

Addressing challenges in communicating adaptation practices to smallholder farmers in Kenya through a radio intervention

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Submitted on 2017, 3 March; accepted on 2017, 5 October. Section: Research Paper

Abstract: Farmers in Africa are particularly vulnerable to the impacts of climate change due to their high dependency on climate-sensitive natural resources. Kenyan farmers are faced with limited public agricultural extension services, narrowing their sources of useful information including adaptive strategies that would help them cope with the impacts of climate change. Radio can be an effective extension tool with the ability to reach many farmers in their local language. This study investigated the potential of radio in influencing the utilization of climate change information by farmers in Kilifi County, located along the Kenyan coast. Education and communication about climate change was undertaken using radio to make available and understandable information to different social and cultural groups. This study revealed that radio can effectively complement other agricultural extension methods and has the potential to engage farmers on climate change issues and motivate them to take action, if appropriate approaches are used. Although very few of the farmers surveyed (33%) reported to have listened to the programs, a high percentage (82%) of those who did implemented the recommended strategies and technologies they heard. The major challenges reported by farmers to accessing the radio programs were lack of a radio and unsuitable program timing. An additional reported challenge was the inability to store or record the programs resulting in farmers relying on their own recollection when implementing strategies. Further research should explore the use of social learning approaches that encourage group rather than individual listenership (such as community listening clubs and community-based radio schools) to overcome these challenges.

Key words: Radio, Farmers, Climate change, Communication

Introduction

The impacts of climate change are being felt globally, with the frequency of extreme weather events projected to increase in the future (Intergovernmental Panel on Climate Change, 2014). Climate change poses a real threat to climate sensitive livelihoods and will hit farming-dependent households the hardest. Therefore, building the capacity of farmers to adapt to the changing climate is critical. The extent of sustainable adaptation depends on the existence of institutions and policies that support it 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, 2003; International Fund for Agricultural Development [IFAD], 2008). Agricultural extension services play a vital role in the growth of the agricultural sector by disseminating relevant, practical and timely knowledge, technologies, and information that would help farmers cope with climate change impacts. This is especially important for African farmers, majority of whom are aware that climate change is happening but lack the technological, financial and informational resources to adapt (BBC World Service Trust, 2010; Gifford, 2011).

This study was conducted in Kilifi County which is located along the Kenyan Coast. Agriculture is the primary economic driver of Kilifi County, with 56% of the land being suitable for agricultural activities (Kilifi County Integrated Development Plan [KCIDP], 2013). The County is reported to have high poverty levels (an absolute poverty level of 71.7%) which have partly been attributed to high population growth rates, high illiteracy levels, poor infrastructure, 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 (KCIDP, 2013), which have negatively impacted various sectors including agriculture. The selection of this county for this study was informed by the comparable geographical, meteorological, and economic similarity of Kilifi County to other low economic coastal regions of Africa. These regions are increasingly suffering from climate change impacts such as drought and floods with severe direct and indirect impacts predicted to have major consequences for their societies and economies (Ofoegbu, Chirwa, Francis, Babalola, 2017; Tobey *et al.*, 2012). Adaptation is therefore a key factor that will shape the future severity of the impact of climate change on farming communities (Lobell *et al.* 2008) and their economic well-being.

Improving farmers' access to extension services and climate change information has been shown to enhance adaptation (Obayelu *et al.*, 2014; Tesfaye and Seifu, 2016). 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 (Anandajayasekaram *et al.*, 2008). Extension officers who provide these services are a key component in creating awareness and training of

farmers in technologies and practices for climate change adaptation. However, in Kenya agricultural extension service provision faces many challenges. These challenges include weaknesses in: establishing research-extension-clientele linkages; packaging and disseminating technologies; and recruitment and capacity building of frontline extension workers (National Agriculture Sector Extension Policy, 2012). Furthermore, the shift in the provision of extension services from the national to County governments has resulted in a lack of coherence in the approaches used by extension officers to reach farmers. In addition to these challenges, 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 Food and Agriculture Organisation (FAO) recommended ratio of 1:400 (Brownhill *et al.*, 2016). Media (newspapers, television, and radio) and Information Communication Technology (ICT) can bridge this 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. 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 (Lucas, 1999; Bakshi and Jha, 2013).

