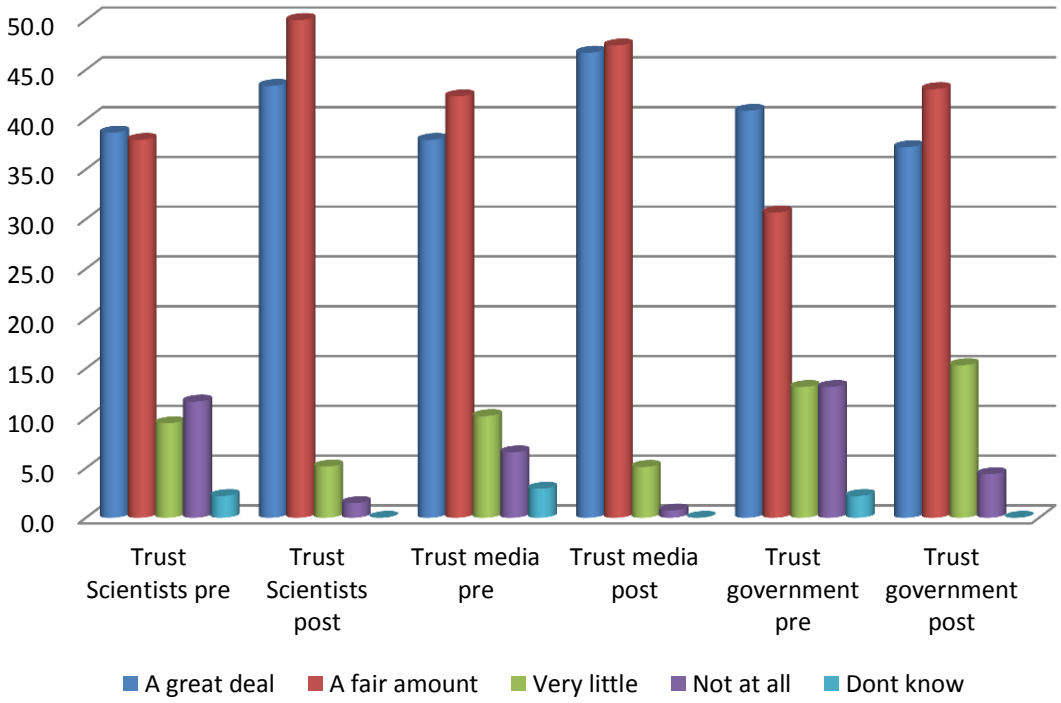


Figure 5.2: Farmers level of trust in what various sources say about the environment

The shift in the farmers' level of trust in what the government said about climate change from "A great deal" to "A fair amount" as well as the decline in the number of farmers who "strongly agreed" that they trusted the Kenyan government to take action against climate change could partly be attributed to an increased attention to recent events that occurred prior to data collection after the intervention. There were reports of an attack on the residents of Mpeketoni located in the neighbouring Lamu County. These attacks caught the attention of national and international media. The government blamed the attack on political rivals due to land issues while the media alleged it was the work of terrorists. The government's handling of the attacks may have contributed to farmers' reduced level of trust in what the government said, including

issues concerning climate change. This event could have elicited some of these reactions by farmers in the FGIs:

> **Male farmer, Watamu:** We cannot trust any government in this world because they do not go by what benefits their citizens but what benefits their interests.
>
> **Male farmer, Rabai:** I do not trust the government completely. Because…a government official may have education qualifications in one area but you find them heading various sectors like they know everything. I don't trust them.

Farmers generally trusted the media and scientists in agronomy issues but exhibited mixed levels of trust in weather forecasts. The near accurate prediction for the onset and duration of the long rains by scientists (conveyed through the radio) could have increased the farmers' level of trust for the media and scientists (including meteorologists). Farmers in the FGIs indicated that:

> **Female farmer, Ganze**: For example they said the rains will start in March, cease for a while and then continue in May. They told us to go ahead and plant; the rains will continue till December … so plant throughout the year. So we believe what the radio says.
>
> **Female farmer, Junju FGI:** They said it will rain a lot and it has to the extent that the rivers are full. Isn't that rain? If the rains continue beyond this it will turn into an El Niño.

Consequently the above comments suggest that as a result of the quite accurate predictions of recent rains, there was an increase in the proportion of farmers who thought that "a great amount" and "some" of the information provided in the news about climate change was accurate [from 31% at pre-intervention to 49% post-intervention for a "great amount" (z=-3.086, p=0.002); and from 35% to 41% for "some" of the information (z=-0.10, p=0.3) respectively]. However, some farmers in the FGIs indicated they believed the media and scientists "50/50" because the weather forecasts were not always accurate and ultimately it is God who really knows when it will rain.

The proportion of farmers who indicated they "Always" used day to day media (other media including radio) to inform their own views on climate change and other environmental issues significantly declined after the intervention (Table 5.4).

Table 5.4: Farmers reported use of media to inform themselves about climate change and how often they followed news about the environment

Frequency	Pre (%)	Post (%)	z	*p*
How often do you use day to day media coverage to inform your own views on climate change and other environmental issues?				
Always	23	7	3.096	0.0020*
Very often	22	22	0	1
Sometimes	24	55	-4.13	<.05*
Rarely	11	9	0.46	0.65
Never	20	7	2.64	0.0083*
How closely do you follow the news about the environment these days?				
Always	31	15	2.59	0.0096*
Very frequently	21	33	-1.82	0.069
Occasionally	36	47	-1.45	0.15
Rarely	9	5	1.098	0.27
Never	3	0	1.74	0.082

*p< .05

However, there was an increase from pre- to post-intervention in the number of farmers who reported "Very frequently" and "Occasionally" closely follow the news about the environment although these findings were not significant.

Farmers reduced use of media to inform their views on climate change and other environmental issues, as well as the frequency of how closely they "Always" followed news about the environment, can partly be explained by farmers in the FGIs acknowledging that the planting season kept them very busy greatly reducing their time to listen to the radio. Interestingly, despite them mentioning they were too busy, the percentage of farmers who indicated that they "never" used the media to inform their views on climate change and other environmental issues declined from 20% to 7%.

5.3 Assessment of the impact of the radio intervention

5.3.1 Adaptation practices implemented by farmers

Thirty three percent of the farmers who were surveyed for this study said they listened to the radio programs, out of which 82% reported implementing one or more adaptation practices they heard. Only 12% of the farmers in the FGIs reported to have listened to the programs. The most common reasons given by farmers in the survey for not listening to the programs were no radio, lack of time, radio stopped working and poor radio signals. The least common reasons were lack of money to buy batteries and forgetting to tune into the programs. According to the farmers in the FGIs the major reason for not listening to the programs was lack of a radio

(Figure 5.3). Some farmers indicated that they would have listened to the programs from their neighbour's radio but the timing of 7.50am was too early to call into their neighbour's house. Other farmers added that they may have access to their neighbour's radio, but they cannot control what programs they listen to. Farmers also indicated that they were too busy trying to make ends meet to listen to the programs, with a few suggesting that the best time to air the programs would be in the evenings.

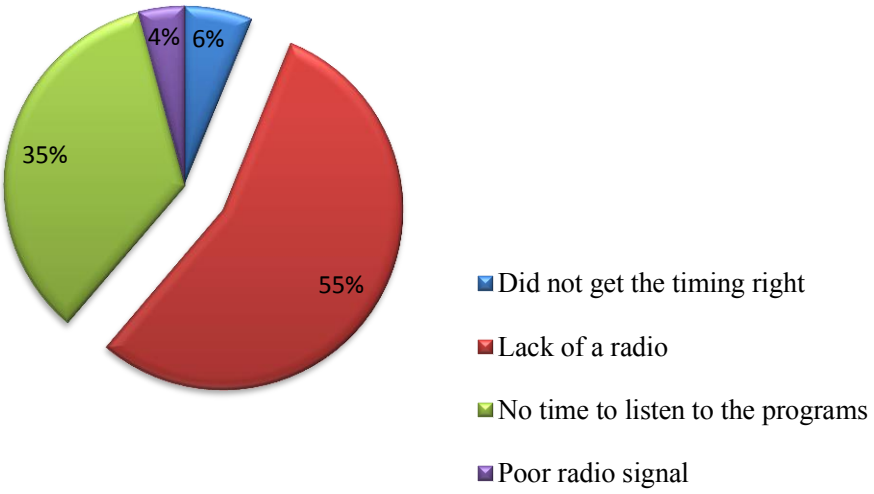


Figure 5.3: Reasons for not listening to the radio programs

The most commonly implemented adaptation practices by farmers in the survey (Plate 5.1) were growing drought tolerant crops (16%), water harvesting (14%), planting trees (13%), using manure (9%), growing both traditional and modern varieties of maize (6%) and accessing loans for farming (6%). Farmers in the FGIs who listened to the programs reported to have harvested rain water using various techniques, planted trees and grew drought tolerant crops such as maize and cassava. Other practices undertaken, though by a minority of the farmers, were taking loans, forming groups and using manure. However, it should be noted that this is a one-time self-reporting of farmers' adoption of the adaptive practices aired. Whether farmers will continue to use them sustainably is unknown and could be subject for future research. Enumerators verified practices adopted by 79% of the farmers who reported to have implemented the recommended climate change practices. No verifications were made for farmers in the FGIs and those who were unavailable for a face-to-face interview during the post- intervention survey. The latter were interviewed by phone.

Water harvesting from a coconut tree in Malindi and a rooftop in Tezo

Neem tree seedlings in Ganze

Plate 5.1: Climate change adaptation practices implemented by farmers

A majority of the farmers reported implementing the recommended practices individually (83%), with very few doing it as a group (17%). Consequently, most of the farmers (78%) indicated that they did not receive any assistance while implementing the climate change adaptation practices. Those farmers who reported to have received assistance said they obtained it from other farmers (69%) or agriculture extension officers (28%). Farmers reaching out to their families and others for assistance in implementing the recommended climate change practices could partly explain the minimal feedback to or interaction with the feedback phone number provided at the end of the radio programs which was monitored daily. The most common questions asked by farmers via the feedback phone were: where to get drought tolerant high yielding cassava and maize varieties, how to control pests in a greenhouse and how to

access loans for farming. Other calls and messages were not relevant to the intervention (e.g. requesting songs or to participate in radio quizzes from other programs).

Farmers were asked to indicate if they were engaging in the following actions and if it was "not", "partly" or "totally" because of climate change (Table 5.5). More than half of the farmers interviewed reported to have limited deforestation and practiced agroforestry totally because of climate change.

Table 5.5: Actions farmers undertook to mitigate climate change

Actions	Not engaging in behavior because of			Engaging in behavior	
	no opportunity (%)	**for some other reason (%)**	**not because of climate change (%)**	**partly because of climate change (%)**	**** totally because of climate change (%)**
Using less fertilizer (1*)	29	27	26	18	N/A
Using less fertilizer (2*)	28	20	18	32	2
Reducing use of fire to clear land (1)	17	15	23	45	N/A
Reducing use of fire to clear land post (2)	4	9	28	42	18
Limiting deforestation (1)	14	8	22	57	N/A
Limiting deforestation post (2)	2	8	2	29	62
Practicing organic farming (1)	19	6	50	25	N/A
Practicing organic farming (2)	21	2	35	42	1
Agroforestry (1)	27	3	26	45	N/A
Agroforestry post (2)	7	4	12	26	51

1*=Pre intervention, 2*=Post intervention
**a new variable "Totally because of climate change" was introduced at the post-intervention phase of the study. Therefore only percentages can be compared

Gender was found to have no significant effect on whether or not farmers implemented the recommended climate change practices they heard on radio ($X^2(1) = 0.11$, n=137, p=.74), with the difference being minimal (82% males and 80% females). Similarly, age, monthly income, level of education, farmers' reported experience of noteworthy changes in the natural environment which they thought was a result of climate change and what farmers believed were the causes of climate change had no significant effect (p>.05) on the adoption of adaptive practices. Importantly, over 70% of farmers implemented climate change adaptation practices they heard irrespective of their age, level of education or their reported experience of noteworthy changes in the natural environment which they attributed to climate change.

Socio-demographic factors have shown mixed influences on farmers' adoption of climate change practices in the literature. Results of this study for socio-demographic factors are similar

to other studies conducted by Okonya et al., (2013) for level of education, also by Gould, Saupe, & Klemme, (1989); Featherstone & Goodwin (1993), Burton, Rigby, & Young, (1999); Dolisca, Carter, McDaniel, Shannon, & Jolly, (2006) and Nyangena, (2007) for age, but in contrast to studies conducted by Deressa, Hassan, Ringler, Alemu, & Yesuf, (2009) for all factors, Etwire, Al-Hassan, Kuwornu, & Osei-Owusu (2013) and Enete and Onyekeru (2011) for both age and gender and Mugi-Ngenga et al., (2016) for age, gender and level of education. Given these inconsistent findings across studies, it is difficult for researchers to conclusively predict how a particular socio-demographic factor will influence how farmers adopt climate change innovations. Further research that investigates these inconsistencies is needed.

5.3.2 Challenges faced by farmers when implementing climate change interventions

The most often reported challenge farmers faced when implementing the climate change adaptation practices they heard on radio was lack of access to financial resources. Interestingly, the second most commonly identified challenge (the high cost of adaptation measures) was also concerned with financial resources (Figure 5.4).

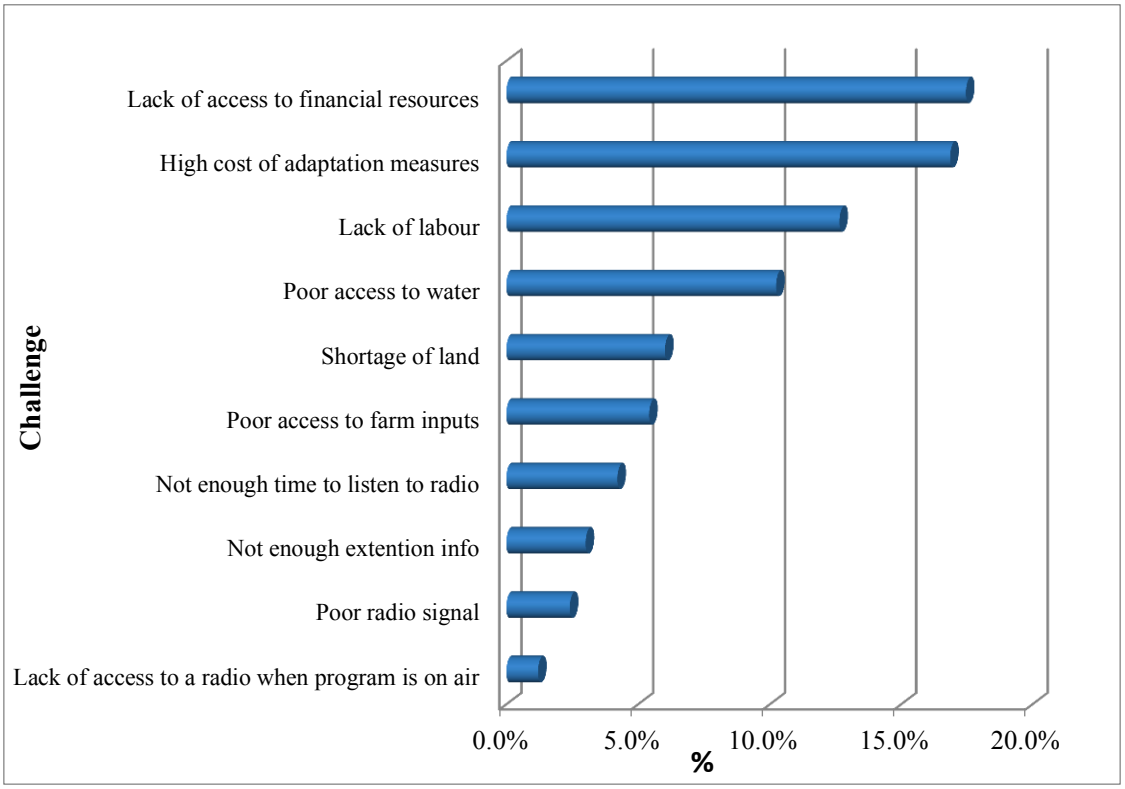


Figure 5.4: Challenges farmers faced while implementing climate change practices they heard on the radio

Other difficulties that farmers reported to face were: not being able to harvest water from rooftops (for watering their kitchen gardens and use within the homestead) because their houses were thatched or their iron sheets were rusted; too much rain that damaged the crops while in the field; and pests. Farmers who did not implement any practice after listening to the programs

indicated that they lacked financial resources while others were waiting for the next season to implement the practices. Farmers in the FGIs who listened to the programs indicated they faced challenges such as high cost of adaptation measures; a fear in taking loans in case they are unable to pay back; inability to store the radio programs for future reference; inappropriate timing of the programs (their mornings were too busy to listen to the programs); and too much or too little rainfall. Farmers from the FGI in Tezo indicated that the heavy long rains damaged their crops. In contrast, farmers in the Malindi FGI stated the rains disappeared in the middle of the growing cycle leading to poor yields.

Nevertheless, a majority of the farmers who listened to the programs were "always" (63%) and 'mostly" (32%) satisfied with them. They reported that the language used in the programs was "always" simple enough to understand (92%) and that the content was "not at all" poorly explained or confusing (75%). Farmers found "All" (75%), "most" (17%), "some" (4%) and "none" (3%) of the programs relevant.

5.3.3 Impact of the intervention on climate change knowledge

The number of farmers who felt that they knew 'a fair amount" about climate change not only increased significantly ($z= -5.2$, $p<.001$) from 33% to 64% respectively, but almost doubled, while those who indicated that they knew "very little" about climate change decreased significantly ($z=3.5483$, $p=0.0003$,) from 44% to 32%. However, it must be noted that farmers gained information about climate change from sources other than the radio programs. These farmers (69%) reported to have obtained climate change information from sources such as: other radio programs (33%); extension officers (28%); the TV (22%) and other farmers (11%). The newspaper (4%) and meetings with the chief (3%) were not common sources of climate change information. The most frequently used source of climate change information other than the radio intervention for farmers in the FGIs was agricultural extension officers.

The number of farmers who indicated they needed a lot more information about climate change significantly increased ($M=1.50$, $SD=0.84$ pre-intervention, $M=1.37$, $SD=0.58$ post-intervention, $t(135) =1.71$, $p<.001$) (where a higher mean indicates the need for less climate change information). Farmers indicated they needed more information on: agricultural interventions available to deal with the effects of climate change (49%); financial resources available to farmers and how to access them (24%); the effects of climate change (17%) and the causes of climate change (9%). Other information farmers wanted to know included emerging or new developments in climate change adaptation and weather information (updates). Farmers in the FGIs mostly wanted to know what other drought tolerant crops they can grow and to learn about other farmers' experiences with climate change in non-coastal areas.

5.4 Summary of Key Findings

This section provides a summary of the key findings of this study. The major findings can be categorised under the following themes: the impact of climate change on farmers' risk perceptions and emotional well-being, the influence of the radio intervention on farmers' perceptions about climate change, farmers reported adoption of recommended adaptive practices and the challenges they faced when implementing the adaptive practices they heard on radio.

This study established that farmers were already feeling the effects of climate change and that they viewed climate change as a risk that threatened their livelihoods, with some reporting that they had suffered negative impacts such as reduced crop yields resulting in economic and emotional stress. Consequently, there was a slight increase in farmers' level of concern about climate change after the intervention, and a majority rated the risk of climate change exerting a significant impact on "them personally", "their families" "their community", " public health in their area", "their economic development", "their environment" and "their future generations" as "High" before and after the intervention. This study also established that climate change had a negative impact on farmers' emotional well-being. Farmers reported that they felt uneasy and apprehensive about what might happen in the near future due to the impacts of climate change and that they felt a sense of loss because climate change impacts are becoming apparent in their local area.

The radio intervention appears to have influenced farmers' beliefs about the causes of climate change. This is because after the intervention, the proportion of farmers who thought that climate change was caused by "partly natural and partly human" activities significantly increased and fewer farmers believed that climate change is caused by an act of God. However, it appears that the radio intervention did not influence farmers' beliefs about and acceptance of climate change and how seriously they perceived it because nearly all farmers reported to believe in its existence and viewed it as a "very serious" problem before the intervention. Surprisingly, after the intervention, the proportion of farmers who thought that climate change was a "very serious" problem in Kenya right now significantly reduced, while those who thought it was a "somewhat" serious problem significantly increased. Additionally, fewer farmers reported to have experienced climate change a "great deal" and fewer "strongly agreed" that climate change is likely to have a big impact on farmers. These last three findings might initially be puzzling but can be explained by the FGIs reporting that the long rains after the pre-intervention survey was administered were good for crop production with some recounting a good harvest as a result.

All farmers who participated in this study initially indicated that they owned a radio or had access to one. However, only a third of the farmers reported to have listened to the programs with the major reason offered for not listening being lack of access to a radio. A vast majority of those who did listen reported to have implemented something they heard. These farmers reported adopting carbon reducing behaviours, such as reducing deforestation, agroforestry and reducing the use of fire to clear land, totally because of climate change. The minimal feedback to or interaction with the feedback phone number provided at the end of the radio programs, which was monitored daily, indicates that to the farmers, the radio intervention was a one-way communication.

This study found that farmers are likely to adopt climate change interventions despite their age, gender, monthly income, level of education and what they believed were the causes of climate change. These factors did not reportedly influence their decision to implement climate change interventions. Farmers appeared to show an increased interest in adapting to climate change post-intervention, as evidenced by the fact that even though a majority of them reported to know a "fair amount" about climate change, a significant number of them indicated that they needed "a lot more information" on agricultural interventions that can help them understand and deal with the effects of climate change. Generally, there was a significant decrease in the proportion of farmers who "always" used day to day media to inform their own views on climate change and other environmental issues as well as for those who "always" closely followed the news about climate change. This decrease can be explained by farmers reporting that they were too busy with their day to day chores and farming activities to listen to the radio as the programs (aired between May to September 2014) coincided with the planting, weeding and harvesting seasons.

Farmers (both in the survey and FGIs) who did not listen to the programs stated that their major challenge was lack of a radio and no time to listen to the programs. Farmers in the survey who listened to the programs but did or did not implement any adaptive practices stated that their major challenge was lack of financial resources and the high cost of adaptation measures. Additionally, farmers who did not implement any practice after having listened to the programs stated that they were waiting for the next season to do so, while those who implemented a practice reported to face other challenges such as lack of labour and poor access to water. Farmers in the FGIs who implemented the adaptive practices reported to face challenges such as inability to store the radio programs for future reference and inappropriate timing of the radio programs since they indicated that their mornings were too busy to listen to the programs.

A discussion and analysis of these findings and those in the previous chapter (from both the pre-intervention survey and FGIs) can be found in the following Chapter six.

Chapter Six: Discussion of results

6.1 Introduction

This study focused on the role of communication in improving farmers' adaptive capacity through a radio intervention. In this chapter, the discussion and analysis of the findings as summarised at the end of the previous two chapters are organised around the central problem and the key or central research question. The central problem addressed by this study is the self-reported impact of climate change by Kenyan farmers and the anticipated need to increase their adaptive capacity. Data collected before the intervention indicated that climate change is having a major impact on farmers and their current ability to cope with the changing climate is limited, therefore stressing the need to increase their adaptive capacity. The key question then, is what approaches can help these farmers better adapt their farming practices to climate change? A radio intervention that communicated adaptive strategies aimed at addressing farmers identified climate change information needs was tried but was limited for several reasons presented in Chapter five which included the one-way limitation of radio communication, farmers not owning a radio, and not being able to store the programs for future reference. These limitations and challenges created a need to examine the role of engagement and learning in improving farmers' adaptive capacity. A further analysis of the literature suggested Mezirow's theory of adult and social learning offered an appropriate theoretical framework for an alternative approach that could address both the farmers' challenges and the limitations found in this study to one-way communication of climate change adaptation information.

In framing this chapter, the terms adaptation, adaptive capacity, agricultural extension and climate change communication as defined in the Literature review chapter are briefly recapped in the context of this study. This study takes a broad view of adaptation as practices undertaken by farmers to cope with climatic variability, while adaptive capacity refers to farmers' ability and knowledge to implement adaptive practices such as growing drought tolerant crops. Agricultural extension on the other hand, is framed around the Kenyan context and it refers to providing farmers with advisory services that can help them improve their farming, income and welfare. Lastly, climate change communication refers to engaging farmers (primarily through radio) with the aim of providing them with relevant and practical strategies/practices that address their climate change information needs in order to increase their adaptive capacity.

This chapter is organised to address the central problem and research question of this study through the following four sections: (1) The impact of climate change on farmers and the need to increase their adaptive capacity; (2) farmers' reported responses to climate change impacts before and after the intervention and the influences on their responses, in adapting their farming practices; (3) challenges farmers reported when implementing adaptive practices before and

after the intervention; and (4) approaches to improving farmers' climate change adaptive capacity, where I draw on Mezirow's adult learning theory to inform recommendations on how farmers can be better educated to respond to climate change. Finally, I provide a conclusion which sets a background for the following chapter that discusses the implications of this study for policy, communication, education and extension.

6.2 The impact of climate change on farmers and their need to increase their adaptive capacity

Farmers in this study reported before the intervention that they were feeling the effects of climate change in the form of severe weather events, such as droughts and floods. Farmers narrated how climate change had negatively impacted on their farming, which is a primary source of their livelihood, by causing unreliable rainfall that resulted in reduced crop yields. These impacts not only affect their daily lives but also threaten the sustainability of their communities and their individual livelihoods in the long term. Their experiences with recent extreme weather seem to have caused nearly all farmers (99%) in this study to believe that the climate was changing in Kenya. A similar result was found in Uganda where 99% of the farmers interviewed reported to have observed a change in the climate in the last ten years (Okonya, Syndikus, & Kroschel, 2013). A study by Krosnick, Holbrook, Lowe, and Visser, (2006) on the public's concern about global warming, also found that people who believe they have witnessed a climatic event such as droughts, floods and cyclones in recent years are more likely to believe in the existence of climate change. The fact that nearly all farmers believed that the climate was changing before the intervention indicates that the radio programs did not influence farmers' acceptance of the existence of climate change.

Farmers' reported experience with droughts and floods places an additional strain in meeting their food, education and health needs. Understandably, it is not surprising that they viewed climate change as a risk that threatened their livelihoods with the negative impact leading to reported socio-economic problems such as children dropping out of school due to lack of money to pay school fees. Risks are the extent of the detriment associated with a specific negative event as a result of exposure to a hazard (Breakwell, 2010). Personal experience of weather events has been found to influence people's perceptions of risk and the perceived likelihood of a risk has been found to increase if it has been recently experienced or can be readily imagined (Spence, Poortinga, Butler, & Pidgeon, 2011). Risks from climate change impacts result from the interaction between "hazards (triggered by an event or trend related to climate change), vulnerability (susceptibility to harm) and exposure (people, assets or ecosystems at risk)" (IPCC, 2014b, p.36), factors to which farmers in this study have been predisposed. People see risks as affecting their physical being as well as their economic status (Tulloch & Lupton, 2003). The public appraise the "credibility or a substance of a threat, as

well as matters of seriousness and vulnerability if the danger is deemed to be 'clear and present" (Reser, Bradley, Glendon, Ellul, Callaghan, 2012, p. 26). Farmers' belief in the existence of climate change, coupled with their experiences with the negative impact of climate change, and their high level of concern about it is likely to increase their likelihood of being receptive to adaptation strategies that would enhance their adaptive capacity.

The negative economic impacts from climate change related weather disasters affected farmers' emotional and psychological well-being. Climate change impacts experienced by farming communities over long periods of time may lead to significant psychological distress (Clayton, Manning, & Hodge, 2014). Research by Searle and Gow (2010) that investigated whether concern about climate change by Australians led to distress found a relationship between the public's concern about climate change and negative emotional reactions such as depression, anxiety and stress. Other global studies have found that climate change is impacting negatively on the psychological health and well-being of individuals (Reser et al., 2012; Doherty & Clayton, 2011). Anxiety and distress are common terms used to describe individuals' responses to the issues of climate change. Some individuals have been reported to have experienced intense worry due to climate change that leads to distress and interferes with their daily living (Searle & Gow, 2010). Climate change related disasters such as droughts are projected to increase in the future (IPCC, 2014a). Australian farmers have been reported to suffer from severe drought related economic hardship which has been linked to their suffering from mental health problems (Berry, Hogan,Owen, Rickwood, & Fragar, 2011). A relationship between the occurrence of drought and farmer suicides in Australia and India has also been reported (Padhy, Sarkar, Panigrahi, & Paul, 2015; Hanigan, Butler, Kokic, & Hutchinson, 2012). This suggests that psychological interventions (discussed further in Chapter seven) that might help farmers cope with the emotional impacts and uncertainties of climate change are therefore needed. However, the greatest boost to their well-being is most likely to result from being able to adapt their farming practices to the changing climate.

People are more likely to adapt to climate change the more they get emotionally aroused with feelings such as concern, fear and anger at present and future environmental threats, and if they see that adapting to climate change may bring net benefits to themselves and their community (Patchen, 2006). The positive effects that ensue from adapting to climate change, known as co-benefits, can motivate farmers to adopt climate change practices (Bain et al., 2015). According to Bain, co-benefits such as economic development, benevolence (a more moral and caring community), reduced disease and poverty levels motivate people to adapt to or mitigate the risks of climate change impacts, despite their views of or the importance they place on climate change. From this study, it can be argued that farmers perceived co-benefits of adapting to climate change included reduced poverty and hunger as they indicated they thought poverty and

hunger would be the most serious problem facing the world in the future if nothing is done to stop it. Given that farmers' livelihoods are dependent on successful and profitable farming it can be assumed that by adopting adaptive practices farmers would increase their income from farming and thereby hope to reduce their family's level of poverty and hunger.

6.2.1 Influence on farmers' concern about climate change

Individuals who have had direct experience with climate related impacts are more likely to be concerned about climate change and undertake sustainable behaviours (Spence et al., 2011) some of which may comprise perceived co-benefits. This creates an opportunity for climate change educators and communicators to engage them on adaptation and encourage their adoption of adaptive practices. However, despite farmers reporting to have experienced the impact of climate variability, this study found that there was an overall decrease from the pre- to post- intervention in farmers' reported concern about climate change as evident by other questions that measured their concern about climate change. Before the intervention farmers' level of anxiety about the duration and quantity of the impending long rains and the impact of this on their farming was high. Climatic variability seemed to make it difficult for farmers to predict impending weather and this created a high level of uncertainty on when they should start planting and what crops to plant. However, the long rains turned out to be sufficient for crop production in most of the areas covered by this study. This could have resulted in the decrease in farmers' level of concern about climate change after the intervention.

Physical environmental cues have been reported to exert an influence on farmers' perceptions of climate change. New weather events can easily wipe out previous opinions that farmers held about climate change, where a particularly hot spell could cause an increase in concern about climate change while a cold snap could have an opposite effect (Egan & Mullin, 2012; Donner & McDaniels, 2013). The study by Krosnick, et al., (2006) found that people who perceived that their local temperatures had increased in the recent past expressed greater concern about climate change than those who had not. Results from the study by Donner and McDaniels, (2013) that investigated the influence of temperature fluctuations on the publics' opinion about climate change in the United States, led them to conclude that climate variability is one of the factors that have caused the change in the publics' opinion about climate change since 1990. Findings from these studies imply that the motivation of farmers to adapt could fluctuate with short term changes in weather. Farmers' experience of a good planting season may give them a false sense of security that may result in their holding back the implementation of adaptive practices. This can be hazardous because climate change is predicted to increase the frequency and severity (owing to the increased intensity and duration of these extreme weather events) of droughts, heat waves and floods in the future. This false sense of security could pose a

challenge to climate change educators and communicators on how to engage farmers to take up adaptive practices.

Findings from this study indicate that some farmers adopted climate change practices even though they did not understand the causes of climate variability. Farmers linked human activities (mostly cutting down of trees and factories) and the will of God to climate change. They emphasized planting trees to bring about rain as they believed that this would solve the problem of drought at their local level. The role of trees in mitigating climate change due to their ability to store carbon was seldom mentioned by farmers, while a few mentioned that air pollution resulted in the depletion of the ozone layer hence the observed increase in local temperatures. These findings imply that the knowledge of climate change science by some of the farmers in this study is low. Slight differences are found when these findings are compared with other studies that investigated what Africans believe are the causes of climate change. Research conducted in Zimbabwe revealed that farmers mostly attributed climate change to natural causes, followed by cultural and religious reasons, and lastly by political problems (Moyo et al., 2012). Unlike this study, human activities such as depletion of natural resources and air pollution were the least mentioned causes of climate change by farmers in the Zimbabwe study. Another study by the BBC World Service Trust (2010) carried out in 10 African countries reported that Africans thought climate change is caused by humans (through cutting down of trees; air pollution; and localized heat from their surroundings as a result of activities such as driving, factories, burning of vegetation), the will of God and depletion of the ozone layer. Similar to this study, other studies have found that the causes of climate change have not been well understood by most of the public due to its complexity, uncertainties and the fact that most of the greatest effects of climate change are predicted to occur in the future (Moser, 2010; Wibeck, 2014; Patchen, 2006).

Similar to this present study, farmers have also been found to adopt climate change practices even with their reported low climate science literacy in Nigeria (Ogunleye & Yekinni, 2012) and Zambia (Nyanga, Johnsen, Aune, & Kalinda, 2011). Some schools of thought have in the past proposed that people who lack basic climate change science knowledge do not understand the evidence of the reality of climate change, its causes and impacts and are not motivated to take action (Kahan et al., 2012). These schools of thought draw from the ideas and theories of the knowledge- deficit model which was proposed by social scientists in the 1980s. This model suggests that the public suffers from a deficit in knowledge which can be fixed by providing the public with scientifically sound information in order to increase their knowledge, action and support for that information (Nerlich et al., 2010; Moser 2010; Osberghaus et al, 2010; Adger et al, 2009). However, previous research has demonstrated that there is not such a causal

relationship between knowledge and action (Cracknell, 2001; Kurtycz, 2005; Kollmuss & Agyeman, 2002) and findings from this present study supports the lack of such a relationship. This therefore suggests that farmers' low climate science literacy should not be regarded as a barrier to adopting practices that would increase their adaptive capacity.

African traditional religion, passed from generation to generation has also been found to influence African farmers' beliefs on the causes of climate change (Pauw, 2013; Tagbo, 2013; Tambo & Abdoulaye, 2013). This could explain why some of the farmers in Kilifi County (who are mostly Muslim or Christian) linked God to the causes of climate change. This is similar to the study conducted by Moyo et al., (2012) with farmers in Zimbabwe which revealed that 48% of respondents indicated that the increase in frequency of poor rainfall seasons was caused by cultural and religious factors. The participants in the focus group discussions of the Zimbabwe study believed that climate change was a result of their ancestors being angry with them because they have abandoned their cultural norms and beliefs. African traditional religion refers to beliefs in a supernatural being (God and spirits) that controls all aspects of humans including their environment and in ancestral spirits which provide protection against calamities such as droughts, diseases and crop failure (Christian, 2014). African traditional religion is intertwined with the culture of the people and is expressed in beliefs and practices, myths and folktales, songs and dances, rituals, proverbs, sacred spaces and objects (Christian, 2014). Many African farmers often interpret events that occur in their farming, such as good yields, droughts and floods, from a religious or cultural perspective. Some of the interpretations may act as barriers while others may enhance adaptation. An example can be given of the *Rimaiibe* and *Fulbe* who live in the same geographical region in Northern Burkina Faso (discussed in chapter 2, section 2.3.1). The *Rimaiibe* embraced adaptation strategies available to them, while the *Fulbe* did not due to cultural differences. It would be prudent of climate change educators and communicators to recognize and understand religious or cultural barriers to adaptation when introducing new concepts to farmers. This understanding could inform the development of approaches that make the adaptive practices being introduced appealing and acceptable (Antwi-Agyei, 2014).

Vulnerability to climate change tends to be highest in parts of the world where religion is highly placed in people's daily life (Murphy, Tembo, Phiri, Yerokun, & Grummell, 2016). African countries are no exception. Many African countries are culturally and religiously pluralistic, meaning more than one religion or philosophy co-exist and a degree of recognition of the presence of other religions occurs between all the parties concerned (Tagbo, 2013). Many Africans affiliate themselves with the beliefs and practices of African traditional religion and other religions such as Christianity and Islam. Findings from a study that explored how Christianity and African traditional religion co-exist in Malawi indicate that traditional religion is strongly related to traditional ecological knowledge that can help in building adaptive

capacity while religious beliefs are associated with the scientific knowledge of adaptation through Faith Based Organisations (Murphy et al., 2016). Therefore, combining traditional religion and other religions can have a positive outcome for adaptation. Climate change educators and communicators can harness the important role of religious and cultural leaders in communities to positively influence adaptation. These leaders can use the teachings and values of their faith to enhance adaptation.

6.3 Farmers' reported responses to climate change impacts before and after the intervention and the influences on their responses, in adapting their farming practices

Understanding farmers' responses to climate change before and after the intervention not only enables the evaluation of the impact of the intervention but also provides an opportunity to learn about their current and potential adaptive capacity. In particular, farmers' responses to climate change before the intervention provide an indicator of their current adaptive capacity, while their responses to the radio program in implementing adaptive practices, along with the challenges they identify, give some insight into their potential to increase their adaptive capacity. In this and the following section, I draw from farmers responses to climate change before and after the intervention as well as from other research, to discuss their reported responses to climatic variability.