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. The findings of this study are part of a larger study which investigated Kenyan farmers' perceptions of and adaptations to climate change before and after a radio program intervention (Mwaniki, 2016). Similar studies that investigated the potential of radio in communicating agriculture and climate change related information to farmers (Chapman, Blench, Kranjac-Berisavljevic, and Zakariah, 2003; Nazari and Hasbullah, 2010; Perez-Teran, Tiani, Touko-Tchoko, and Tchatchou, 2015) did not consider their existing knowledge on the issues to be addressed and their information needs before developing radio programs. These studies largely used a linear approach (Odame, 2007) to promote adoption of agricultural innovations where extension agents/radio producers disseminated technologies developed by researchers via radio to farmers who were expected to implement them. This paper aims to address the limitations of these studies in three stages. In the first stage farmers' information needs as well as their use of Information and Communication Technology (ICT) (including radio, TV, newspapers, social media and mobile phones) to inform themselves about climate change were identified. In the second stage radio programs that informed the

identified information needs to enhance farmers' adaptive capacity were developed and aired. In the last stage, an evaluation of the impact of this information on farmers' responses to adaptation and the challenges and limitations of radio for increasing their adaptive capacity was conducted. Results from this study will contribute to informing practitioners working in the field of climate change/agriculture communication about possible considerations they should make while developing communication initiatives, especially in African coastal communities whose livelihoods are mostly dependant on climate sensitive natural resources (Ofoegbu *et al.*, 2017).

Agriculture extension and communication

The meaning of agricultural extension has evolved over time and is interpreted differently by extension agents and practitioners based on their experiences and the type of extension services they provide (Leeuwis and Van den Ban, 2004; Oakley and Garforth, 1985). Purcell and Anderson (1997) define agricultural extension as 'the process of helping farmers to become aware of and adopt improved technologies 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 interpretation 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). In this study agricultural extension is framed around the Kenyan context and it refers to the provision of advisory services to farmers by extension agents that can help them improve their farming, income and welfare. Agriculture communication on the other hand refers to sharing of agricultural and natural resources related ideas and information which forms a large part of agricultural extension agents jobs (Oakley and Garforth, 1985). Essentially, agricultural communicators communicate, disseminate and educate the public about agriculture in order to help improve the lives of rural families (Federer, 2015). Agriculture extension and communication are guided by different theories, professional codes and outcomes which are further discussed in the following sections.

Agriculture extension

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 3 ha), medium scale (3 to 49 ha) or large scale (50 to 30,000 ha), 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. 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.

Agriculture communication

History of agriculture communication: 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” (African Farm Radio Research Initiative [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 and 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 and Bussiek, 2011). Rural radio which is a geographically descriptive term (Chapman *et al.*, 2003) 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 and Castello, 2003;). The first rural radio in Africa was founded in Homa Bay, Kenya in 1982 with support from United Nations Educational, Scientific and Cultural Organisation (UNESCO) (FAO, 2006). Centre Inter-africain d’Etudes en Radio Rurale (CIERRO) which was established in 1978 in Ouagadougou, Burkina Faso greatly contributed to the emergence and development of rural radio in Africa (Matha, 2001). This contribution was in the form of training radio broadcasters, seminars, conducting research on methodological approaches to rural radio communication, publishing training manuals for rural radio broadcasters, and facilitating meetings with rural

communication professionals to promote local rural radios (Matha, 2001; FAO, 2006).

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 and 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 and Bussiek, 2011). Since then several other community radio stations have been licenced. Kenya has recently seen an increase in agricultural content both in rural and community radio using local languages. 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.

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 and 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, social media and radio listening groups have transformed radio from a one way to a two-way communication medium (Rao, 2015).

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). 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 and Bussiek, 2011).

Other challenges outlined by FAO (2006) in a sensitisation workshop on rural radio for policy and decision makers in East and Southern Africa that are still relevant today include limited capacity of broadcasters in developing agricultural programs, limited accessibility to radios by listeners, political instability in some African states, and the lack of policies that recognise and support rural and community radio stations as important development tools. Despite these challenges 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, and the 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 and Castello, 2003).

Agricultural radio program formats

Agricultural radio programs are produced using various formats which include live or recorded panel discussions with experts, phone-in-shows, agricultural news which could include market and weather information, and mini-dramas. These programs are usually intertwined with music and sometimes feature the voices of farmers sharing their experiences and perspectives on farming. Due to cost limitations of producing radio programs indicated earlier, it is not always possible for

producers to go out to the field to conduct interviews with farmers, farming groups, or experts for their programs. Additionally, some of the radio program formats such as mini-dramas have high production costs. These financial constraints have resulted in producers 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). Other than financial constraints, some journalists lack the capacity to produce programs covering technical subjects such as agriculture or climate change due to lack of specialisation in the respective subject area, the know-how of reporting technical issues in a simple language tailored to their audience, and inadequate information sources (Muchaba, Mungai, Atakos and Radeny, 2016). Fortunately, journalists interested in producing or reporting on agricultural or climate change issues have access to a myriad of trainings, workshops and short courses offered by various NGOs across Africa such as Climate Change, Agriculture and Food Security (CCAFS), UNESCO, Farm Radio International (FRI), African Media International (AMI), Food and Agriculture Organisation (FAO) amongst others.