There exists a positive relationship between farmers' access to information required to make the decision to adapt to climate change and their adoption behaviour where access to information through extension services increases the chances of farmers adopting climate change innovations and practices (Antwi-Agyei, Dougill, & Stringer, 2014; Kimaru-Muchai, Mucheru-Muna, Mugwe, Mairura, & Mugendi, 2013; Deresa et al., 2009; Maddison, 2007; Hassan & Nhemachena, 2008; Yirga, Shapiro, & Demeke, 2007). However, some people who are aware that climate change is happening lack the knowledge of the specific actions to take and how to undertake them in order to cope with the effects of climate change (Gifford, 2011). Fortunately, farmers have access to various opportunities from which they can obtain more climate change information that would help them adapt to climate change. Farmers in this study who had listened to the programs reported to have obtained climate change information from: other radio programs (30%); extension officers (25%); the TV (20%) and other farmers (13%). These results are similar to findings by Kimaru et al., (2013) for farmers' use of extension officers from government and non-governmental organisations to source information on use of animal manure for their farming (22%), but in contrast for their use of radio/TV (2%) and other farmers (25%). It is hoped that the various information sources used by farmers in this study will remain useful in facilitating their learning of climate change adaptive practices.

The critical role played by agricultural extension service providers in facilitating a learning environment for farmers needs to be recognised. Adult learning does not occur in a vacuum (Merriam, Caffarella, & Baumgartner, 2007). Due to the social nature of farmers and of learning it would be ineffective to use radio in isolation to inform and educate them on climate change issues (Myers, 2008). Learning is a recurring process in which adults act and interact within their social situations (Lave, 1988). Farmers' learning of agricultural practices usually occurs in a "cultural context with many levels of interactions, shared beliefs, values, knowledge, skills, structured relationships, and symbol systems" (Hansman, 2001, p. 45). These interactions are mediated through the use of approaches (e.g., agricultural extension officers and conversation with friends) and spaces (e.g., demonstration plots and farmer field days) that encourage learning through dialogue. The fact that less than half (41%) of the farmers in this study indicated that they received occasional and effective extension support at the pre-intervention phase of this study, is an indication that more needs to be done in increasing not only the number and reach of agricultural extension providers but also the approach in providing agricultural extension services to farmers in Kilifi County.

6.3.1 Farmers' responses to climate change impacts before the intervention: An indicator of their current adaptive capacity

Farmers reported to have implemented adaptive practices, such as mixed cropping and agroforestry before the intervention. This indicates that they were already taking steps to adapt their farming practices. However, these farmers seemed to be reactive rather than proactive in some of their responses to climatic variability. For example, I observed that the water harvesting techniques used by many households were ad hoc and many lacked water storage capabilities. The little rain water that was harvested only served their short term water requirements. This meant that the water would not last long after a rainy season. Their reactive approach to adaptation makes them ill prepared for future weather related disasters and further increases their vulnerability. This presents a need to educate farmers on the importance of taking proactive measures to adaptation and provide them with not only available options to choose from but also the capacity to implement appropriate options.

It is evident that climate variability and the difficulties of predicting the weather create uncertainty and impedes farmers from making decisions on the timing of their farming activities. This contributes to their food insecurity. Farmers reported that current weather forecasts are not always accurate, with a few stating that they believed the updates "50/50". Early weather warning systems are important in informing governments and their citizens on emerging hazardous environmental conditions such as floods, droughts and cyclones so that actions can be taken in advance in order to reduce the imminent risks or impacts. However, the

meteorological services in Kenya - and more so in Africa generally - are poorly funded with little allocation from the government for investment in climate monitoring equipment and infrastructure that would assist in capturing meteorological data (World Meteorological Organization & African Union, 2010; Kisaka et al., 2015). This challenge inhibits countries providing early warnings and climate risk information that is essential for disaster risk management, especially to farmers whose livelihoods are climate sensitive (Antwi-Agyei, 2014).

Farmers' perception of lack of accurate forecasting from the meteorological department leads some to draw on indigenous knowledge to infer changes in weather patterns. Local knowledge has been variably termed as "indigenous knowledge" or "traditional knowledge" and can be defined as unique knowledge held by indigenous people in a given location that is embedded in their culture and embodied in their practices and is transmitted from generation to generation (Shava, 2013). Indigenous knowledge can help build the adaptive capacity of communities and their resilience to climate change (Lebel, 2013). Farmers in this study reported to have used animal, tree and wind behaviour to predict changes in weather patterns. Similarly, studies in other countries such as Zimbabwe (Muguti & Maposa, 2012); Canada (Turner & Clifton, 2009); Tonga (Nakashima, Galloway, Thulstrup, Ramos Castillo, Rubis, 2012); Australia (Green et al., 2010) and India (Santha, Fraunholz, Unnithan, 2010) have also reported use of indigenous methods to predict weather. Farmers, across all age groups sampled, reported use of indigenous methods to predict weather which suggests that this knowledge has a higher chance of being transmitted from generation to generation. Older farmers are however viewed to be more knowledgeable on the use of indigenous knowledge for climate forecasting than younger farmers (Mugi-Ngenga, 2016). Some farmers in the focus groups reported, climate variability makes the use of indigenous knowledge to predict weather unreliable. It is therefore not entirely clear for how long farmers will continue to rely on this knowledge alone to predict weather (Antwi-Agyei et al., 2014). Access to accurate weather forecasting information could enhance the adoption of adaptive practices by African farmers who mostly rely on rain-fed agriculture (Antwi-Agyei, 2014). The findings that farmers' perceived meteorological data as inaccurate and indigenous knowledge as unreliable places them in a precarious situation and greatly reduces their capacity to cope with climatic variability.

Only a few of the farmers in this study used indigenous knowledge to cope with the changing climate. Farmers used indigenous knowledge in storing their harvests (e.g. maize) and in water and soil conservation. Additionally, the intercession of rainmakers was sought during prolonged dry spells. Some of the farmers reported to have mixed both indigenous and scientific knowledge to cope with the effects of climate change. For example, some farmers reported to

have grown both the indigenous and scientifically improved maize varieties in order to benefit from the reported pest resistance of the indigenous varieties and the drought tolerance of the improved varieties. This would increase the likelihood that farmers got a maize harvest in the face of a pest outbreak or water stress. These farmers were therefore making an adaptation by themselves based on their knowledge and experiences as well as from external knowledge of researchers. There is no doubt that local knowledge has its challenges in that like scientific knowledge, it may be contested. However, local knowledge can positively influence farmers' ability to cope with and adapt to changing environments whether climatic or otherwise (Naess, 2013).

6.3.2 Farmers' responses to climate change impacts after the intervention

This study revealed that the radio has the potential to influence farmers to adopt adaptive practices despite the low percentage (33%) of farmers who reported listening to the programs. This finding is supported by the fact that 82% of the farmers (in the survey) who listened to the radio programs reported implementing something they heard (enumerators verified practices adopted by 79% of the farmers in the survey as indicated in Chapter five, section 5.3.1). This high adoption of adaptive practices by farmers who listened to the programs reveals their potential adaptive capacity and could partly be explained by the fact that nearly all farmers believed that climate change is happening in Kenya and that they had personally experienced the effects of climate change. A majority of the farmers being concerned about climate variability and their perception of climate change as a risk to their livelihoods could have also contributed to their adoption of the practices they heard. High perceived risk has been found to have a positive influence on people's motivation to adapt to climate change (Osberghaus, Finkel, & Pohl, 2010).

The time of season seems to be an important consideration when broadcasting radio programs if they are to improve farmers' adaptive capacity. It could be argued that water harvesting would have been the most commonly implemented intervention given that the farmers reported having received heavy rainfall during the long rainy season. However, this was not the case. Some farmers may not have seen the need to harvest rain water because it was in abundance at that time. This supports a previous finding that implied farmers' motivation to adapt fluctuates with short term changes in weather. Perhaps the programs on water harvesting would have been more effective if they were aired during a dry spell. This way it is hoped that as the farmers experience the effects of a prolonged dry spell they will make plans to harvest and store the rain water for future use when the rains start.

Economic resources (be it financial means, capital resources, wealth or poverty) are a determinant of individuals' adaptive capacity (Smit & Pilifosova, 2003). This means that

farmers' capacity to implement adaptive practices to cope with climate change can be especially difficult if they are economically disadvantaged. This in turn may lead to a negative impact on their psychological well-being. Heads of households whose only source of economic livelihood is farming have the responsibility of providing needs such as food, shelter, clothing, health and education to their families. They need to respond to their families' need for security and well-being despite their farming being threatened by severe weather events such as droughts and floods. This can evoke negative emotions of worry and fear of not being able to provide for their families. This situation may result in the emergence of psychological and economical barriers to the adoption of climate change practices that would help the family cope. Therefore, responding to climate change and other environmental challenges should be treated as originating in psychological (i.e. behavioural, cognitive, emotional, and social) processes rather than viewing them as solely scientific and technical problems (Koger et al., 2011).

Adaptation to climate change, especially in developing countries, largely relies on the actions carried out by individuals in their local environments and hence it is important to consider how psychological factors (cognitive characteristics such as thoughts and feelings that affect behaviour) may influence adaptive action (Osberghaus et al., 2010). Reser et al., (2012) define psychological adaptation to climate change as

> individual adjustments and changes in risk perception, threat appraisal, and associated cognitive, emotional, and motivational responses to the threat and perceived physical environmental impacts of climate change, as well as to altered behavioural responses and engagements associated with such changed thinking, feeling, and motivational responses. Psychological adaptation also and necessarily refers to those underlying psychological processes mediating and moderating such individual change (e.g., emotion management, self perception, self-efficacy, protection motivation, coping strategies), as well as to the achieved state of relative balance with respect to own needs and environmental press and/or threat. (p.142)

Psychological adaptation in this study refers to self-reported changes in how the farmers were thinking, feeling, understanding and acting towards climate change impacts (Reser et al., 2012). For example, more than half of the farmers in this study "strongly agreed" that they could personally help to reduce climate change by changing their behaviour and "tended to agree" that they increasingly found themselves more likely to attend to media reports, articles and discussions about the nature or impacts of climate change after the intervention. Psychological adaptation which is a powerful mediator of individual level behavioural adaptation and mitigation (Reser et al., 2012) can be achieved through the intervention of psychologists who can help individuals deal with the psychological impacts of climate change and help them overcome barriers to action some of which may be economic or psychological (Swim et al.,

2009; Gifford, 2011). However, access to psychologists by farmers in Kilifi County may be difficult given that there are very few psychologists in Kenya and their services are costly. Another possible approach (discussed further in Chapter seven) would be the use of counsellors who are more readily available, with some providing their services pro bono.

The radio intervention seemed to have motivated farmers to become engaged in taking action in mitigating climate change. Reser et al., (2012) define behavioural engagement as "Behavioural involvement in an activity or course of action, as distinct from a motivation or intention to take a particular action" (p. 231). A majority of the farmers in this study (>50% of those who listened to the programs) reported to have engaged in carbon reducing behaviours such as limiting deforestation and agroforestry totally because of climate change, even though they were not necessarily aware that these were carbon reducing behaviours. These findings indicate that the farmers who engaged in behaviours totally or partly because of climate change were becoming more aware that their pro-environmental actions can help reduce the effects of climate change. When individuals engage in small actions which they believe could have resulted in positive outcomes, they feel empowered by the perception of control over the situation and are more likely to engage in larger actions resulting in a positive feedback loop (Koger, Leslie, & Hayes, 2011).

6.4 Challenges farmers reported when implementing the adaptive practices before and after the intervention

Data collected prior to the intervention as well as the evaluation of the impact of the radio intervention revealed challenges that farmers faced when implementing adaptive practices. These challenges are discussed next.

Lack of access to financial resources and the high cost of adaptation measures were the most frequently cited challenges by farmers in this study who implemented the climate change interventions. This finding is corroborated by other climate change adaptation literature (Tambo & Abdoulaye, 2013; Antwi et al., 2014; Kithiia, 2011; Bryan et al., 2013) which found that financial factors are key barriers that impede farmers from implementing climate change innovations. The capacity for individuals to adapt to climate change is largely a "function of their access to resources" (Adger, 2003, p.29), such as climate change information/advisory services as well as finance. The good rains received during the long rainy season meant that farmers were engaged with farming activities and therefore their need for financial resources to purchase farm inputs and planting material was high. However, all of the most commonly adopted interventions by farmers in this study had a cost implication. For example, growing of drought tolerant crops (which was the most commonly implemented climate change practice), such as cassava, maize, and pigeon peas, would require that farmers purchase the planting

material. Most of the farmers' comments when asked if they had anything else to add at the end of the surveys were requests for assistance from the government for farming inputs and irrigation technologies with some of the farmers requesting free seeds and fertilizers. During the survey and FGIs with farmers it was noted that the government was providing free improved maize and pigeon pea seeds to the farmers for planting. However the seeds were not enough for every farmer. This meant that the farmers had to either purchase the seeds or use their own saved seeds.

This study established that farmers rate the challenges they face in their farming according to weather conditions and where they are at in the seasonal farming calendar. Before the intervention farmers cited poor access to water as the major challenge when adopting climate change practices followed by lack of access to financial resources. However, post-intervention, poor access to water was the fourth most frequently mentioned challenge by farmers, while lack of financial resources moved to top place. This change in priorities could be explained by the fact that farmers were just coming out of a dry spell at the beginning of this study in March 2014 (as discussed in section 6.2.1) and their access to water at that time was a challenge. However, the long rains turned out to be good for their farming and this could have resulted in access to water becoming a lower priority and challenge post-intervention.
Despite farmers' grievances about the lack of enough agriculture extension providers, it appears that they were able to access extension services (which included information in the radio programs) since the frequency of farmers citing this grievance moved from fourth place to eighth place after the intervention. On the other hand, lack of labour was the sixth most cited challenge before the intervention but was the third most frequently mentioned challenge after the intervention. This could be because the demand for labour was lower at the pre-intervention phase of this study since most farmers had not started planting. The good rains received during the long rainy season (prior to the post-intervention survey) are likely to have increased the demand for labour on the farms. According to the Kilifi County Integrated Plan (2013), the rate of unemployment in Kilifi County is approximately 30%. In the rural areas the youth who are a source of farming labour are mainly engaged in non-farming activities such as sand harvesting, quarrying and the motor bike business commonly referred to as "boda boda" (Kilifi County Integrated Plan, 2013). This could have led to a labour deficit when the demand for farm hands was high.

6.4.1 Challenges and limitations of radio for increasing farmers' adaptive capacity

All farmers who participated in this study indicated that they owned a radio or had access to one. However, post-intervention results revealed that only a third of the farmers listened to the programs. Farmers reported that one of the major challenges that prevented them from listening

to the programs was the lack of a radio. This study did not differentiate the number of farmers who owned a radio with those who reported to have access to one. This could mean that most farmers had access to a radio rather than owned one. Various studies across Africa have documented radio as the dominant or most widely used mass media for disseminating information (Girard, 2003; Boykoff & Roberts, 2009; Myers, 2008). These studies have also established that a majority of rural households own radios with Farm Radio International citing the rural household radio ownership in Africa as 76% (Sullivan, 2011). It is therefore evident that this study covered a community of farmers who fell in the category of low radio ownership.

Lack of time to listen to the radio programs was reported as a challenge by farmers in the survey and FGIs, post-intervention. This finding is supported by the decrease after the intervention in the proportion of farmers who "always" used day to day media to inform themselves about climate change and who "always" closely followed the news about climate change. The onset of the long rains meant that farmers were busy with land preparation and planting and therefore had limited time to listen to the radio. This finding suggests that the timing of radio programs is critical in determining whether or not the programs are listened to by farmers. Some farmers indicated that the best time to air the programs would be in the evenings as they wind down their day instead of in the mornings. Airing the programs in the mornings for this study was informed by a previous study carried out by the researcher in various regions of Kenya where a majority of the farmers indicated that their preferred radio listening times was in the mornings. One of the possible ways of overcoming the challenge of when to air the programs would be to air the programs in the mornings before the farmers leave their homes for work and repeat them in the evenings when they have returned home. However, this solution may be costly. Myers (2008) acknowledges that one of the challenges of developing content for African radio is the high cost of producing radio programs and purchasing radio station air time. Consequently, most of the radio content in Africa is composed of live studio based programs rather than pre- prepared programs, i.e. high impact dramas, features and talk shows with experts; most of which are produced and funded by NGOs (Myers, 2008).

One of the focus groups expressed the challenge of not being able to store the radio programs for future reference. Unless the farmers write down the information from the programs, they will largely rely on their memory to recall the information. The five minute programs also referred to as micro-programs (Girard, 2003) used in this study provided farmers with short and to the point information segments that should help them adapt to climate change. Additionally, the five minute programs were short enough to be aired on radio without incurring very high costs (fortunately, air time was pro bono for this study). To overcome the challenge of storing

the radio programs, radio producers could summarize the program content into a local language and send it as a mobile phone text message to farmers from time to time. However, this is time consuming and may not be cost effective or sustainable. This study also established that farmers had limited interaction with the radio station through the phone number provided at the end of the program. A vast majority of farmers (86%) indicated that they did not contribute to agricultural programs they heard on radio (through calling or texting the radio station). Additionally, nearly all farmers in the survey (99%) did not use social networking sites (i.e. Facebook and Twitter) to interact with the radio stations. Radio has been mostly viewed as a one-way communication media but this view is rapidly changing within radio production circles with the increase in various methods that encourage feedback from farmers through calls, text messages and more recently social media. However, as this study has established, these methods of feedback are rarely used by farmers in the rural areas of Kilifi County.

6.5 Approaches to improving farmers' climate change adaptive capacity

This section provides recommendations on addressing: the limitations of radio as an educative tool, the challenges farmers faced in accessing the radio programs, and possible approaches of improving farmers adaptive capacity given the impact of climate change on their farming and emotional well-being.

Adult learning in a social context

Social learning approaches are recommended to educate farmers about adaptive practices given the challenges they reported to face in accessing the radio programs. These challenges included not owning a radio and not being able to store the programs for future reference. Farmers listening to radio programs in groups and discussing what they have heard creates a social learning environment that enables meaningful learning of adaptive practices being introduced and promotes collective rather than individual recollection of adaptive practices communicated. This increases the likelihood of farmers implementing the adaptive strategies being introduced. Strategies that can help farmers to become better educated to respond to climate change can be identified by drawing on adult learning theory. Jack Mezirow provides useful perspectives on the dynamics of what learning is and how it becomes meaningful to adult learners in a social context. These perspectives, which I identify as being central to Mezirow's adult learning theory, are discussed next under the following headings: critical assessment of beliefs and assumptions, reflection, critical reflection and dialogue. This is followed by a discussion on the implications of Mezirows' adult learning theory on educating farmers about adaptive practices then by specific approaches and recommendations for addressing the challenges faced by farmers.

Critical assessment of beliefs and assumptions

Mezirow emphasises that learners come to learning situations with beliefs and assumptions which may impede or facilitate learning. Learners, in order to learn, need to critically assess these beliefs and assumptions, open up to new perspectives, revise their views, and act based on the new perspectives (Sokol & Cranton, 1998). For example, farmers can be encouraged to critically assess the beliefs and assumptions that influence their reactive rather than proactive approach to adaptation. This process involves dialogue and usually occurs in a social setting with the intervention of a facilitator. According to Mezirow (1991), the learning process involves

> the extension of our ability to make explicit, schematize (make an association within a frame of reference), appropriate (accept an interpretation as our own), remember (call upon an earlier interpretation), validate (establish the truth, justification, appropriateness, or authenticity of what is asserted), and act upon (decide, change an attitude toward, modify a perspective on, or perform) some aspect of our engagement with the environment, other person, or ourselves. (p.11).