Theoretical perspectives for climate change communication

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. However, before delving into these discussions, it is important to note that climate change communication is largely informed by dominant agriculture and life sciences communication practices and approaches some of which have been discussed earlier.

Challenges of communicating climate change information

Climate change communication “is as complex as the science” (Chess and Johnson, 2007, p. 223). Indeed, 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). 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. 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 *et al.* 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).

Strategies for effective climate change communication

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 and 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 input-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" both of which assume that the provision of more scientific information to the public will result in their acceptance of scientific and technological advancements and result in a greater convergence between the knowledge and attitudes of the public 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).

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 traditional African education culture is more oral than written. Indeed, the identity of the Mijikenda people who are the main inhabitants of Kilifi County is expressed through oral traditions which include songs and dance (UNESCO, 2014). A well designed educational radio program can capitalise on this oral tradition by preserving the oral heritage of indigenous agricultural practices and incorporating new 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. 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.

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). The messenger should ideally be a person trusted by the community such as a local scientist, a religious leader, village elder or a government official.

Lastly, establishing the public's climate change information needs 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. This baseline information can be used to tailor communication initiatives before starting any local communication activities. 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).

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 (such as: the use of imagery, metaphors, and cultural narratives, and monitoring and evaluation of the radio programs) provide 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. 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 (1990; 1991), emerged as a useful way to frame an analysis and recommendation.

Methods

Research location

This study was carried out in Kilifi County which is located along the Kenyan coast and is mainly inhabited by the Mijikenda who comprise nine distinct Bantu speaking ethnic groups. The county has seven sub-counties and ranges in altitude from 1m to 310 m above sea level. The annual rainfall and temperatures range from 350 to 1300 mm and 24 °C to 27 °C respectively (Jaetzold and Schmidt, 1983; KCIDP, 2013). Kilifi County has two main rainy seasons; long rains from April to July and short rains from October to December.

Research design

Data were collected in two phases; before and after the radio program intervention. This study used a mixed methods pre-post-intervention design approach for data collection and analysis. Mixed methods research combines the strengths of both quantitative and qualitative research to address their respective weaknesses. Qualitative data supported or augmented the quantitative data collected (Creswell and Plano Clark, 2011), enriched findings, and sought to explain observed trends or gaps from the quantitative data. Four types of data collection were employed:

surveys with farmers, focus groups interviews (FGIs), key informant interviews and interviews with climate change experts. Data collection prior to the intervention included all four types whereas after the intervention only surveys and FGIs were conducted with the same farmers surveyed or interviewed before the intervention. The pre-intervention surveys and interviews informed the content for the radio program intervention, while the post-intervention survey and FGIs were aimed at investigating how the programs aired impacted on farmers' response to climate change and the challenges they faced in accessing the radio programs. Participants of this study were rural farmers aged 18 years and above, who initially reported that they owned or had access to a radio.

Surveys: Sample size and data collection

Data on the number of farmers in Kilifi County were obtained from the 2009 Census data (Kenya National Bureau of Statistics, 2009). The total number of farmers initially surveyed at the pre-intervention phase of this study was 442. Proportionate-to-population size methods were used to allocate the sample size (442 farmers) to each of the seven constituencies in the County. Multi-stage sampling techniques were used in selecting households. Stratification sampling was undertaken on the basis of administrative boundaries, land size holdings, and farming systems. Selection of households for the administration of semi-structured surveys was done randomly. 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).

Seven pre-intervention questionnaires were excluded from the pre-intervention data due various reasons which included missing data and contradictory responses which rendered them unreliable. Additionally, 14 of the potential farmers to be re-interviewed in the post-intervention survey were not re-interviewed for various reasons including relocation, sickness, 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 21 cases were removed from the data set, bringing the total number of farmers included in the quantitative data analysis to 421. Data analysis when evaluating the impact of the radio intervention on farmers was completed only with farmers who reported listening to the radio programs (n=137).

Recruitment of farmer groups, climate change experts and key informants

Farmer groups recruited for FGIs were randomly selected from a list of farmer groups registered with the Kenya National Farmers Federation (KENAFF) in Kilifi County. The farmer groups, which were 11 in total (Table 1), were mainly composed of women groups and groups with mixed age and gender. FGIs were composed of four to eight members who were randomly selected from the groups they belonged

to. To improve participation of women, three out of the 11 FGIs were held with women groups (Atwi-Agyei, Dougill, and Stringer, 2014). The same farmer groups who were interviewed during the pre-intervention survey were interviewed again in the post intervention survey.