Learning is the "process of using a prior interpretation to construe a new or a revised interpretation of the meaning of one's experience in order to guide further action" (Mezirow, 1991, p.12). To make meaning means to make sense of or interpret an experience. Making '*meaning'* becomes *'learning'* when we then use this interpretation to guide decision-making or action (Mezirow, 1990). Meaning is construed both pre-linguistically (through cues and symbolic models) and through language (Mezirow, 1991). Language enables us to "find concepts with which to punctuate the flow of experience, to locate it in time and space, and to identify objects, events, feelings, circumstances, and context" (Mezirow, 1991, p. 58). Language not only describes things and events that we experience but constructs them.

Reflection

Climate change educators facilitating learning in a social context should consider that reflecting back on prior learning is central to adult learning. Reflection involves individuals critically exploring their experiences in order to lead to new understandings and appreciations (Mezirow, 1990). Reflection includes making "inferences, generalizations, analogies, discriminations, and evaluations, as well as feeling, remembering, and solving problems. . . using beliefs to make an interpretation, to analyze, perform, discuss, or judge" (Mezirow, 1990, np). Most learning occurs as a result of the process by which we define and solve problems (Mezirow, 1990),

hence learners should be encouraged to reflect on the content or description of a problem and the process or the approaches that can be used to solve the problem. For example, farmers may be asked to reflect on the challenge of lack of water for farming during a dry spell and the strategies they can use to store rain water for future use when it is in abundance, such as harvesting water from roof tops and constructing water pans. Content and process reflection can play a role in thoughtful action by allowing learners to consciously assess what they know about taking the next step in a series of actions and consider whether they will be on track in doing so (Mezirow, 1991; Mezirow, 1981).

Critical reflection

Unlike reflection which involves the assessment of the assumptions implicit in beliefs, including beliefs on how to solve problems, critical reflection requires adult learners to become aware of and challenge their presuppositions prior to learning (Mezirow, 1990). This requires that learners challenge their meaning perspectives with which they have made sense out of their encounters with the world, others and themselves. Meaning perspective is "the structure of assumptions within which new experience is assimilated and transformed by one's past experience during the process of interpretation." (Mezirow, 1990, p.1).

A pastoral community in Kaikor, Turkana North (Kenya) offers an example of how farmers can challenge their meaning perspectives. Their livelihood, which entails walking long distances in search of pasture and water for their livestock and domestic use, has been threatened by continuous drought spells due to climate change. The droughts have led to loss of livestock and even lives as a result of hunger and malnutrition. As a result, they have diversified their source of livelihood to include trade and agropastoralist activities, such as growing food crops under irrigation and planting of Aloe. As these farmers contemplate taking up other livelihood options they may have to reflect on their past experiences and the assumption that pastoralism is the mainstream source of livelihood for their community. Additionally, in the Turkana culture the women's voice is rarely heard or included in decisions about the use of natural resources. This and other decisions are made by the elders in traditional meetings which women do not attend. Yet, women are regarded as principal managers of natural resources (Figueiredo & Perkins, 2013). For meaningful learning about adaptive practices to occur, both men and women of this community need to critically reflect and challenge the assumptions they make about women's knowledge in sustainable resource management, their role in responding to climate change and why their voices need to be heard. Critical reflection is not concerned with the "how or the how-to of action, but with the why the reasons for and the consequences of what we do" (Mezirow, 1990, np).

Dialogue

We give meaning to experience by participating in dialogue with others through the use of language. Language bonds us into a dialogic community and participating in a dialogic community is significantly important for the facilitation of adult learning (Mezirow, 1991). Extensive participation in dialogue is particularly important when reconciling meanings of the same thing. This is especially true in multilingual societies (such as the Mijikenda) where individuals may not understand the same languages but similar ones. In this regard, the meaning of a word is not defined by how it is used or by the rules governing it but by what people believe it could be. This variability in meaning together with common elements allows us to adapt language to new experience (Mezirow, 1991). Hence, social interaction that allows for dialogue is essential in adult learning but educators must consider that cultural tools and practices including language enable participants to make a "culturally defined sense and meaning of the world" (Stevenson & Stirling, 2010, p. 221). This is because adult learners have already assimilated a set of beliefs about the world, other people, and themselves and these beliefs influence how they perceive and comprehend new information (Mezirow, 1990; Mezirow, 1981).

6.5.1 Use social learning approaches to educate farmers about adaptive practices

Mezirow's perspectives have provided a background on how learning can be made meaningful in a social context. Social learning approaches are recommended in this study as possible ways of overcoming the challenges of: 1) the low radio ownership amongst rural farmers in Kilifi, 2) farmers not being able to store the radio programs, and 3) the dominant one-way communication use of radio. Social learning theory emerged in response to a growing recognition that "learning occurs through situated and collective engagement with others" (Collins & Ison, 2009, p.370), where cultural processes are seen as mediators of human activity and learning, and can both facilitate or impede learning (Mezirow, 1990; Stevenson & Stirling, 2010). It is acknowledged in the literature that the term social learning conceals a multiplicity of definitions/interpretations depending on the context in which the learning is taking place (Wals & Leij, 2009; Glasser, 2009; Pahl-Wostl & Hare, 2004). The point of social learning is not what people should know but rather how people learn. However, what it means for learning to be social is debateable. For some, social learning means learning by individuals that occurs in social settings, while for others it means learning in social aggregates (Glasser, 2009). This learning could be at a group organisation level or at the level of networks of actors and stakeholders (Wals & Leij, 2009). Five interpretations of social learning in the literature are offered by Glasser (2009):

> • Social learning is a higher form of learning occurring in a social context for the purpose of personal and social adaptation (Goldstein 1981, p. 237).

> • Social learning is the process by which organisms 'see' their environmental circumstances by intelligence gathering and act with foresight or prepared adjustment. This principle of precautionary but evolutionary adjustment may be a vital one for responding to environmental stress (O'Riordan 1995, p. 4).
> • [The] combination of adaptive management and political change is social learning (Kai Lee 1995, p. 228).
> • Social learning [is the p]rocesses by which society democratically adapts its core institutions to cope with social and ecological change in ways that will optimize the collective well-being of current and future generations (Woodhill 2002, p. 323).
> • 'Social learning' reflects the idea that the shared learning of interdependent stakeholders is a key mechanism for arriving at more desirable futures. With time, the concept of 'social learning' has intertwined with related ideas such as soft systems thinking… and adaptive management… A consistent characteristic of the various approaches is that they advocate an interactive (or participatory) style of problem solving, whereby outside intervention takes the form of facilitation (Leeuwis and Pyburn 2002b, p. 11). (p.47).

Keen, Brown, & Dyball (2005) provide another perspective of social learning as "the collective action and reflection that occurs among different individuals and groups as they work to improve the management of human and environmental interrelations (Keen et al., 2005, p. 4). In the influential work of Bandura (1977) social learning refers to cognitive processes by which individual learning based on observation of others and their social interactions within a group can be a source of learning, for example through interpersonal relations involving imitation of role models.

Social learning theorists note that the potential and quality of learning is dependent in part on the diverse perspectives that expose the participants to other ways of thinking (Stevenson & Stirling, 2010). The social cohesion among the participants of the social learning process allows for the different perspectives to be taken seriously as a contribution to advancing the participants understanding (Stevenson & Stirling, 2010). Wenger (2009) posits that the primary focus of the theory of social learning is on "learning as social participation." (p.210).This means being active participants "in the *practices* of social communities and constructing *identities* in relation to these communities." (Wenger, 2009, p. 210). Similar to Wenger, Glasser (2009) defines social learning as learning by individuals or collectives with the involvement or input drawn from others. However, because social learning can occur without the facilitation of participatory processes (Reed et al., 2010), Glasser (2009) further categorises social learning as passive or active. Passive social learning can occur at individual or collective level and does not require direct feedback or input from others in the form of communication or interaction. This learning may result from for example reading a newspaper, listening to a radio program or searching the internet. Active social learning on the other hand is dialogical and is built on

communication and interaction with others, where the interactions between participants are viewed as opportunities for meaningful learning (Glasser, 2009; Wals & Noorduyn, 2010).

Drawing from the perspectives on social learning and from the results of this study it appears that farmers who listened to the aired radio programs were passive social learners. Given the limitations of the one-way radio communication, this study recommends farmers moving from passive to active social learning where social learning emerges through

> practices that facilitate knowledge sharing, joint learning, and co-creation of experiences between stakeholders around a shared purpose in ways that:
>
> > **1.** Take learning and change beyond the individual to communities, networks, or systems; and
> >
> > **2.** Enable new shared ways of knowing to emerge that lead to changes in practice. (Ensor & Harvey, 2015, p.2)

Learning in this case occurs as a result of the collaborative and reflective processes that allow for the development of a shared sense of meaning of the content in question amongst a diverse group of people with different types of knowledge and perspectives (Dyball, Brown, & Keen, 2009; Ensore & Harvey, 2015; Wals & Noorduyn, 2010; Nursey-Bray, Harvey & Smith, 2016).

In this context, farmers become co-inquirers with the climate change or agricultural experts or educators of the problem and content in question, with a group facilitator taking a mediating role in helping to make meaning of the farmers' thoughts on the content (e.g., climate or farming practices) in line with their cultural beliefs and values. This results in co-constructed knowledge that can be aligned to both technical knowledge of climate and farming and the communities' personal understanding and resolution of the issues as well as their cultural beliefs and values.

Climate change experts or educators can facilitate the identification of the needs of the groups and create a negotiated meaning of the climate change concepts and ideas being introduced (Scott & Gough, 2003). A negotiated meaning is the shared or agreed understanding of a concept which includes aligning personal understanding of ideas with culturally accepted understandings (Dyball et al., 2009). This requires dialogue and collaboration amongst the learners. Educators regularly introduce new concepts, symbols and procedures that have culturally determined meanings. Learners need to decide what these mean. A negotiated meaning should result in a shared or agreed understanding of the relevant concepts. For example, the Maasai in Kenya are pastoralists who strongly believe that the size of their herd (rather than the quality) is directly proportional to their wealth. They believe that God made them the custodians of the world's cattle and their diet is mostly composed of meat (Ferraro & Andreatta, 2011). Climate change has negatively impacted on the availability of pasture and

water for their livestock-based livelihood and as a result, they have lost many of their cattle to prolonged drought. Researchers have intervened to save the situation by providing them with several options which include encouraging them to reduce the size of their herds by selling them off in times of drought and taking up insurance for their livestock (Barret, Carter, Chantarat, McPeak, & Mude, 2008; Carter et al., 2008). Both these options would require negotiating the meaning of insurance and the concept of reducing herd size as an economic measure/strategy (Carter et al., 2008).

Community Listener Clubs (CLCs) and radio schools are examples of social learning approaches that climate change educators or facilitators can use when introducing new strategies and concepts to increase farmers' agricultural and personal adaptive capacity. CLCs and radio schools promote group rather than individual listenership, dialogue and learning and are therefore very useful approaches to use in rural communities which have low radio ownership. They promote dialogue through active participation and sharing of information and knowledge, by both men and women farmers about their farming concerns and needs. This can empower women farmers and create a sense of solidarity amongst farmers in the community (FAO, 2011). CLCs and radio schools could also offer a different approach to the provision of agricultural extension services to farmers and could help overcome the challenge of the limited number and reach of agricultural extension officers as reported by farmers in this study. In this case, the agricultural extension officers could serve as facilitators of the CLCs and radio schools.

Community Listeners' Clubs

CLCs provide farmers with the opportunity to listen, discuss, generate ideas and plan actions about what they have heard on radio together (FAO, 2011; Girard, 2003). CLCs, whose model was developed by the Food and Agriculture Organization (FAO), were initially set up in Niger and the Democratic Republic of Congo in 2006. According to FAO (2011), the CLCs are participatory in nature and "stimulate mobilization, dialogue, sharing of experiences, collaboration and…action among men and women stakeholders." (p. 8). The functioning of the community listening clubs generally follows the following pattern (Plate 6.1):

Plate 6.1: Functioning of community listening clubs

Source: FAO (2011)

[1]The first phase of identifying the theme for the radio program is facilitated by leaders often whom are women who have been selected and trained for that role.
[2]The programs are prepared by the radio staff in consultation with experts once the theme has been identified.
[3]Active listening starts after the program has been broadcast and it may be on individual or group/ live or broadcast.
[4]During dialogue, support from an expert/agriculture extension officer can be sought-usually a woman. The producers may record and broadcast the exchanges to fuel the discussions.
[5]discussion and dialogue results in decisions for taking action
[6] means for action are sought (through partnerships, funding)
[7]Putting planned actions into practice
[8]challenges, success stories are documented and shared with the community

Radio Schools

Radio schools originated in Columbia and function on the same principles as CLCs of being participatory and encourage dialogue. Radio schools are composed of small organized listening and learning groups that are facilitated by a facilitator (Dagron &Tufte, 2006). A typical radio school session usually follows the sequence (Figure 6.1):

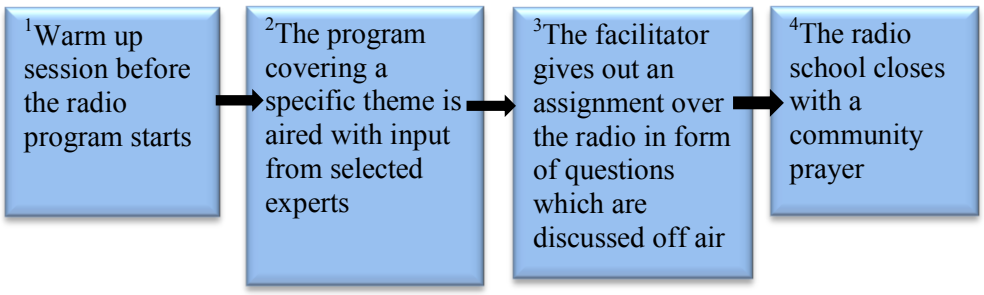


Figure 6.1: Sequence of events in a radio school

[1]The warm up sessions involve the broadcaster airing feedback from the listeners who had written to the broadcaster.
[2]The theme may be determined from farmers' feedback.

[3]Discussion of issues that arise from the assignment may be facilitated by an agricultural extension officer and lead to ideas for possible solutions. These discussions are put together and forwarded to the radio station for processing and airing.

Radio schools may be used in conjunction with Farmer Field Schools (FFS), a practice that has been successfully tried in the Philippines (Lucas, 1999) where the radio programs were aired as the FFS took place. The use of FFS is not new to farmers in Kilifi County who reported that they attend FFS (53%) and are also members of farmer groups. The integration of radio schools with FFS creates the advantage of reaching farmers who do not attend the FFS but may be listening to the programs in groups.

6.5.2 Enhance early weather warning systems to enhance farmers adaptive capacity

Farmers reported that climate change made their use of indigenous knowledge to predict weather unreliable resulting in a decline in its use. Farmers also reported that the weather information from the meteorological department was sometimes inaccurate, with some reporting to trust it "50/50". Accurate weather information is one of the factors that promote successful farming. Early weather warnings and climate risk information provided to farmers in a timely and effective manner could not only increase their adaptive capacity but also save lives. The Kenyan government should increase its investment in climate monitoring equipment and infrastructure essential for improving the quality of weather forecasts. Additionally, the government should increase its investment in building the capacity of meteorologists especially in the face of new technological advances in the field because a skilful human resource is an important component in forecasting severe weather and extreme climatic events. This will hopefully result in more accurate weather forecasts which could in turn increase the public's trust in weather information issued by the meteorological department.

6.5.3 Integrate local knowledge into climate change adaptation efforts

A few farmers in this study reported to use traditional/local knowledge to cope with the effects of climate change in storing their harvests or in soil and water conservation. Local best practices within communities can be identified and documented for the purpose of integrating them into formal adaptation strategies. These practices can then be integrated into the wider communities with the aim of making them available to policymakers, planners and local communities (Drame & Kiema, 2012). When local knowledge is shared more widely and integrated into modern/formal mitigation and adaptation strategies, it results in technologies that are rich in local content. Incorporating local knowledge into formal climate change adaptation and mitigation studies creates the advantage of local participation of community members in the design of the climate change interventions, and facilitates greater understanding, effective communication and increased adoption of the innovations (Nyong,

Adesina, & Osman Elasha, 2007). This can also contribute to ensuring the economic and socio-cultural sustainability of the climate change innovations.

6.5.4 Enhance farmers' access to financial resources to increase their adaptive capacity

Financial barriers have been seen as a serious constraint in adopting climate change interventions (Antwi-Agyei et al., 2014). Many African farmers do not have access to credit, loans and subsidies that would help them implement agricultural interventions available to them. A study conducted in 11African countries (which included farmers in Kenya, Ghana, South Africa, Zimbabwe and Egypt) found that farmers who have access to credit are able to make use of available information and resources to adopt technologies (such as new crop varieties and irrigation technologies) that would help them cope with the effects of climate change (Hassan & Nhemachena, 2008). In this study, farmers in the FGI in Ganze were part of a larger group growing ABE chilies under an arrangement with a food company which provided them with inputs such as simple drip irrigation kits (Figure 4.1), seeds and fertilizers on credit. To pay back for these inputs, the food company deducted their dues from farmers' individual sale of harvested chili to the company. This model can be used with other crops, with the aim of increasing food security in the county.

Farmers increased access to financial resources could also help them tackle the challenges of poor access to water and lack of labour that they reported. For example, to help solve the problem of poor access to water during dry spells, farmers could employ rainwater harvesting and storage techniques that result in longer term storage of rainwater such as harvesting rainwater from rooftops and storing it in water tanks. On the other hand, mechanisation may help to reduce famers need to rely on labour on their farms. Both these suggestions require the financial ability of farmers to invest in these technologies, which many of them lack (Njeru et al., 2015). Efforts should therefore be made by the government and NGOs to improve farmers' access to financial resources including credit and loans. Efforts should also be made by the government to help farmers access insurance products that could provide them with a safety net in times they are unable to repay loans used to finance their farming activities due to low prices or climate change impacts such as drought and floods. These measures could increase the likelihood of farmers investing in climate change interventions and hence increase their adaptive capacity.

6.5.5 Employ psychological interventions to help farmers cope with the emotional impact of climate change

Results from this study indicate that climate change is negatively impacting on the emotional well-being of farmers in Kilifi County. Climate change impacts experienced by farming communities over long periods of time may lead to significant psychological distress (Clayton,

Manning, & Hodge, 2014). Psychologists are well positioned to provide guidance that enables individuals and communities adapt to the psychological impacts and threats of climate change (Doherty & Clayton, 2011; Australian Psychological Society, 2010). Psychologists can also share the knowledge and understanding of how people perceive the risks of climate change and how they can change their behaviour to mitigate climate change (Australian Psychological Society, 2010). However, it is acknowledged that the low number of psychologists in Kenya makes the use of their expertise to provide mental health support to farmers, impractical. Recommendations on possible approaches to overcome this challenge are discussed in Chapter seven.