Table 1- Number of participants in focus group interviews (FGIs)

CATEGORY	GENDER			AGE (range in years)			GROUP TYPE*	CONSTITUENCY	SUB- LOCATION	
	PRE- INTERVENTION		Total	POST- INTERVENTION		Total				
	F	M		F	M					
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

Climate change experts and key informants were purposefully selected. The purpose of climate change experts was to provide answers or content that addressed farmers information needs identified during the pre-intervention surveys and FGIs. These answers were audio recorded by the radio producers to generate content for the production of radio programs. Ten experts knowledgeable in the field of climate change at the local level were selected from government and non-governmental institutions dealing with climate change issues in Kilifi. Information on climate change adaptation was sought from farmers who had implemented adaptive practices and were willing to share their experiences and knowledge with other farmers over the radio. Five Key informants including a chief, an assistant chief, village elders, and agricultural extension officers were selected for this study. Key informants 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.

Data collection before the intervention was conducted from February to March 2014, while data collection after the intervention was conducted from the end of September to mid-October 2014.

Data collection instruments

Data collection instruments for this study included semi-structured surveys that included Likert scale questions, semi-structured interviews with a list of key questions, pictures, videos and audio recordings. The information sought included household socio-demographics; access to extension support; use of media; awareness and utilisation of ICT (radio, mobile phones, and internet). The only differences between pre- and post-intervention survey instruments were: (1) the post-intervention survey instrument did not have questions on household socio demographics because these details remained the same for the households visited, and (2) the post-intervention survey instrument had a section that assessed whether the farmers had listened to the programs; whether they had adopted any adaptive practices that they had heard in the programs; what challenges they faced while accessing the radio programs; and whether they had received any climate change information other than what was broadcast in the programs aired.

Five enumerators were recruited to collect survey data due to the large number of households to be sampled. Qualitative data from FGIs and interviews with key informants were collected by the lead author. All interview schedules used in this study were translated to Kiswahili, Kenya's national language and one of the common local languages spoken in Kilifi. 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. 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. One of the issues identified was that the term climate change directly translated into Kiswahili means short-term changes in weather patterns. Consequently, this is what the farmers understood the term to mean. This misconception was addressed by the enumerators explaining to the farmers before data collection that climate change in the context of this study is the change in type, frequency and intensity of climate patterns recorded over long periods of time, usually decades or longer. This description was included in the introduction section of the questionnaires.

The radio intervention

Farmers' information needs identified from the pre-intervention surveys, FGIs and interviews with key informants informed the development of radio programs.

Information needs were identified by analysing the following questions: 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? A total of 16 programs were developed in Kiswahili and broadcast by Pwani FM; one of the state owned stations of the Kenya Broadcasting Corporation (KBC), operating in Mombasa County. According to B. O. Wandago (personal communication, September 19, 2017) Pwani FM was established in 2002 as a commercial radio station. This station mainly broadcasts in Kiswahili and Kigiriana (a local language) in Mombasa, Kilifi, Kwale and Tana River Counties located in the coastal region of Kenya. The station mostly airs entertainment and educational programs which include agricultural programs. An MoU signed between Pwani FM and Farmer Voice Radio (FVR) in 2011 saw the transformation of its agricultural programs from mostly live shows with experts to more vibrant and interactive five minute programs that included drama repeated several times in a week. FVR's 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 extension agents and experts from universities, research institutes, NGOs and the Ministry of Agriculture. Agricultural programming at Pwani FM has recorded many success stories as a result of this extension model which links farmers and extension officers with the radio. The successes included sponsorship for producing some of the programs by interested organisations such as the Coconut Development Authority based in Mombasa.

Radio producers at Pwani FM developed the radio programs from interviews conducted with climate change experts that addressed expressed farmers' information needs. This involved frequent consultations with the first author. The programs were aired 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. 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 farmers' attention, encourage them to follow up and be engaged beyond the program to implement climate change interventions that were communicated. A mobile number was provided at the end of the programs to allow feedback (comments and questions) from farmers on programs aired. The programs were five-minutes in length and were aired at 7.50am from Monday to Saturday. Each of the programs aired on Mondays and Tuesdays were repeated twice in the period from Wednesday to Saturday meaning each program was aired thrice in a given week. 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.

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 and key informant interviews were transcribed in Kiswahili. The transcripts were then translated into English. The transcribed data in the form of text were imported into QSR NVivo10. The data were thematically coded using an inductive approach (Gray, 2014). The process of inductive analysis involved “discovering patterns, themes, and categories” (Patton, 2002, p. 453) in the data. This meant that the themes were data driven i.e. they emerged from the data (Gray, 2014). 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 *et al.*, 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).

Results and discussion

This section first reports farmers’ socio-demographic data, information needs, reported use of ICT and access to extension services before the radio intervention. Findings on the assessment of the impact of the radio intervention on farmers are then presented next.

Socio-demographics

The survey revealed extreme levels of poverty and low literacy levels among the respondents (Table 2). This poverty profile indicates that there is a great need to impact this farming community economically with affordable technologies that enhance their productivity and adaptation to climate change. All farmers reported to earn a living from farming, with 8% reporting to earn a living from activities in addition to farming such as formal and informal employment, pension and land rentals.

Table 2 - Farmers socio-demographics

<i>Gender</i>	%
Females	49.9
Males	50.1
<i>Age (years)</i>	
19-24	8.0
25-34	25.9
35-44	24.0
45-54	19.0
55-64	11.4
65-74	8.8
75 and older	2.9
<i>Level of education</i>	
Primary education	58.4
Secondary education	15.9
College and above	3.8
No formal education	21.9
<i>Average monthly income (USD)*</i>	
Less than 50	59.3
50.5 to 101.01	28.3
101.02 to 202.02	8.6
202.03 to 303.03	1.7
303.04 to 454.55	1.2
454.56 to 606.06	0.7
66.07 to 757.58	0.2

N=421

Farmers' information needs

Analysis of questions from the survey and FGIs that aimed to identify farmers' information needs revealed the following needs categorised by themes (Table 3). Questions to be addressed in developing the radio intervention programs were identified from these information need themes. Additionally when farmers in the FGIs were asked what more information they required (FGIs and open ended question in the survey), some indicated that they needed to learn about "modern

ways of farming”, while others nominated the causes and effects of climate change. These identified information needs provided a context for the development of radio programs (See Appendix for a list of the programs).

Table 3 - Summary of farmers' identified information needs

INFORMATION NEED THEMES	IMPLIED CLIMATE CHANGE QUESTIONS
Climate change background	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • How can farmers access agricultural extension services?

Farmers reported use of ICT

All farmers who participated in this study initially indicated that they owned a radio or had access to one (mostly their neighbours). Nearly all farmers (91%) reported that they listened to Pwani FM. Radios in the households were reported to be primarily controlled by all family members at times (56%), most farmers found agricultural radio programs very useful (60%), and a majority (73%) either “strongly agreed” or “agreed” that current agriculture radio programs met their agricultural needs (Table 4).

Table 4 - Farmers control over the radio and their views on agricultural programs

QUESTION	FREQUENCY*	%
<i>Who controls which radio programs are listened to in your household?</i>		
Primarily male adults	140	33
Primarily female adults	7	2
Primarily children	10	2
Everyone at times	237	56
Others	27	6
<i>Do you find agriculture programs useful?</i>		
Yes, very useful	252	60
Yes, occasionally useful	109	26
No	59	14
Not sure	1	0
<i>Do current agriculture radio programs meet your agriculture needs?</i>		
Strongly agree	148	35
Agree	159	38
Neither agree nor disagree	89	21
Disagree	16	4
Strongly disagree	9	2

*N=421

These findings suggest that the radio programs had a high probability of being listened to by farmers who participated in this study.

When asked if they had adopted any agricultural practice they had heard on the radio, a slight majority (56%) indicated adopting at least one practice (Table 5). This finding indicates the potential of radio in enhancing the adoption of adaptive practices aired on radio.

Asked whether they participated (called into or sent text messages) in the agricultural programs aired on the radio, a majority of the farmers (86%) indicated

Table 5 - Farmers reported adoption of agricultural practices before the intervention

ADOPTED?	FREQUENCY	%
Yes, many	88	21
Yes, one or two	149	35
Not yet but plan to	76	18
No	108	26
TOTAL	421	100

they did not. Some of the reasons for this included lack of money to buy airtime; lack of a mobile phone; constant congestion in the communication lines as well as lack of time and interest. Others said they did not know the radio station's number or expressed fear of being heard on radio. The first three reasons were also found in a study conducted across five African countries (Ghana, Malawi, Mali, Tanzania and Uganda) that investigated how ICTs are changing rural radio in Africa (Sullivan, 2011). 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 their cell phones.