6.6 Conclusion

Farmers in this study reported to suffer from severe and prolonged weather events such as droughts and floods. They viewed climate change as a risk that threatened their livelihoods, with some reporting that they had suffered economic impacts such as reduced crop yields or loss of livestock. Farmers also stated that the effects of climate change weighed negatively on their emotions with some reporting to feel angry, confused and irritated. Climate change related weather disasters can negatively impact on farmers' psychological well-being (Berry et al., 2011) and even lead to suicide in some cases (Padhy et al., 2015; Hanigan, Butler, Kokic, & Hutchinson, 2012). Psychological intervention services that would help farmers cope with the impacts of climate change are therefore needed.

Farmers reported responses to climate change before and after the intervention revealed their current adaptive capacity and their potential to enhance their adaptive capacity, respectively. Farmers responded to the changes in climate by adopting practices they heard regardless of what they thought were the cause of climate change. This suggests that farmers' knowledge of the science or cause of climate change is not necessary for them to take action (Cracknell, 2001; Kurtycz, 2005; Kollmuss & Agyeman, 2002). The implication of this finding is that the focus of climate change education and communication strategies should be in providing farmers with climate smart technologies that can increase their adaptive capacity rather than increasing their scientific literacy.

Farmers also reported to use indigenous knowledge to infer changes in weather patterns and to cope with the effects of climate change. Traditional knowledge is viewed as innovative in times of distress (Naess, 2013) and it can add value in the development of sustainable mitigation and adaptation strategies (Nyong et al., 2007). However, farmers reported a decline in their use of traditional knowledge to predict weather because climate change made its use unreliable. They also reported unreliable weather forecasting information from the meteorological department

with some reporting to trust it “50/50”. Early weather warnings and climate risk information therefore need to be provided to farmers in a timely and effective manner to increase their adaptive capacity.

Farmers reported barriers to implementing the climate change practices they heard were lack of access to financial resources, high cost of adaptation measures, lack of labour and poor access to water. The major challenges reported by farmers to hearing the radio programs were no access to a radio or unsuitable program timing, while a challenge reported by those who did listen was the inability to store or record the programs resulting in a need to rely on their own recollection when implementing the adaptive practices. Enhancing farmers access to financial resources that would help them adapt to climate change, use of psychological interventions to help farmers cope with the emotional impacts of climate change, enhancing early weather warning systems and integrating local knowledge into climate change adaptation/mitigation efforts, are recommended to overcome these challenges. Use of social learning approaches that encourage group rather than individual listenership (such as community listening clubs and community-based radio schools) are recommended as social learning approaches that can be used to educate farmers on climate change practices they can adopt.

The next chapter concludes the thesis by providing recommendations for policy, practice and future research.

Chapter Seven: Conclusion

7.1 Summary of Study

The impact of climate change is being felt globally, but the world's poorest nations which have the least economic, institutional, educational, scientific and technical capacity to deal with its adverse effects are the most vulnerable. Climate change poses a real threat to climate sensitive livelihoods that are dependent, for example, on agriculture. Adaptation is therefore a key factor that will shape the future severity of the impact of climate change on farmers (Lobell et al., 2008) and their well-being. The extent of sustainable adaptation depends on the existence of institutions and policies that support adaptation as well as actions that may help build the adaptive capacity of farmers, such as increasing their access to appropriate technologies, financial resources and information (Adger et al., 2003; IFAD, 2008). Improving farmers' access to extension services and climate change information has been shown to enhance adaptation (Tesfaye & Seifu, 2016; Obayelu, Adepoju, & Idowu, 2014). However, this information should be tailored to the farmers' economic circumstances, their agricultural environment and their expressed needs (Bryan, Deressa, Gbetibouo, & Ringler, 2009).

Farmers in Kenya are faced with limited public agricultural extension services, leaving them with few sources of useful and reliable information that might help them cope with the impact of climate change (Juana et al., 2013). Radio is a mass media extension tool that potentially can bridge this gap because its strength is widely regarded to lie in its ability to reach a wide audience of farmers and provide them with agricultural information in a language they understand (Chapman et al., 2003). Successful communication approaches are those which contextualise content and understand the perceptions and realities of local communities (Ensor & Harvey, 2015). Additionally, understanding farmers' perceptions about climate change before the implementation of a communication intervention is important in informing the development of the initiatives (Moser, 2010).

The problem that this study set out to address was the need to increase farmers' adaptive capacity in the face of the self-reported impact of climate change on their farming. The strategy for addressing this need was to design and produce a radio intervention that provided information on agricultural adaptations for farmers in Kilifi County. The study first established farmers' climate change perceptions and adaptation needs through a survey and focus group interviews. The survey and interviews revealed farmers wanted to know what actions they could undertake in order to adapt their farming to climate change. They specifically also wanted to know how to access timely and accurate weather forecasts in order to prepare for the severe impacts of climate change they reported to be experiencing. The challenges that farmers reported to experience with their farming also provided a basis for identifying their climate

change adaptation needs. For example, farmers reported suffering from poor access to water and farm inputs, lack of financial resources to meet the high cost of adaptation measures, and insufficient agriculture extension information and support to implement adaptive agricultural practices. Results from the survey and focus group interviews before the intervention informed the development and subsequent airing of radio programs which provided the farmers with locally relevant adaptive agricultural practices in order to increase their adaptive capacity. Lastly, the impact of these radio programs and their climate change information on farmers' perceptions of and adaptation to climate change was assessed through surveys and focus group interviews with the same farmers and groups.

Surveys and interviews before the intervention revealed the specific nature and extent of the impact of climate change on farmers in Kilifi County. The farmers reported negative economic impacts on their primary source of livelihood from increased frequency and duration of extreme weather, such as droughts and floods, which reduced their yields from crops and livestock. The resulting economic hardships and uncertainties, according to many farmers, also adversely affected their emotional and psychological well-being. Farmers' reported responses to cope with climate change impacts prior to the radio intervention, (which included agroforestry, planting/keeping drought tolerant crops and livestock and use of indigenous knowledge to infer changes in weather patterns) revealed their current adaptive strategies.

Farmers' responses after the radio intervention indicated the potential and challenges of radio to increase their capacity to implement appropriate adaptive strategies. Even though only a third of the farmers reported to have listened to the programs, a vast majority of those who listened reported implementing something they heard (although verification of the implementation of the adaptive practices was not done for all farmers). The most commonly implemented interventions by farmers in the survey were growing drought tolerant crops, water harvesting, planting trees, and using manure. The high cost of adaptation measures, lack of financial resources, lack of labour and poor access to water were the major challenges faced by farmers who implemented the adaptive practices. These challenges limited the farmers' capacity to implement the strategies they heard. For example, some farmers planted fewer trees than they desired due to lack of labour and poor access to water. Farmers viewed the radio as a one-way communication medium with little opportunity to store the information conveyed for future reference or discuss the information or ideas. The major challenge that prevented a majority of the farmers from listening to the radio programs was the lack of a radio. It is therefore evident that this study was undertaken within a community with low radio ownership. Farmers who did not own radios reported prior to the intervention to have access to their neighbours but this came with the challenge of them having to call in on their neighbour before 8.00am and having to request them to switch the channel.

Educating farmers about adaptation using the radio needs to go beyond providing them with information on climate-sensitive adaptive farming practices, to integrating social learning approaches that result in adaptation at the individual or group level (where group members assist each other in the process of adaptation). Farmers' co-learning about adaptation strategies in a social context creates the opportunity for interactions in which challenges and problems are shared and understandings and potential solutions are discussed and clarified, thereby increasing the likelihood of appropriate and effective adaptation practices being implemented. Social learning approaches help to overcome the limitations and challenges of low radio ownership and the dominant one-way communication that radio presents, including farmers not being able to store the information communicated for future reference. Having multiple listeners, and perhaps note takers, can enable the recall of information for the group that individuals may have missed or forgotten. Specific social learning approaches that encourage group (rather than individual) listenership and two-way communication and debate in the form of Community Listening Clubs and radio schools are suggested to address the problem of lack of access to a radio and the limitations of one-way communication. The social nature and positive focus of these groups can also provide support to the farmers reporting psychological issues and pressures that result from the negative impact of climate change on their livelihoods.

7.2 Limitations of the study

The limitations outlined in this section either apply to or emerged after the radio intervention.

All farmers in this study reported to either own a radio or have access to one during the pre-intervention survey. However, during the post-intervention survey it was evident that some farmers had a challenge of accessing a radio in order to listen to the programs. These farmers indicated that they could listen to the programs via their neighbours' radio. Perhaps I could have integrated other radio listening approaches (i.e. radio listening groups) in the study design to accommodate farmers who did not have access to a radio. Farmers who could not be reached in person as well as those in focus groups self-reported that they implemented the climate change adaptive practices broadcasted. It was therefore not possible to verify if they had really implemented the practices or if they merely provided a socially acceptable response that affirmed that they had indeed listened to the programs and implemented some practices even when they had not. Another limitation is the radio programs were not always aired on schedule even though every effort was made to ensure that they were. This was due to operational issues at the radio station which were beyond the producers' control. This means that some farmers may have missed some of the programs because they tuned in at the scheduled time. Some farmers in the focus group interviews were not available to be re-interviewed after the intervention. This means that their views after the intervention were not included in the study and therefore reduced the size of the informant pool. Lastly, the

programs were aired in May 2014 when the rains were at their peak. This means that they were aired when the rains had already started. The interval between the start of the long rains (March) and when the programs were aired (May) could have limited farmers' implementation of some of the adaptive practices aired. Additionally, the good rains received increased the likelihood of farmers' implementation of adaptive practices that required irrigation. The situation could have been different had the rains failed.

7.3 Implications of this study for policy, practice and future research

7.3.1 Implications for policy

Due to the severe impacts of climate change currently being experienced by farmers in Kilifi County, it is important that they are adequately prepared for imminent disasters such as floods and droughts. Policies that address disaster preparedness and management by rural communities in order to increase their adaptive capacity should therefore be formulated. This study revealed that climate change impacts were negatively affecting farmers' psychological well-being. This necessitates psychological interventions to help identify and develop strategies which address the mental distress brought about by the threats of climate change and support individuals in overcoming barriers to action, some of which are economic and others psychological (Swim et al., 2009; Gifford, 2011). However, it is acknowledged that farmers' access to psychological help may not be practical given that there are very few psychologists in Kenya and their services are costly. Farmers could seek mental health support from counsellors working in Faith Based Organisations and NGOs (such as the Kenya Red Cross) who are more readily available especially in the rural areas of Kenya, with some providing their services free of charge to individuals after disasters, some of which are climate related. The government should create policies that support these organisations in providing free mental health support to individuals. Additionally, the government should endeavour to train and hire more mental health specialists (including community mental health workers) and increase the number of hospitals or facilities providing mental health services in the country.

Farmers in this study reported incidences of pollution and destruction of mangrove forests by salt factories present in Kilifi County. Guidelines that control pollution that results in the increase in the amount of greenhouse gasses in the atmosphere and enhance the conservation of mangrove forests should be formulated at the County level. Additionally, farmers reported the wanton destruction of trees by individuals resulting in the reduction of the County's forest cover. This has in turn increased the demand for timber. To meet this demand people have been reported to illegally cut down forest trees or use fruit trees for timber and firewood. Policies that encourage private land owners to plant and manage trees in the County possibly through incentives should be developed. The incentives could include providing free seedlings for a

number of trees purchased from government nurseries, subsidizing the cost of seedlings or creating a pool of environmental conservation grants (which include tree planting) to be accessed by farmers.

The provision of agricultural extension services was viewed as inadequate by farmers in this study. Given the low ratio of extension officers to farmers (1:1500), many farmers suggested that their number and reach needs to be increased. More extension officers should mean farmers having ready access to relevant, accurate, timely and up to date technologies and information that would increase their productivity. Radio can only complement but not replace the important work of agricultural extension officers. The government should therefore consider using innovative participatory and demand driven (rather than top down) strategies aimed at increasing their number and reach such as contracting the private sector (private companies, NGOs, faith-based organizations (FBOs), and community-based organizations (CBOs) dealing in agriculture) to take up bigger roles in the provision of extension services to smallholder farmers in poorly served areas. Incorporating the use of information and communication technology (mobile phones) and mass media (radio) with a focus of reaching farmers in groups rather than individually (especially in areas with low radio ownership) can be another strategy.

One of the major barriers to adaptation by farmers in developing countries is the lack of financial means (Tambo & Abdoulaye, 2013). This barrier was also identified by a majority of the farmers in this study. In this regard all efforts should be made by the government to increase farmers' access to financial resources. This could be achieved by the government providing loans to farmers to implement adaptive practices at lower interest rates, or the provision of innovation grants to farmers. Other approaches could be the government: subsidising farm inputs used in the implementation of climate smart technologies by farmers; encouraging insurance companies to develop insurance products that insure farmers from losses resulting from climate change impacts, such as drought and floods; and increasing farmers' access to insurance products that cover their farming activities. These kinds of policies will hopefully create a financially enabling environment that could increase farmers' investments in climate change adaptation practices.

7.3.2 **Implications for practice**

The finding that some farmers adopted adaptive practices despite their low knowledge of climate change science suggests that communication and education strategies should mainly focus on creating awareness and training of farmers on the use of climate smart technologies (such as low cost drip irrigation kits and farm machinery suitable for small-holder farms) that would increase their adaptive capacity rather than increase their scientific literacy on climate change. Some farmers in this study reported to use indigenous knowledge to cope with climate

change. Climate change communicators and educators should consider identifying, incorporating and sharing more widely suitable local or indigenous mitigation and adaptation knowledge that would help farmers cope with climatic variability. Traditional knowledge and practices provide an important informally time-tested basis for dealing with the challenges of climate change and their integration into formal adaptation/mitigation strategies can provide farmers with technologies that are contextually and culturally rich (Gyampoh, Amisah, Indinoba, & Nkem, 2009).

This study has demonstrated that farming in Kilifi County occurs under severe climatic conditions such as floods and droughts. Farmers are constantly faced with uncertainty on the quality of the rainy seasons in terms of the duration and quantity of rainfall. It is acknowledged that long range weather forecasting, including of potential disasters, is an inexact science, however the Kenya Meteorological Service should provide as accurate and timely as possible early warnings of extreme weather events and related climate risk information. This information is essential for disaster risk management and for farmers whose livelihoods are climate sensitive. The government should build the capacity of meteorological personnel to provide these services as well as invest in equipment that would help meteorologists better predict future weather patterns. This could enable farmers to plan their farming better and help them prepare early for predicted weather disasters.

The current and predicted impacts of climate change will negatively impact the mental health and well-being of vulnerable populations in particular (Doherty & Clayton, 2011).Psychological interventions are recommended to address the negative emotional impact of climate change on farmers. However as indicated earlier, access and availability of psychologists in Kenya is not only limited but costly. Other sources of or approaches to psychological support to farmers are therefore needed. Social support structures present within farming communities can offer such help. For example, Australian farmers have been found to be resilient in the face of climate change calamities such as prolonged droughts (Berry et al., 2011). One possible explanation for this resilience is the benefit from the high level of social connectedness present in rural communities (Berry et al., 2011) and in more recent years to the Beyond Blue support service and the associated advertising campaign that has reduced the stigma of seeking mental health assistance especially for men. The different agencies involved with the provision of agricultural extension services can encourage farmers to turn to their friends or farming groups to share their feelings about the impact of climate change on their emotional well-being as well as the behavioural changes they need to make to mitigate climate change (Randall, 2009). The assistance of a counsellor may be sought to facilitate the process.

This study established that farmers rate the challenges they face while implementing climate change practices according to the weather conditions they are experiencing. For example, the pre-intervention survey was carried out when farmers were coming out of a dry spell and the onset of the long rain season was expected. Poor access to water was rated as the biggest challenge when implementing climate change practices by farmers before the intervention. However, this challenge was rated fourth after the intervention. This change in ranking was attributed to farmers in most areas surveyed reporting that the long rains were good. Additionally, despite water harvesting being rated as the major challenge before the intervention, it was not the most commonly implemented practice after the intervention. These findings suggests that the different agents (i.e. agricultural extension officers, radio producers) involved in the production of radio programs that address climate change issues should consider the time of season when broadcasting radio programs. It is therefore recommended that programs covering water harvesting methods should be aired during the dry season rather than when the rainy season has already started. Farmers are more likely to comprehend the importance of water harvesting and to make plans to take action when they are undergoing a period of water stress rather than when they have water in abundance.

Lastly agricultural extension officers should consider adjusting their work schedules in order to incorporate assisting community listener clubs and radio schools. Extension officers who sometimes provide support to farmers in groups could allocate some of their time to organize and attend group meetings to facilitate dialogue between participants in community listener clubs or radio schools after they have listened to a radio program. They could also provide farmers with technical advice regarding how to put their planned actions into practice including advice on how or where they might source funding. However, unlike many other areas in Kenya (i.e. Nyeri and Embu Counties), Kilifi County reported a significant number of farmers not belonging to groups (35%). It is therefore important that extension officers device innovative ways of encouraging farmers to join or form groups for the purpose of social learning and easier access to extension officers.

7.3.3 **Implications for future research**

Future research could evaluate the sustainability and effectiveness of the adaptive practices that farmers reported to implement after the intervention with the aim of establishing whether they adopted the most appropriate ones and if the adopted practices stood the test of climate impacts experienced after their implementation. For example, after a dry spell, an evaluation could be done to establish whether the water retention pits helped to conserve enough water in the soil to successfully grow vegetables or if rainwater harvested from rooftops served farmers during the dry spell.

This study found that climate change has negatively impacted on farmers' emotional wellbeing. Future research by experts in this field may need to investigate the psychological impact of climate change on African famers whose findings could be incorporated into climate change mitigation and adaptation policies and interventions in order to help farmers overcome or cope with their climate related distress and barriers to adaptation. Further research could also explore the use of CLCs and radio schools in farming communities with low radio ownership. Pilot studies can be done in selected regions to assess the practicability and sustainability of the models in Kilifi County. Finally, this study identified only a few indigenous practices that farmers reported to use to cope with the impacts of climate change. A wider study with the aim of identifying and documenting more indigenous practices which directly contribute to adaptation is proposed. The identified practices can then be integrated into climate change adaptation studies and assessed for their social acceptance, replicability, and the investment required to implement them.