Farmers access to extension services

When asked how much extension support they got, half the farmers said they got occasional and effective (41%) or frequently and effective support (9%), 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 farmers were of the opinion that it was easier to receive extension support as groups rather than individually. Some farmers reported visiting research institutes or attending meetings called by their chiefs where agricultural extension officers were usually given a chance to talk to them. The radio was the most popular means of obtaining agricultural information followed by conversation with friends (Table 6). Radio can only complement but not replace the important work of agricultural extension officers. Given the low ratio of extension officers to farmers, 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.

Table 6 - Sources used by farmers to obtain agricultural information (%)

	RADIO	TV	NEWS PAPER	LECTURES	SOCIAL NETWORKING SITES	GOVERNMENT SOURCES	CONVERSATION WITH FRIENDS
<i>Never</i>	8.6	74.8	77.2	76.5	98.5	64.1	28.0
<i>Once or twice</i>	23.8	9.0	15.0	12.6	1.0	22.1	29.0
<i>More than twice</i>	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.

Assessment of the impact of the radio intervention

Adaptation practices implemented by farmers

Thirty three percent of the farmers who were surveyed for this study reported to have listened to the radio programs, out of which 82% reported implementing one or more adaptation practice they heard. Every farmer present in the FGIs was asked if they had listened to the radio programs. Only 12% reported to have listened. Reasons for the low listenership for farmers who were surveyed and those in FGIs are provided later on page 304 in the section titled Challenges and limitations of radio for increasing farmers' adaptive capacity. The most commonly adapted practices by farmers in the survey 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 aired practices adopted, though by a minority of the farmers, were taking loans, forming groups and using manure. Loans provide farmers with the financial resources to implement technologies or practices that enhance their adaptive capacity. Enumerators verified practices adopted by 79% of the farmers in the surveys 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.

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 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. 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.

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.

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, and level of education 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 or their level of education.

Impact of the intervention on climate change knowledge

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). This finding indicates that the radio programs increased farmers' interest in information that would enhance their adaptive capacity. Farmers indicated they needed more information on: agricultural interventions available to deal with the effects of climate change (49%); financial resources available to farmers that would enable them adopt adaptive practices and how to access them (24%); the effects of climate change (17%) and the causes of

climate change (9%). Other information farmers wanted to have 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.

The radio program intervention seemed to have increased farmers' knowledge about climate change. This is because the number of farmers who felt that they knew 'a fair amount' about climate change after the intervention, 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 aired on Pwani FM. 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.

Farmers' reported level of trust in scientists and media on climate change and environmental issues

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 $M = 0.0533, SD = 0.6238, t(136) = 3.521, p = 0.001$). 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 . . . 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 half the time because the weather forecasts were not always accurate and ultimately it is God who really knows when it will rain. It appears that farmers’ level of trust in the media and scientists varied with the accuracy of weather forecasts. This finding highlights the importance of accurate weather forecasts by meteorologists in building farmers trust in the media and scientists on environmental and climate change issues.

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

Table 7 - 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
<i>How often do you use day to day media coverage to inform your own views on climate change and other environmental issues?</i>				
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*
<i>How closely do you follow the news about the environment these days?</i>				
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

* $p < .05$

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%.

Challenges and limitations of radio for increasing farmers' adaptive capacity

Challenges with accessing the radio programs

The major reasons given by farmers in the surveys for not listening to the programs were lack of a radio and limitations of time. Other reasons provided were their radios stopped working and poor radio signals. A similar finding was found in Nigeria (Otene, Okwu, and Gwaza, 2015) for poor radio signals, while inappropriate program schedule times was found in Benin (Zossou, Vodouhe, Van Mele, Agboh-Noameshie, and Lebailly, 2015). The major reasons given by farmers in the FGIs for not listening to the programs were the same as those for farmers who were surveyed; lack of a radio followed by lack of time to tune into the programs. Farmers in the FGIs explained that the airing of the programs coincided with the long rain season when they were busy with land preparation and planting, competing for time to listen to the radio. Some farmers in the FGIs 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. The higher percentage of farmers who did not listen to the radio programs for FGIs compared to those who were surveyed could partly be explained by the fact that some farmers in the FGIs were not available to be re-interviewed after the intervention therefore reducing the size of the informant pool. This meant that their views after the intervention including whether they listened to the program or not were not included in the study.

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 (with repetition) on radio without incurring very high costs. 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. Some of the reasons for this limited interaction were provided earlier. 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 the Kenyan radio production circles with the increase in various methods that encourage feedback from listeners 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. Hence to them, radio remains a one-way communication medium.