7.4 Conclusion

Agriculture is the primary source of income for most rural people in Kilifi County, yet it occurs under extreme climatic variability. Despite this, they have remained resilient because as one male farmer in Magarini put it "farming is in our blood." Farmers are the agents of change who are best placed to define their local adaptation needs by saying why they are vulnerable, how they experience vulnerability, and what changes could help them adapt to climate variability (Palutikof, Boulter, Ash, Smith, Parry, Waschka, & Guitart, 2013), issues that this study investigated. Farmers in this study do not need to be convinced that climate change is happening because nearly all of them believed it was. This study also established that increasing farmers' scientific literacy on climate science is not necessary because they implemented adaptive practices despite what they thought were the causes of climate change. From the challenges that farmers reported to face with climate change when implementing adaptive practices, it can be deduced that what farmers in Kilifi County need is an enabling environment that increases their capacity to adapt to a changing climate. Experts seeking to introduce practices that aim to increase farmers' adaptive capacity should therefore engage with farmers at their current level of adaptation and with the resources they have. This requires an understanding of the farmers' economic, cultural, technological, psychological, and informational barriers that contribute to their vulnerability.

In a radio interview (2014) about the future of radio, John Donham, the CEO of TuneIn (a US based internet radio aggregator company with over 100,000 radio networks and radio stations worldwide) stated

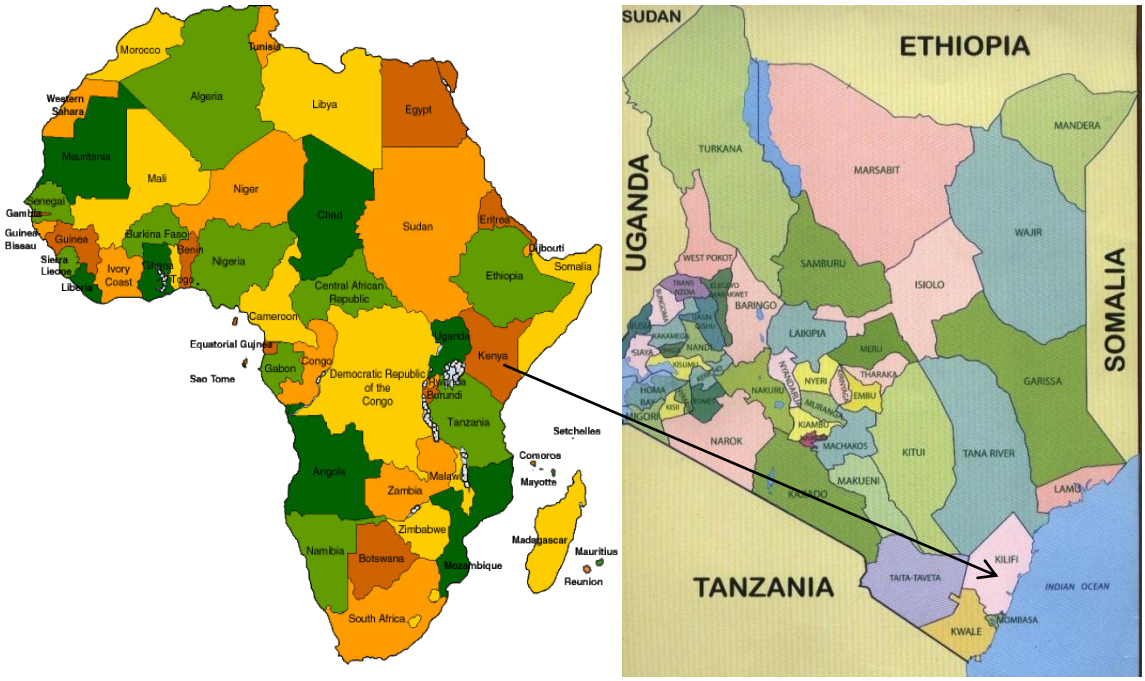
> Radio is the oldest mass medium, and it has worked well for nearly a century… It's the original form of 'social media' in that it allows you to connect with other people and ideas in your community or beyond, for free; this is what makes radio unique and the reason behind its longevity.

The future of radio as a means of communicating and educating the public on various issues including climate change remains bright and it will continue to do so as long as the practitioners working in the field adapt to the evolving communication needs and technological advances in the field. During data collection, it was evident that farmers in Kilifi were not only receptive to the radio program intervention but to a few other adaptive practices (such as growing the ABE chilli under drip irrigation and planting Eucalyptus trees in woodlots) that would increase their capacity to cope with the changing climate. However, it was also evident that economic challenges increase their vulnerability to climate change impacts and impedes them from doing more. Increasing farmers' access to financial resources would not only enhance their ability to implement adaptive practices but also help them deal with their mental health issues, some of which arise from lack of financial means to support their families through farming in the face of climate change.

One of the factors that can enhance farmers' uptake of adaptive practices is access to locally relevant and practical information on how to implement the practices (Bryan et al., 2009; Obayelu et al., 2014). Radio can effectively complement other agricultural extension methods and has the potential to engage farmers on climate change issues and motivate them to implement adaptive practices. However, the challenges that farmers reported to face with accessing the radio programs support the fact that providing information alone is not enough to increase their adaptive capacity. Other approaches that enhance the meaningful learning of adaptation strategies being introduced are required. This study proposes the use of social learning approaches such as community listening groups and radio schools with the support of agricultural extension officers as facilitators when introducing strategies and concepts that can help to increase farmers' adaptive capacity. Lastly, because adaptation to climate change demands a multidisciplinary approach, it is the onus of researchers from various disciplines to continue to investigate and develop strategies and policies that address the issue including the challenges faced by farmers when accessing or implementing adaptive practices. The researchers from different disciplines need to work collaboratively and in co-ordination in order for their efforts to be effective and sustainable (Koger et al., 2011).

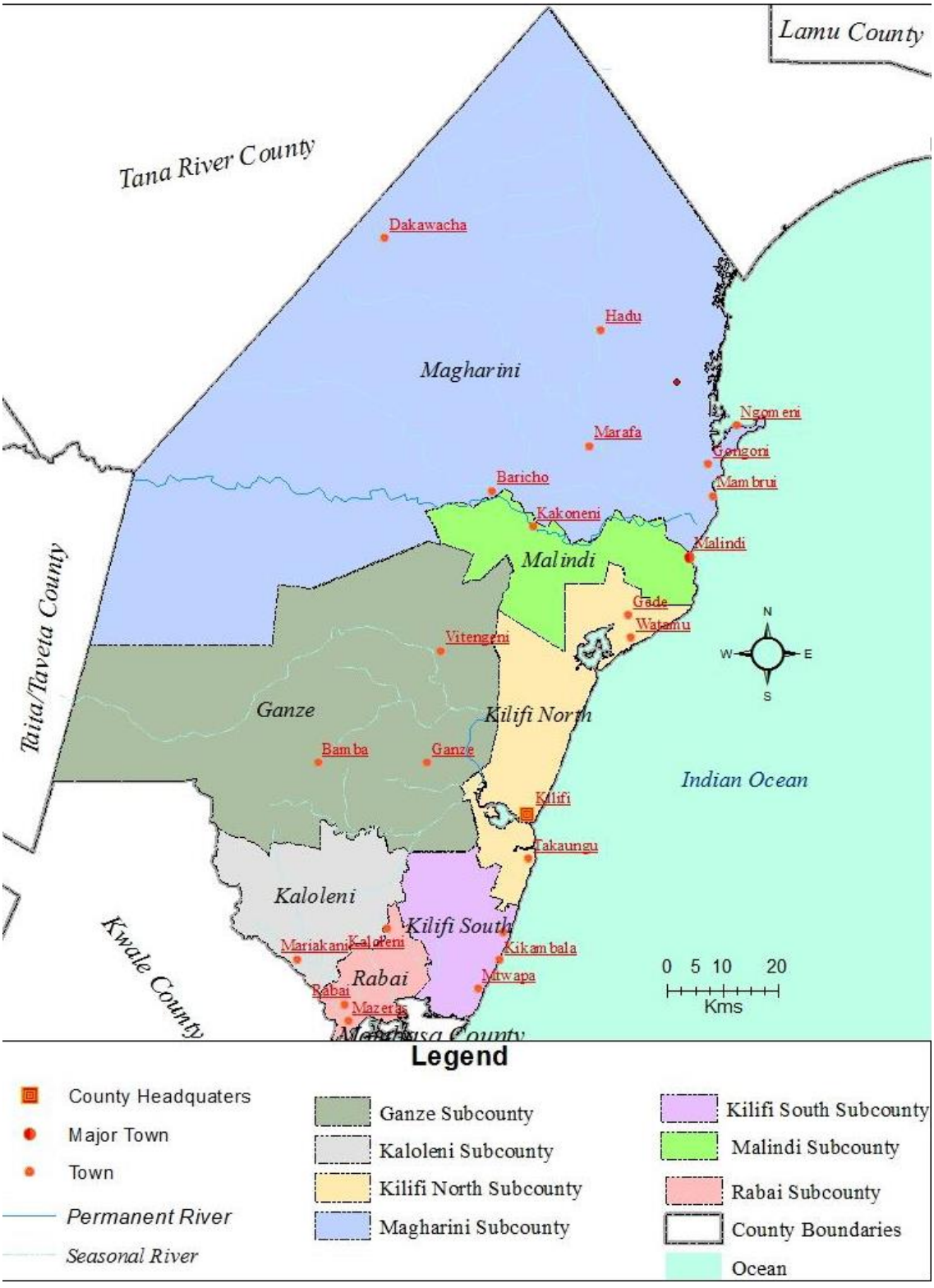
Appendix A

Maps of Africa, Kenya and Kilifi County



Source: Google maps

Map of Kilifi County



Source: Kilifi County Integrated Plan (2013)

Appendix **B**

Primary and secondary sampling units

Table 1: Administrative units: Number of locations and sub locations in Kilifi County

Constituencies	Area (Km^2)*	No. of Locations	No. of Sub-locations
Kilifi North	530.30	6	22
Kilifi South	400.60	6	16
Ganze	2941.60	16	48
Malindi	627.20	8	18
Magarini	6979.40	8	28
Kaloleni	686.40	11	21
Rabai	205.90	7	12
	12,371.4	62	165

*Excludes land occupied by the Arubuko Sokoke forest and the Indian ocean

Source: Kenya County Integrated Plan (2013)

Table 2: Number of farmers surveyed per selected sub-location

Constituency	Location	Sub-location	Total
Kilifi North	Gede	Dabaso	14
Kilifi North	Watamu	Jimba	14
Kilifi North	Tezo	Kibarani	13
Kilifi North	Tezo	Mtondia /Majaoni	13
Kilifi North	Takaungu	Mavueni/Majajani	14
Total			**68**
Kilifi South	Junju	Gongoni/Vipingo	15
Kilifi South	Ziani	Ngombeni	15
Kilifi South	Banda ra Salama	Pingilikani	15
Kilifi South	Mtwapa	Kijipwa	14
Kilifi South	Ziani	Ziani	15
Total			**74**
Ganze	Dida	Bale	9
Ganze	Dida	Dida	11
Ganze	Ganze	Ganze/Tsangalaweni	9
Ganze	Dida	Kahingoni	9
Ganze	Vitengeni	Mitsedzini	9
Ganze	Ganze	Pentanguo	9
Total			**56**
Magarini	Magarini	Bomani	10
Magarini	Fundisa	Fundissa	9
Magarini	Marafa	Madina	11
Magarini	Fundisa	Marereni	8
Magarini	Magarini	Marikebuni	9
Magarini	Gongoni	Shomella	9
Total			**56**
Kaloleni	Kaloleni	Chalani/Mihingoni	9
Kaloleni	Kaloleni	Kaloleni Vishakani	7
Kaloleni	Kayafungo	Kinagoni	8
Kaloleni	Kayafungo	Mbalamweni	5

Constituency	Location	Sub-location	Total
Kaloleni	Kaloleni	Mikiriani	9
Kaloleni	Kayafungo	Miyani	7
Kaloleni	Kayafungo	Mrimani	6
Kaloleni	Jibana	Nyalani	9
Total			**60**
Rabai	Jibana	Tsagwa	8
Rabai	Rabai	Buni Kisimani	7
Rabai	Rabai	Kaliangombe /Jimba	7
Rabai	Mwawesa	Mikahani	8
Rabai	Ruruma	Miyuni	7
Rabai	Rabai	Mwele Kisurutini	6
Rabai	Mwanamwinga	Viragoni	8
Total			**51**
Malindi	Malindi	Barani	12
Malindi	Malindi	Kijiwetanga	12
Malindi	Ganda	Mere	11
Malindi	Ganda	Msabaha	10
Malindi	Malindi	Sabaki	11
Total			**56**
Grand Total			**421**

Appendix **C**

INFORMATION SHEET: For semi structured interviews

PROJECT TITLE: **The influence of a radio intervention on farmers' understanding and practices in climate change mitigation and adaptation in Kenya**

You are invited to take part in research about the use of radio in educating and communicating climate change information to the farming community in Kilifi County. This will involve asking you questions about your beliefs, values, and attitudes towards climate change and what climate change interventions you have put in in place to cope with climate change impacts. Programs addressing climate change issues will be aired on Pwani FM at times outlined in the program schedule to be provided to you. Participating in this study will require you to listen to these programs. This study is being conducted by Ms. Fiona Mwaniki and will contribute to her PhD in Education at James Cook University, Australia.

If you agree to be involved in this study, I request your participation in the following way:

I will read out a verbal statement to you requesting your consent to participate in this research. If you agree to participate, your verbal consent will be audio recorded and you will be required to complete a face to face survey that should take approximately one hour. This will involve me asking you questions. I will write down your answers in the questionnaire. Some questions will require more elaboration from you. These will be audio taped with your permission. Your personal details such as your name and mobile number will be documented so that I can remind you to listen to the radio programs developed. I will also carry out another survey with you in December 2014 after the programs have been aired to get some feedback. Pictures of climate change interventions you have put in place may be taken with your consent for documentation purposes.

Your responses and contact details will be strictly confidential. All the collected data will be kept securely for five years. You will have the right to edit or withdraw any information that you have contributed before the completion of data collection in December 2014. Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. You may also withdraw any unprocessed data from the study. Data from the study will be used in research publications and reports. You will not be identified in any way in these publications.

If you have any questions about the study, please contact:

Principal Investigator: Fiona Mwaniki **School of Education** **University: James Cook University** **Email: Fiona.mwaniki@my.jcu.edu.au**	**Principal Supervisor: Robert Stevenson** **Second supervisor : Philemon Chigeza** **School of Education** **James Cook University** **Email: Robert.stevenson@my.jcu.edu.au**

If you have any concerns regarding the ethical conduct of the study, please contact: Human Ethics, Research Office James Cook University, Townsville, Qld, 4811 Phone: (07) 4781 5011(ethics@jcu.edu.au)

INFORMATION SHEET: For focus group interviews

PROJECT TITLE: **The influence of a radio intervention on farmers' understanding and practices in climate change mitigation and adaptation in Kenya**

You are invited to take part in research about the use of radio in educating and communicating climate change information to the farming community in Kilifi County. This will involve asking you questions about your beliefs, values, and attitudes towards climate change and what climate change interventions you have put in coping with climate change impacts. Programs addressing climate change issues will be aired on Pwani FM at times outlined in the program schedule to be provided to you. Participating in this study will require you to listen to these programs. This study is being conducted by Ms. Fiona Mwaniki and will contribute to her PhD in Education at James Cook University, Australia.

If you agree to be involved in this study, I request your participation in the following way:

I will read out a verbal statement to you requesting your consent to participate in this research. If you agree to participate, your consent will be audio recorded and you will be part of a group discussing climate change issues in your community. This group interview should take approximately one and a half hours. The interviews will be video recorded for reference during data analysis. Your personal details such as your name and mobile number will be recorded so that I can remind you to listen to the radio programs developed. I will also carry out another group interview with you in December 2014 after the programs have been aired to get some feedback.
Your contact details will be strictly confidential, however your responses will not be confidential and confidentiality cannot be assured. All the collected data will be kept securely for five years. You will have the right to edit or withdraw any information that you have contributed before the completion of data collection in December 2014. Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. You may also withdraw any unprocessed data from the study. Data from the study will be used in research publications and reports. You will not be identified in any way in these publications

If you have any questions about the study, please contact:

Principal Investigator: Fiona Mwaniki
School of Education
University: James Cook University

Email: Fiona.mwaniki@my.jcu.edu.au

Principal Supervisor: Robert Stevenson
Second supervisor : Philemon Chigeza
School of Education
James Cook University

Email: Robert.stevenson@my.jcu.edu.au

If you have any concerns regarding the ethical conduct of the study, please contact: Human Ethics, Research Office James Cook University, Townsville, Qld, 4811 Phone: (07) 4781 5011(ethics@jcu.edu.au)

INFORMATION SHEET: For interviews with experts

PROJECT TITLE: **The influence of a radio intervention on farmers' understanding and practices in climate change mitigation and adaptation in Kenya**

You are invited to take part in research about the use of radio in educating and communicating climate change information to the farming community in Kilifi County. This will involve asking you questions about what your organisation is doing to educate and communicate climate change information to residents of Kilifi County. Programs addressing climate change issues will be aired on Pwani FM at times outlined in the program schedule to be provided to you. This study is being conducted by Ms. Fiona Mwaniki and will contribute to her PhD in Education at James Cook University, Australia.

If you agree to be involved in this study, I request your participation in the following way:

If you agree to participate in this discussion, you will be required to sign a consent form. The discussion will take approximately one hour and will be audio recorded for reference during data analysis. With your consent, parts of the discussions may be used to develop radio programs for broadcast with Pwani FM.

All the collected data will be kept securely for five years. You will have the right to edit or withdraw any information that you have contributed before program broadcast or the completion of data collection in December 2014. Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. You may also withdraw any unprocessed data from the study. Data from the study will be used in research publications and reports. You will not be identified in any way in these publications.

If you have any questions about the study, please contact:

Principal Investigator: Fiona Mwaniki **School of Education** **University: James Cook University** **Email: Fiona.mwaniki@my.jcu.edu.au**	**Principal Supervisor: Robert Stevenson** **Second supervisor : Philemon Chigeza** **School of Education** **James Cook University** **Email: Robert.stevenson@my.jcu.edu.au**

If you have any concerns regarding the ethical conduct of the study, please contact:
Human Ethics, Research Office James Cook University, Townsville, Qld, 4811
Phone: (07) 4781 5011(ethics@jcu.edu.au)

Appendix **D**

VERBAL INFORMED CONSENT FORM

This administrative form has been removed

Appendix **E**

INFORMED CONSENT FORM (to be signed by climate change experts and key informants)

This administrative form has been removed

***Appendix* F**

Semi-structured interview schedule

Key: HHH=House Hold Head, CC=Climate Change										
Locators										
County name: Kilifi				**Name of household head (HHH)(Key decision-maker):**						
Constituency:				**Name of respondent *(if not HHH):***						
Location:				**Contact information:**						
Village name:				**Name of Interviewer:**						
Date of Survey: *day*__**/mo__2013** **Start Time: ___:___ End Time: ___:___**										
Household Socio-Demographics										
1. Are you the Head of Household? *(circle)*	1= Yes				2= No					
2. Relationship of respondent to HH	1=child	2=wife	3=Husband	4=other (specify)						
3. Sex of respondent *(circle)*	1= Male				2= Female					
4. Age of respondent *(circle)*	1= 18 to 24		2= 25 to 34		3= 35 to 44		4=45 to 54			
	5=55 to64		6=65 to 74		7=75 and older					
5. Marital Status of respondent *(circle)*	1= Singe/never married				2= Divorced/ separated					
	3= Living with partner/married				4= Widowed					
6. Please indicate your monthly income (ksh)	1=less than 5000	2=5,001 to 10,000	3= 10,001 to 20,000	4= 20,001 to 30,000	5= 30,001 to 45,000	6= 45,001 to 60,000	7=60,001 to 75,000	8= 75,001 to 90,000	9= 90,0001 to 105,000	10= 106,000 and above
7. Highest level of education of respondent *(circle)*	1= No formal education				2= Primary education					
	3= Secondary education				4= College and above					

8. Who makes [the majority of] decision on farm activities? *(circle)*	1= Husband	2= wife	3= both	4= Other family members
	99= Other (specify)_____			
9. What activities do you undertake during the year to earn a living? *(circle all that apply)*	1 =Dry land farming 2 = Irrigated farming 3 = Subsistence Farming 4 = Commercial Farming	5 = Market gardening 6 = Fishing 7 = Product sales 8 = Formal employment	9 = Informal employment (on farm) 10 = Informal employment (off farm) 11 = Pension 12 = land rentals	
	99 = Other (specify)			
10. What type of right does your household have over this land	1= It belongs to you	2=Rental	99=Other (specify)_____	

11. What is the size of your farm?	1 = ¼ to ½ Acres	2 =>1/2 acre to 1 Acre	
	3 = >1acre to 5 Acres	4 = >5 to 10 Acres	
	5 =>10 to 15 Acres	6=Over 15 Acres (please indicate)…….	

12. For how many years have you lived in this general area?	1=1-10 yrs	3=>20-30 yrs	5=>40-50 yrs
	2=>10-20 yrs	4=>30-40 yrs	6=+50 yrs

13. How much of your land is devoted to farming?	1 = ¼ to ½ Acres	2 =>1/2 acre to 1 Acre
	3 = >1acre to 5 Acres	4 = >5 to 10 Acres
	5 =>10 to 15 Acres	6=Over 15 Acres (please indicate)…….

14. What crops do you grow **Number codes:** **1**=Yes, home use **2** =Yes, sale **3** = No	**Crop**	**Code**	**Crop**	**Code**
	a)Maize		b)Groundnuts	
	c)Beans		d)Cashew nuts	
	e)Green grams		f)Coconuts	
	g)Cassava		h)Sweet potatoes	
	i)Indigenous vegetables		j)Other crops (specify) _____	
	Exotic vegetables grown (Spinach, broccoli, lettuce etc)			

15. What is your staple food crop? *(circle)*	1= maize	2 = cassava	4=Millet	3 = rice	**99 = Other (specify)**
16. Have you completed a survey in the last two years addressing environmental issues?		1=Yes		2=No	

Climate change beliefs, attitudes, and emotions				
17. What do you think will be the most serious problem facing the world in the future if nothing is done to stop it?	1=Environmental disasters i.e. drought, floods, cyclones		2=Terrorism	3=Poverty/hunger
	4=War		5=Overpopulation	6=Insecurity
	7=Education		8=Health care	9=Diseases
	10=Government debts		11=The economy (inflation, unemployment)	12= Morals/values
	13=Others			
18. As far as you know, do you personally believe the climate is changing in?		1=Yes	2=No	3=Don't know
	Kenya			
	World			
19. What would you say is the cause of climate change (if YES to above question)	1=entirely caused by natural processes		2=mainly caused by natural processes	
	3=partly natural processes and partly human activities		4=mainly caused by human activity	
	5=entirely caused by human activity		6= an act of God	
	7= There is no such thing as climate change		8=don't know	
	9=Other (Indicate)			
20. How would you rate the condition of the natural environment in:	**Kilifi County**		**Kenya**	
	1=Excellent		1=Excellent	
	2=Good		2=Good	
	3=Fair		3=Fair	
	4=Poor		4=Poor	
	5=Very poor		5=Very poor	
21. How has climate change affected your farming?	1=caused a reduction in crop and animal yields	2= caused a change in planting/harvesting dates	3=changed the type of crops you grow or livestock kept	
	4=Caused you to abandon some farming enterprises	5=Others (specify)		
22. When, if at all, do you think Kenya will start feeling the	1=We are already feeling the effects		5=In the next 100 years	
	2=In the next 10 years		6=Beyond the next 100 years	

	effects of climate change?	3=In the next 25 years	7=Never	
		4=In the next 50 years	8=Don't know	
23.	How concerned if at all, are you about CC?	1=Very concerned	4=Not at all concerned	
		2=Fairly concerned	5=Don't know	
		3=Not very concerned		
24.	How much have you personally experienced the effects of CC	1=A great deal	2=A moderate amount	3= A little	4=Not at all
25.	In the last five years, have you …	a) Taken part in an environment event?	Yes	No
		b) given money to a group that aims to protect the environment	Yes	No
		c) taken part in a conservation activity (e.g. tree planting)	Yes	No
		d) been a member of an environmental group	Yes	No
26.	How serious a problem do you think CC is right now?	1=Very serious	2=Somewhat serious	3=Not so serious	4=Not serious at all
27.	If nothing is done to reduce climate change in the future, how serious a problem do you think it will be for Kenya & the world in the future?	**Kenya**	**World**	
		1=Very serious	1=Very serious	
		2=Somewhat serious	2=Somewhat serious	
		3=Not so serious	3=Not so serious	
		4=Not serious at all	4=Not serious at all	
28.	How much do you think CC is influencing the frequency and intensity of weather events such as floods and droughts in Kilifi?	1=Very much	2=Often	3=Sometimes	4=Rarely	5=Not at all
29.	Have you experienced any noteworthy changes or events in the natural environment over the last ten years which you would think might be due to CC?	1=Yes	2=No	
30.	If YES to above please tell me what these events were, the years they occurred and why it was of particular significance to you	**Events** (e.g. flood, drought, cyclones, bushfire)	**Years**	**Why significant**

32. What describes your thoughts about how often natural disasters are happening?	1=I don't think these natural disasters are happening more often than they used to be	2=I have no idea whether these natural disasters are happening more often than they used to be	3=I think these natural disasters are happening more often than they used to be, but it's just natural fluctuation in earth's temperatures		4=I think these natural disasters are happening more often than they used to be, and it's an act of God		4=I think these natural disasters are happening more often than they used to be, and humans are contributing significantly to it	
33. To what extent do you agree or disagree with the following statements? (tick)	**Statement**		**Strongly agree (1)**	**Tend to agree (2)**	**Neither agree/ Disagree (3)**	**Tend to disagree (4)**	**Strongly disagree (5)**	**Don't know (6)**
	a) I trust the Kenyan government to take appropriate action against climate change							
	b)I can personally help to reduce CC by changing my behaviour							
	c)Climate change will mostly affect areas that are far away from here							
	d)My local area is likely to be affected by climate change							
	e)Climate change is likely to have a big impact on farmers							
	f)My actions to reduce the effects of CC in my community will encourage others to reduce the effects of global warming through their own actions							
	g)It is hard to imagine that individuals like myself can make a difference with respect to a global phenomenon such as CC							
	h) I have seriously thought about alternative places to live because of the increasingly evident impacts of climate change							

	i)I feel uneasy and apprehensive about what might happen in the near future due to the impacts of climate change						
	j) I feel some sense of loss because climate change impacts are becoming apparent in my local area						

33. What actions are you currently taking to reduce your carbon footprint? (tick all that apply)	**Actions**	**No I am not engaging in this behavior because:**		**Yes I am engaging in this behavior**	
		Of no opportunity to do so	**For some other reason (state reason**	**Not because of CC at all**	**Partly because of CC**
	1=Minimizing tillage				
	2=Using less fertilizer				
	3=Adding biochar to soil				
	4=Reducing use of fire to clear land				
	5=Limiting deforestation				
	6=Practicing organic farming				
	7=Agroforestry				
	8=Rotational grazing of animals				
	9=Recycling-cans, bottles				
	10=used of renewable energy e.g. solar, biogas				

	11= Nothing					
	99=Others					

35. In your opinion What is the risk of CC exerting a significant impact on …		**High risk**	**Medium risk**	**Low risk**	**Very low risk**	**No risk**
	You personally					
	Your family					
	People in your community					
	public health in your area					
	economic development in your area					
	environment in your area					
	Future generations					

36. How does climate change make you feel?	1=Irritated	2=Angry	3=Confused	4=Powerless	5=hopeful	6=fearful
	7=Bored	8=Ashamed	9=Despair	10=guilty	11=excited	12=joyful

MEDIA

37. How much do you feel you know about climate change?	1=A lot	2=A fair amount	4=very little	5=Nothing

38. How much more information do you feel you need about CC?	1=I need a lot of information	2=I need some more information	3=I need a little more information	4=I do not need any more information
	(b) Indicate what more information you require:			

39. How much do you trust what these different sources say about the	Scientists	1=A great deal	2=A fair amount	3=Very little	4=Not at all
	Media	1=A great deal	2=A fair amount	3=Very little	4=Not at all

environment?	Government	1=A great deal	2=A fair amount	3=Very little	4=Not at all	
40. How often do you use day to day media coverage to inform your own views on CC & other environmental issues?	1=Always	2=Very often	3= Sometimes	4= Rarely	5=Never	
41. How much agreement do you think there is among scientists that CC is happening	1=Nearly all scientists agree	2=Most scientists agree	3=Some scientists agree	4=No agreement amongst scientists	5=don't know	
42. How closely do you follow news about the environment these days?	1=Always	2= Very frequently	3=Occasionally	4=Rarely	5=Never	
43. How much of the information provided in the news about CC would you say is accurate?	1=A great amount of it	2=Some of it	3= Little of it	4= Very little of it	5=None of it	6=Don't know

44. Which of the following sources do you use to obtain agricultural information & what is the frequency in their use in the last six months? (tick all that apply)	**Sources**	**Never**	**Once or twice**	**More than twice**
	TV			
	Radio			
	Newspaper			
	Magazines/journals			
	Books			
	Lectures, talks, formal education			
	Brochures, leaflets, fliers			
	Films			
	Social networking sites (facebook, twitter, blogs)			
	Internet sites			
	Government sources (KARI, Kenya Met dep)			
	Conversations with family members			
	Conversations with friends			

Extension Support

45. How much extension support do you get? (circle)	1 = none	2 = occasionally and not effective	4= frequently but not often effective
	1= occasionally and effective	3= frequently and effective	5= as much as I want and need

47. What are the sources of your extension?
Code (a) 1= Not used, 2= Occasional, 3= Frequent
48. How trusted are they? **Code (b)**
1= Not trusted 2 = Sometimes trustworthy **3** = Always trustworthy

Extension support	Code(a)	Code (b)	Extension support	Code(a)	Code (b)
a)Govt officer			f)NGO		
b)Co-op society			g)Private firm		
c)Other farmers			h)Radio		
d)Television			i)Mobile phone – SMS or voice call		
e)Farmer bulletins/magazine			j) Other (specify)		

49. Which groups or organizations do you belong to? *(circle all that apply)*	0= none 1= NGO 2=Savings group 3=Village farmer group/farmer field school (FFS) 4= Religious organization 5= Radio listener group 99 = Other (specify) _____

50. Do you attend farmer field days?	1= Yes	2= No
51. Do you have demonstration plots in your area	1= Yes	2= No

52. How useful do you find demonstration plots	1=very useful	2=useful	3=not useful	

53. Distance to the nearest (Kms)		1=0-5	2=6-10	3=11-15	4=16-20	5=21-25	6=26-30	7=+31
	Market							
	University							
	Research institute							
	Meteorological department							

54. What interventions have you adapted in order to cope with the effects of CC	1=Planting/keeping drought tolerant crops and livestock	2= Irrigation	3=Use of biogas	4= Water harvesting
	5=Agroforestry	6=Mixed farming	7= Doing nothing	8=changing planting and harvesting dates
	9=implementing water and soil conservation techniques	10=Switching to non-farming activities	8=Other (Specify)	
55. What challenges have you faced while adopting the interventions mentioned above?	1=Not enough extension information to implement practice	2=Lack of access to financial resources	3=Lack of labour	4=Shortage of land
	5=Poor access to water	6=Poor access to farm inputs	7=High cost of adaptation measures	8=Other (specify)
56. How do you receive weather updates for your area	1=Radio	2=Cell phone	3=Agriculture officer	4=Other (state)
57. Are the weather updates reliable	1=Yes	2=No		
58. Do you use indigenous knowledge to predict weather	1=Yes	2=No		
	If yes, state how:			
59. Do you use indigenous knowledge/practices to cope with the effects of climate change?	1=Yes	2=No		
60. If yes to above, please explain				

Awareness and utilization of ICT-Radio, Mobile phones and internet

61. Which of the following communication methods do you use? *(circle all that apply)*	1 = Pen and Paper 2 = Telephone 3 = Cell phone (voice) 4 = Cell phone (SMS)	5 = Internet 6 = Radio 7 = Television 99 = Other (specify) _____
62. Who normally listens to the radio in your household? *(circle all that apply)*	1= Men only 2= women only 3= Both men and women	4= Children only 5= Everyone 99= Other (specify)_____
63. Which is your preferred language of listening? Circle all that apply	1 = English 2 = Swahili	3 = Local dialect (specify) 99 = Other (specify)_____

64. What are your preferred radio programs? *(Circle all that apply)*	1= News-general 2= Weather report 3= Agriculture programs 4= Music 5= Dramas	6= Comedies 7= Talk shows 8= Agriculture news 99= other (specify)_____

65. Is there a community radio listening group in this community?	1 = Yes, I belong	3 = No	2 = Yes, I don't belong

66. Do you find radio programs on agriculture to be useful to you? (circle)	1= Yes, very useful	2= Yes, occasionally useful	3= No

67. Do current agriculture radio programs meet your agriculture needs? (circle)	1= Strongly agree	2= Agree	3= Neither agree nor disagree
	4= Disagree	5= Strongly disagree	

68. Do you listen to Pwani FM?	1=Yes	2=No

69. Are any of the radios that you own portable enough to be taken into the field for listening? (circle)	1= Yes, more than one	2= Yes, one of them
	3= No	4= No, I don't own a radio

70. Who controls what radio programs are listened to in your HH?	1= primarily male adults	2= primarily female adults	3= primarily children	4= everyone at times

71. Have you adopted any agriculture practice due to information you first heard on radio?	1 = Yes, many	2 = Yes, one or two	3 = Not yet but plan to	4 = No

72. Do you get to contribute in any way to agriculture programs that you hear on the radio?	1 = Yes (indicate how)_____ 2 = No (indicate why)_____

73. Do you receive any agricultural information on your cell phone?	0 = No	1 =Yes, regularly	2 = Yes, occasionally

74. Is there anything you would like to say about your views on climate change which this survey has not addressed?

Appendix **G**

Impact Assessment Survey

Constituency:		**Name of respondent *(if not HHH):***		
Location:		**Contact information:**		
Village name:		**Name of Interviewer:**		
Date of Survey: *day*__**/mo__2014** **Start Time: ___:___ End Time: ___:___**				
Climate change beliefs, attitudes, emotions and values				
1. What do you think will be the most serious problem facing the world in the future if nothing is done to stop it?	1=Environmental disasters i.e. drought, floods, cyclones	2=Terrorism	3=Poverty/hunger	
	4=War	5=Overpopulation	6=Insecurity	
	7=Education	8=Health care	9=Diseases	
	10=Government debts	11=The economy (inflation, unemployment)	12= Morals/values	
	13=Others			
2. As far as you know, do you personally believe the climate is changing in?		1=Yes	2=No	3=Don't know
	Kenya			
	World			
3. What would you say is the cause of climate change	1=entirely caused by natural processes	2=mainly caused by natural processes		
	3=partly natural processes and partly human activities	4=mainly caused by human activity		
	5=entirely caused by human activity	6= an act of God		
	7= There is no such thing as climate change	8=don't know		
	9=Other (Indicate)			
4. When, if at all, do you think Kenya will start feeling	1=We are already feeling the effects	5=In the next 100 years		
	2=In the next 10 years	6=Beyond the next 100 years		
	3=In the next 25 years	7=Never		

	the effects of climate change?	4=In the next 50 years			8=Don't know			
5.	How concerned if at all, are you about CC?	1=Very concerned			4=Not at all concerned			
		2=Fairly concerned			5=Don't know			
		3=Not very concerned						
6.	How much have you personally experienced the effects of CC	1=A great deal	2=A moderate amount	3= A little	4=Not at all			
7.	How serious a problem do you think CC is right now?	1=Very serious	2=Somewhat serious	3=Not so serious	4=Not serious at all			
8.	If nothing is done to reduce climate change in the future, how serious a problem do you think it will be for Kenya & the world in the future?	**Kenya**	**World**					
		1=Very serious	1=Very serious					
		2=Somewhat serious	2=Somewhat serious					
		3=Not so serious	3=Not so serious					
		4=Not serious at all	4=Not serious at all					
9.	How much do you think CC is influencing the frequency and intensity of weather events such as floods and droughts in Kilifi?	1=Very much	2=Often	3=Sometimes	4=Rarely	5=Not at all		
10.	What describes your thoughts about how often natural disasters are happening?	1=I don't think that these natural disasters are happening more often than they used to be	2=I have no idea whether these natural disasters are happening more often than they used to be	3=I think these natural disasters are happening more often than they used to be, but it's just natural fluctuation in earths temperatures	4=I think these natural disasters are happening more often than they used to be, and humans are contributing significantly to it	**5=** I think these natural disasters are happening more often than they used to be, and it's an act of God		
11.	To what extent do each of the following statements	**Statement**	**Strongly agree**	**Tend to agree**	**Neither agree/ disagree**	**Tend to disagree**	**Strongly disagree**	**Don't know**
		a) I have changed the way I think						

describe your response to threat of climate change after having listened to the climate change information aired on radio?(tick)	about the seriousness of environmental problems						
	b) Increasingly I find myself more likely to attend to media reports, articles and discussions about the nature or c) impacts of climate change						
	d) I have often discussed my thoughts and feelings about climate change with others over the past several months						
	e) Media coverage of climate change consequences from Kenya and around the world and have changed my appreciation of how soon we are likely to experience the impacts of climate change						
	f) a) I trust the Kenyan government to take appropriate action against climate change						
	g) b)I can personally help to reduce CC by changing my behavior						
	h) c)Climate change will mostly affect areas that are far away from here						
	i) d)My local area is likely to be affected by climate change						
	j) e)Climate change is likely to have a big impact on farmers						
	k) I tend to think differently these days about what is l) acceptable and sustainable and not acceptable with respect to my						

	farming practices						
	m) f)My actions to reduce the effects of CC in my community will encourage others to reduce the effects of global warming through their own actions						
	n) g)It is hard to imagine that individuals like myself can make a difference with respect to a global phenomenon such as CC						
	o) h) I have seriously thought about alternative places to live because of the increasingly evident impacts of climate change						
	p) i)I feel uneasy and apprehensive about what might happen in the near future due to the impacts of climate change						
	q) j) I feel some sense of loss because climate change impacts are becoming apparent in my local area						