Limitations of the study

All farmers in this study reported to either own a radio or have access to one during the pre-intervention survey. This study did not differentiate the number of farmers who owned a radio with those who reported to have access to one. 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. Farmers reporting low radio ownership could mean that most of them 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; Myers, 2008; Boykoff and Roberts, 2009). These studies have also established that a majority of rural households own radios (Sullivan, 2011). It is therefore evident that this study covered a community of farmers who fell in the category of low radio ownership. Perhaps other radio listening approaches (i.e. radio listening groups) could have been integrated in the study design to accommodate farmers who did not have access to a radio.

Farmers surveyed who could not be reached in person as well as those in focus groups self-reported that they implemented the 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. Lastly, the programs were aired in May 2014 when the rains had already started and were at their peak. 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.

Recommendations on overcoming barriers in communicating climate change information to enhance farmers' adaptive capacity

This study found that the radio intervention that communicated adaptive strategies aimed at addressing farmers identified climate change information needs was limited for several reasons 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 Jack Mezirow's theory of adult and social learning, which offered an appropriate theoretical framework as 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.

Adult learning in a social context

Social learning approaches are recommended to educate farmers about adaptive practices given the challenges they reported in accessing the radio programs. Social learning theory emerged in response to a growing recognition that "learning occurs through situated and collective engagement with others" (Collins and 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 and 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 (Pahl-Wostl and Hare, 2004; Glasser, 2009; Wals and Leij, 2009). Glasser (2009) provides five interpretations of social learning from the literature. The commonalities that emerge from these interpretations are that social learning occurs in social settings/contexts for the purpose of individual and social adaptation (Glasser, 2009) where the interactions between participants are viewed as opportunities for meaningful learning (Wals and Noorduyn, 2010).

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 and 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 and Stirling, 2010). Group meetings centred on radio intervention programs can therefore offer farmers the opportunity for collective rather than individual recollection of adaptive practices communicated and promote interactions in which challenges and problems are shared and understandings and potential solutions are discussed and clarified. In this way farmers' co-learning about adaptation strategies in a social context

can increase the likelihood of appropriate and effective adaptation practices being implemented. Indeed social learning approaches have been successfully used in Africa with farmers in Uganda (Karubanga, Kibwika, Okry and Sseguya, 2017) Ghana (Taiwo and Asmah, 2012; Conley and Udry, 2010); Kenya (Kristjanson, Harvey, Van Epp, and Thornton, 2013) and Cameroon (Sonii, 2007) to name but a few examples.

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, central to Mezirow's adult learning theory, are discussed next under the following headings: critical assessment of beliefs and assumptions, critical reflection, and dialogue. This is followed by a discussion on the implications of Mezirow's 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 and Cranton, 1998). This process involves dialogue and usually occurs in a social setting with the intervention of a facilitator. 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 this interpretation is used to guide decision-making or action (Mezirow, 1990).

Critical reflection

Reflecting on prior learning is central to adult learning. Reflection involves individuals critically exploring their experiences to pave way for new understandings and appreciations (Mezirow, 1990). This requires the assessment of the assumptions implicit in beliefs, including beliefs on how to solve problems. Unlike reflection, 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 Turkana (Kenya) offers an example of how farmers can challenge their meaning perspectives. 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 and 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 speak dialects of the same language. 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 and Stirling, 2010, p. 221).

Using 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 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 emerges through 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 and Harvey, 2015, p.2)

In the Kilifi context, farmers can become co-inquirers with the climate change or agricultural experts or educators of the problem that needs solving or 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 can result 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 and 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. 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 and 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 *et al.*, 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 (Girard, 2003; FAO, 2011). These discussions may be facilitated by agricultural extension officers and require farmers to have close collaboration with radio producers. 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).

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 (refer to Dagon and Tufte, (2006) for a detailed description). 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 to 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.

Conclusion

This study has established that radio can effectively complement other agricultural extension methods and has the potential to engage farmers on climate change issues and motivate them to take action, if appropriate approaches are employed. This study revealed barriers to communicating climate change information through radio from a Kenyan-Kilifi County perspective. The major barriers expressed by farmers in the surveys and FGIs were low radio ownership, the planting season competing for their time to listen to the radio, poor radio signals, inappropriate timing of the programs, and the inability to store radio programs for future reference. 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 as possible ways of overcoming these challenges and limitations. 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. Having multiple listeners, and perhaps note takers, can enable the recall of information for the group that individuals may have missed or forgotten. Agricultural extension officers who sometimes provide support to farmers in groups should consider adjusting their work schedules in order to incorporate community listener clubs and radio schools. They could also provide farmers with technical advice regarding how to put their planned actions into practice. However, Kilifi County reported a significant number of farmers not belonging to groups (35%). It is therefore important that extension officers devise innovative ways of encouraging farmers to join or form groups for the purpose of social learning and easier access to extension officers.