12. Which of the following actions are you taking? (tick all that apply)	**Actions**	**No I am not engaging in this behavior because:**		**Yes I am engaging in this behavior**		
		Of no opportunity to do so	**For some other reason (state reason**	**Not because of CC at all**	**Partly because of CC**	**Totally because of CC**
	1=Minimizing tillage					
	2=Using less fertilizer					
	3=Adding biochar to soil					
	4=Reducing use of fire to clear land					

	5=Limiting deforestation					
	6=Practicing organic farming					
	7=Agroforestry					
	8=Rotational grazing of animals					
	9=Recycling-cans, bottles					
	10=used of renewable energy e.g. solar, biogas					
	11= Nothing					
	99=Others					
13. In your opinion What is the risk of CC exerting a significant impact on …		**High risk**	**Medium risk**	**Low risk**	**Very low risk**	**No risk**
	You personally					
	Your family					
	People in your community					
	public health in your area					
	economic development in your area					
	environment in your area					
	Future generations					

MEDIA				
14. How much do you feel you know about climate change?	1=A lot	2=A fair amount	4=very little	5=Nothing

15. How much more information do you feel you need about CC?	1=I need a lot of information	2=I need some more information	3=I need a little more information	4=I do not need any more information	
	Indicate what more information you require:				
16. How much do you trust what these different sources say about the environment?	Scientists	1=A great deal	2=A fair amount	3=Very little	4=Not at all
	Media	1=A great deal	2=A fair amount	3=Very little	4=Not at all
	Government	1=A great deal	2=A fair amount	3=Very little	4=Not at all

17. How often do you use day to day media coverage to inform your own views on CC & other environmental issues?	1=Always	2=Very often	3= Sometimes	4= Rarely	5=Never
18. How closely do you follow news about the environment these days?	1=Always	2= Very frequently	3=Occasionally	4=Rarely	5=Never

19. How much of the information provided in the news about CC would you say is accurate?	1=A great amount of it	2=Some of it	3= Little of it	4= Very little of it	5=None of it	6=Don't know

Extension Support		
20. Have you received any climate change information other than what was broadcast in the climate change programs aired?	1=Yes	2=No
21. If yes to above question, kindly state the source of information	1=other radio programs	2=extension officer
	3=newspaper	4=neighbor
	5=Internet	6=other (state)
22. Have you implemented any climate change interventions you heard in	1=Yes	2=No

	the programs									
23.	If No to question 24, why were you not able to implement **any** CC interventions aired	1)=I did not understand the information on how to implement it								
		2)=The program did not provide enough information								
		3)=I did not agree with the practice/information								
		4)=I do not get to make decisions about practices in the household								
		5)=Lack of resources/finance								
		6)=Other (state)								
24.	If yes to Q 24 what interventions did you adapt in order to cope with the effects of CC (Please refer to the topic guide) (This question refers to CC interventions implemented and those listened to but not implemented)	**Topic**	**How much was relevant to you**				**i**	**ii**	**iii**	**iv**	**v**
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
			None	Some	Most	All					
i.	Implementation	1=I will try to implement this									
		2=I have already implemented this									
		3= I did not implement this because: If there are any interventions aired that the farmer was interested in but not able to implement	a)=I did not understand the information on how to implement it								
			b)=The program did not provide enough information								
			c)=I did not agree with the practice/information								
			d)=I do not get to make decisions about practices in the household								
			e)=Lack of resources/finance								
			f)=Other (state)								
ii.	What challenges have you faced while adopting the	1=Not enough extension information to implement practice	2=Lack of access to financial resources		3=Lack of labour		4=Shortage of land				

interventions mentioned above?	5=Poor access to water	6=Poor access to farm inputs	7=High cost of adaptation measures	8=Poor radio signal reception	
	9=Lack of access to radio when program is on air	10=Not enough time to listen to radio	11=Other (specify)		
iii) Did you implement the intervention(s) individually or as a group?	1=Individually	2=Group			
iv. Did you receive assistance from other farmers' or experts in implementing the intervention(s)	1=Yes	2=No			
v. From whom did you receive the assistance (if yes to above)	1=Extension officer	2=Other farmers	3=Research institute		
	Other (specify)				
Awareness and utilization of ICT-Radio, Mobile phones and internet					
25. Was the language used in the programs simple enough to understand?	1=not at all	2=Sometimes	3=mostly	4=always	
26. Did you think the content was poorly explained or confusing?	1=not at all	2=Sometimes	3=mostly	4=always	
27. What is your level of satisfaction with the climate change programs	1=not at all satisfied	2=Sometimes satisfied	3=mostly satisfied	4=always satisfied	
28. Is there anything you would like to say about your views on climate change which this survey has not addressed					

Appendix H

Focus group discussion guide

Demographics

1. Take note of:
    i. The number of females and males in the group
    ii. Average age of the group
    iii. What the group generally does to earn a living
    iv. Crops grown in the area and what is the staple food crop
    v. How many years group members have lived in this area (range)

Climate change beliefs, attitudes, emotions and values

1. Group members will be asked: have you experienced the effects of climate change? If not, when do you think you will start feeling the effects of climate change? Is the world's climate changing? How serious a problem do you think climate change is? Who will climate change affect most-individuals, families, their community, developed countries, future generations?
2. Group members will be requested to free list the following:
    - What they believe are the causes of climate change
    - What are the indicators of climate change
    - What are the effects of climate change to them personally and to the community
3. The group will be asked to mention climate change events they have experienced in the last 10 years, the years they occurred and why these events were significant and to comment about the frequency of natural disasters
4. What emotions does climate change bring out within members of the group?

Media

5. Does the group feel they need to know more about climate change, what information do they need to know, what are their sources of climate change information and how much do they trust the sources, do they think scientists are in agreement on climate change issues

Extension support and utilization of ICT

8. Group's use of and reliance on indigenous knowledge for weather forecasts
9. Group's use of indigenous knowledge in coping with the effects of climate change
10. How much extension support do they get and what are the sources, do they belong to any organizations or groups, do they attend farmer field days, do they have demonstration plots in their area
11. Do agriculture programs interest group members and do the programs meet their agricultural needs? have group members adopted any agriculture practice heard on radio
12. What adaptations have group members adopted in order to cope with climate change impacts, and what challenges did they face when adopting the practices?

Appendix I

Focus group discussion guide (impact assessment)

Demographics

1. If there are new/missing members in the group, take note of:
    i. the number of females and males in the group

Climate change beliefs, attitudes, emotions and values

2. Group members will be asked: if they have experienced the effects of climate change? If not when do they think they will start feeling the effects of climate change? Is the world's climate changing? How serious a problem do they think climate change is? Who will climate change affect most-individuals, families, their community, developed countries, future generations
3. Group members will be requested to free list the following:
    - What they believe are the causes of climate change
    - What are the indicators of climate change
    - What are the effects of climate change to them personally and to the community

Media

4. Does the group feel they need to know more about climate change, what information do they need to know, what are their sources of climate change information and how much do they trust the sources

Extension support and utilization of ICT

5. How much extension support do they get and what are the sources?
6. Do agriculture programs interest group members and do the programs meet their agricultural needs?
7. Did the group members listen to the radio programs? Members who did not listen will be prompted to provide their reasons
8. Group members who listened to the programs will be asked what practices they adopted in order to cope with climate change impacts, and what challenges they faced when implementing the practices
9. Have group members received any climate change information other than what was broadcast in the climate change programs aired? If yes, discuss these sources

Appendix J

Question guide for interviews with key informants

1. What are your beliefs about climate change-do you believe it is happening and what are its causes?
2. What are the indicators of climate change in Kilifi County?
3. What are the effects of climate change on the community?
4. Are scientists and the government in agreement on climate change issues?
5. What are the existing adaptive practices that can be utilized by farmers?
6. What challenges do farmers face in adopting these practices and what is your organization doing to assist?
7. What has been (or is) the role of media in educating and communicating climate change issues? What are the communities' sources of climate change information?
8. Which organizations are dealing with climate change issues in Kilifi?
9. How are communities living in Kilifi utilizing indigenous knowledge in coping with the effects of climate change?
10. How useful are farmer field days and demonstration plots to community members?
11. What activities does your organization undertake in order to create awareness on climate change within the community?

Appendix K

Summary of programs aired

No	Topic	Summary of content	Experts	Dates aired 2014
1	Climate change background	-what is climate change -causes of climate change	-MoA -ASDP	28 & 30 May, 5 June 12 & 15 August
2	Climate change background	-effects of climate change to farmers' and fisherman -effects of climate change to oceans	-MoA -ASDSP -KEMFRI	29 May & 6 June 13 & 16 August
3	How to cope with the effects of climate change	-climate smart agriculture -planting drought tolerant crops e.g. cassava, expanding our food choice -fishing smart-sustainably	-MoA -ASDP -KEMFRI	9, 10, 11 June 14 & 18 August
		Comprehensive overview of 28 May to 13 June		12 to 14 June
4	Weather	-why the weather has changed causing delayed rainy seasons and a change in the duration of rainy seasons -why are weather updates sometimes inaccurate	-KMD	16, 19, 23 June 19 & 26 August
5	Weather	-where to get meteorological data -joining farmer groups so as to get fast and easy access to agriculture extension officers -seeking the services of agriculture extension officers so as to access agricultural services	-KMD	17, 20, 24 June 20 & 27 August
6	Agriculture extension	-how to access agriculture extension information	-MoA - ASDP -Farmer	18, 21, 26 June 21 & 28 August
		Comprehensive overview of 16 to 26 June		27, 28 & 30 June
7	Water conservation	-use of water retention pits with polyethene "moist gardens"	-MoA extension officer -Farmer	1, 4 & 8 July 29 August & 2 September
8	Water harvesting	- using coconut leaves to harvest rain water into a container (traditional method) -harvesting water from the roof of houses	-MoA extension officer	2, 5 & 9 July

No	Topic	Summary of content	Experts	Dates aired 2014
		or from an iron sheet - harvesting water from rock catchments -digging dams		30 August & 3 September
9	Water harvesting	-harvesting water into a plastic lined water pan -digging wells -digging trenches (kaselenga) along which vegetables are grown	MoA extension officer	3, 7, & 10 July 1 & 4 September
		Comprehensive overview of 1 to 10 July		11 & 12 July
10	Accessing loans	-getting financial assistance from banks; cooperatives; merry go round; government-njaa marufuku Kenya, Uwezo fund so as to improve access to financial resources for farming -Joining groups as a means of accessing loans	-Farmer - MoA	16, 17, 18 July 5, 6, September
11	Strategies that help farmers cope with climate change	-planting and eating drought tolerant crops such as oats, sweet potatoes, cow peas and pigeon peas. -selling the previously mentioned crops to buy maize in areas where maize is not doing well -planting indigenous maize such as "Kanjerenjere", "Mzihana" that are drought tolerant and mixing them with improved varieties -planting sorghum to sell to beverage making companies	-KEFRI	22 , 24 & 26 July 9 & 11 September
12	Strategies that help farmers cope with climate change	-storing seeds in village seed banks for use by future generations. This is to address the indigenous maize varieties that are getting extinct -planting traditional crops from KALRO or from village seed banks (domestication of wild crop species) -planting trees in a wood lot, under agroforestry or along the fence -stopping deforestation. Some trees are medicinal while others are a source of food and can help improve the climate -using cuttings (vipandikizi) rather than shoots (matagaa) to plant cassava	-KEFRI	23, 25 & 27 July 10 & 12 September
13	Strategies that help farmers cope with	-planting drought tolerant cassava varieties such as "Tajirika", "Nzalauka", "Shishibe", "Siri" bred by KALRO	-KALRO	31 July, 4 & 7 August

No	Topic	Summary of content	Experts	Dates aired 2014
	climate change	-mixing early and late maturing cowpeas in your farm -planting wild forest trees on your farm such as Mizambarau, Ukwaju, Mibuyu for fruits and food -stopping the use of slash and burn methods for land preparation -planting 10% of your land with fruit trees or trees for timber or fuelwood		13 & 18 September
14	Strategies that help farmers cope with climate change	-reducing soil erosion in your farm by: -gathering all plant residues and putting them along soil erosion trenches rather than burning them -planting grass such as "makarikari" along the trenches -using fanya juu system -using zai pits -using manure	-KALRO	1, 5 & 8 August 15 & 19 September
15	Strategies that help farmers cope with climate change	-planting drought tolerant crops such as sorghum, sweet potatoes, legumes-e.g. cowpeas-mix early and late maturing varieties, pigeon peas, green grams, cassava resistant to Cassava Mosaic disease such as Tajirika, Nzalauka, shibe, and siri, Reinforcing: -use manure -Zai pits -do not slash and burn	-KALRO	2, 6 & 9 August 16 & 20 September
16	Final program	- recap of information in all the programs		11 August 22 September

Key:

ASDSP=Agricultural Sector Development Support program

KEFRI=Kenya Forestry Research Institute

KALRO=Kenya Agriculture and Livestock Organisation

MoA=Ministry of Agriculture

KMD=Kenya Meteorological Department

KEMFRI=Kenya Marine and Fisheries Research Institute

Appendix L

Transcripts of programs

Program 7: Water retention pits

Intro tune

Wandago (producer) Greetings and welcome again to our agricultural program brought to you by Pwani FM with the aim of providing farmers with the opportunity to carry on with their farming despite the challenges they face with climatic variability

Intro tune continues and ends

Today we will talk about moist gardens as a water conservation strategy. This is one of the ways of dealing with lack of water [for irrigation] due to climate variability. It is an easy method [to implement] and can be used by any farmer. What you need is polyethene sheets and manure and you will be able to conserve enough moisture to grow vegetables on your farm. We visited a place called Maungu where we met with farmers who have managed to get a harvest using this method in the face of dry spells that occur in that area. This is Mr. Victor Kinango an agricultural officer telling us more about this technology

Victor Kinango To make the moist garden, dig a hole 2 feet deep and 2 feet wide. As you dig, separate the top soil from the middle soil. Take half of the top soil and mix with about 4Kgs of manure. Take a black nylon that will prevent water seeping out of the soil and line the hole with it. Then pour in the top soil mixed with manure into the hole first. Sprinkle some pesticide on top of the soil to kill insects that may be present in the soil that may attack the crops you want to plant. Then pour in the middle layer of soil that you had set aside. Plant one crop in all corners of the hole and one in the middle. There should be five crops in total in the hole. The advantage of this hole is that it conserves water for use by the plants.

Wandago Miss Angelina Mudalia is one of the farmers using this technology. Even though it is currently raining in most parts of the Coastal area, Miss Mudalia says this method has enabled her grow vegetables even during a dry spell.

Bi Mudalia	My farm is very beautiful. I like seeing green on my farm. Through determination I have grown pumpkin and baby marrow and cowpeas...and not just here, I have another farm somewhere else. This is just a small home garden
Wandago	Gauging from her level of joy it is evident that this method has been useful to her. But what kind of crops can be grown using this method? Mr. Kinango tells us more
Victor Kinango	You can grow crops such as cowpeas eehh green grams, pumpkin, even onions, and tomatoes
Wandago	Miss Mudalia whom we heard earlier praises this technology that can help families especially those living in dry areas like Maungu and other Coastal areas. Every farmer can improve their farming by seeking the advice of experts.
Bi Mudalia	I would like to tell [the audience] we can reduce our cost of living [using this technology]. They will eat healthy food and it will reduce the incidence of diseases. Because many people nowadays spend a lot of money treating diseases that are preventable by eating healthy/nutritious food.
Wandago	In today's program we have talked about one of the methods of conserving moisture on your farm especially at a time when we require technologies that can help us cope with lack of irrigation water and with climate change. Like we have been told, you can easily grow vegetables using this method in your home. We would like to stress that advice from experts will enable you to carry out your farming in the recommended way in the face of the impact of climate change. If you have any question or if you have a technology that you use to cope with climate change that you would like to share with us do not hesitate to talk to us on 0728979578 (repeated). This agricultural program is brought to you by Pwani FM. I am Wandago Ondogo.
Outro plays	

Program 10: How farmers can access loans

Intro tune plays

Wandago Greetings and welcome once again to our agricultural program brought to you by Pwani FM. Today we will talk about how farmers can access loans so that they can progress with their farming despite the challenges that climate change presents them.

Mijikenda melody plays

Wandago Today Charo is meeting with his friend Mr. Lewa from Kaloleni to discuss about how they can access loans. Later, they visit Mr. Jonathan Sulubu, who is the Mombasa County Director of Agriculture for more advice.

Bwana Charo Ahhh Mr. Lewa, why are you really stressing on the issue of getting loans?

Bwana Lewa Well, if I give you examples-the price of fertilizers is high, the same for pesticides, so when you get a loan you can be able to access the inputs faster

Bwana Charo Now I understand. It is true. Now that we have met Mr. Sulubu the Director of Agriculture, we will get some advice for sure. How can we access the loans?

Bwana Sulubu Aaahm for farmers needing loans they can access them from various avenues including banks, cooperatives, Uwezo Fund which is primarily for women and youth, and the usual Merry go rounds. But all these avenues require that people be in groups and that those groups are registered. After which they should meet the conditions laid out by the respective institutions on how to get the loans.

Bwana lewa Yaahh thank you

Bwana Charo I have understood that very well. But tell us what are the conditions that need to be fulfilled because I know my wife and friend in the village would like to know

Bwana Sulubu For example banks-there are banks that have been helping farmers. They have their ways in which they look at the conditions farmers must have in order to access the loans. So individuals or groups who need a loan must have some form of security that can be used as collateral if for example one of the members has difficulties in paying back the loan

Bwana Sulubu	Other than that, there are cooperatives where members can get a loan for farming
Bwana Charo	And how is the government helping in this issue?
Bwana Sulubu	there are funds that can be accessed by the youth and women at the grassroots level. Even in our ministry there is a government project called "Njaa Marufuku Kenya" in which groups that have different projects such as fishing can request for funds to assist them. Groups dealing with animal husbandry are given approximately Ksh 1.5 Million [~$17,600], while those growing crops are given approximately Ksh 1,020,000 [~$ 12,000]
Bwana Charo	Mr. Lewa it looks like you understand these things better from the many meetings you attend in Kilifi. What do you think?
Bwana Lewa	Eeeh my fellow farmers, it will be easier to access help if we are in groups. As an individual it can be challenging to benefit from a loan because we mostly depend on our parents farms. The title deeds are in our parents' names and others do not have title deeds. When you want a loan, you will be asked to provide security…and you don't have it. When you are in a group, that group can be a form of security for getting a loan
Bwana Charo	I will go back home with a good message. If we don't get [loans in the bank] we can go to the government. The youth and women can also benefit
Ondogo Wandago	I am sure you are now familiar with the types of loans/funding you can access in your County. Do not forget to tune into our next program where Charo visits an officer from the ministry of Cooperatives in order to further understand how farmers can join cooperatives in order to access loans. If you have any questions, talk to us through this number 0728979578 (repeated). This agricultural program is brought to you by Pwani FM. I am Wandago Ondongo.
Outro plays	

Appendix **M**

Ethics approval

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