Further research should be done to 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. Future research could also evaluate the sustainability and effectiveness of the adaptive practices that farmers reported to have implemented 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.

References

- Adger W.N., 2003. Social Aspects of adaptive capacity. In J.B. Smith, R.J.T. Klein, and S. Huq (Eds.), *Climate Change, Adaptive Capacity and Development*. (pp.29–49). London: Imperial College Press.
- [AFRI] African Farm Radio Research Initiative, 2008. *Communicating with Radio: What do We Know? Findings from selected rural radio effectiveness evaluations*. Retrieved August 25, 2017 from <https://publications.farmradio.org/communicating-radio-know-findings-selected-rural-radio-effectiveness-evaluations/>
- Anandajayasekeram P., Puskur R., Workneh S., Hoekstra D., 2008. *Concepts and practices in agricultural extension in developing countries: a source book*. Retrieved January 5, 2017 from <https://books.google.com.au/books?hl=en&lr=&id=ScVyEphv15EC&oi=fnd&pg=PR5&dq=Concepts+and+practices+in+agricultural+extension+in+developing+coun-tries:+a+source+book.&ots=A9lBfMznat&sig=HPWxFPagN6hojn1D-GruL9Z5rTx8#v=onepage&q=Concepts%20and%20practices%20in%20agricultural%20extension%20in%20developing%20countries%3A%20a%20-source%20book.&f=false>
- Antwi-Agyei P., Dougill A. J., and Stringer L. C., 2014. Barriers to climate change adaptation: Evidence from Northeast Ghana in the context of

- a systematic literature review. *Climate and Development*, 1-14. doi: 10.1080/17565529.2014.951013
- Bakshi S., and Jha J., 2013. Interactive Radio/Audio Interventions in Elementary Schools in Karnataka, India: A Policy Simulation Exercise. Retrieved March 2, 2017 from http://gdn.int/admin/uploads/editor/files/GDN_PEMRP_CBPS_PS_Education.pdf
- Barrett C. B., Carter M. R., Chantarat S., McPeak J., and Mude, A., 2008. Altering poverty dynamics with index insurance: northern Kenya's HSNP+. Retrieved March 2, 2017 from <https://cgspace.cgiar.org/handle/10568/782>
- BBC World Service Trust, 2010. Africa talks climate: The public understanding of climate change in ten countries. Retrieved May 11, 2016 from www.africatalksclimate.com
- Berman S. D., 2008. The Return of Educational Radio? *The International Review of Research in Open and Distributed Learning*, 9(2). Retrieved June 15, 2016 from <http://www.irrodl.org/index.php/irrodl/article/view/563/1038>
- Bordenave J., 1977. Communication and rural development. Retrieved June 18, 2014 from <http://eric.ed.gov/?id=ED144158>
- Boykoff M.T. and Roberts J.T., 2007. Media Coverage of Climate Change: Current Trends, Strengths, Weaknesses. (Human development report, 2008, 3). Retrieved March 2, 2017 from <http://hdr.undp.org/en/content/media-coverage-climate-change>
- Brownhill L., Njuguna E. M., Bothi K. L., Pelletier B., Muhammad L. W., and Hickey G. M., 2016. Food security, gender and resilience: Improving smallholder and subsistence farming. doi:10.4324/9781315745855
- Carter M. R., Barrett C. B., Boucher S., Chantarat, S., Galarza F., McPeak J., Trivelli C., 2008. Insuring the never before insured: explaining index insurance through financial education games. Retrieved September 12, 2016 from <https://cgspace.cgiar.org/handle/10568/765>
- Centers for Disease Control and Prevention, 2008. A guide to conducting household surveys for Water Safety Plans. Retrieved March 2, 2017 from <http://search.cdc.gov/search?query=A+guide+to+conducting+household+surveys+for+Water+Safety+Plans&utf8=%E2%9C%93&affiliate=cdc-main>
- Cerquiera M.T., Casanueva E., Ferrer A.M., Fontanot G., Chavey A., and Flores R., 1979. A comparison of mass media techniques and a direct method for nutrition education in rural Mexico. *Journal of Nutrition Education*, 11(2), 133-137. [http://dx.doi.org/10.1016/S0022-3182\(79\)80127-2](http://dx.doi.org/10.1016/S0022-3182(79)80127-2)
- Chapman R., Blench R., Kranjac-Berisavljevic G., & Zakariah A., 2003. Rural radio in agricultural extension: The example of vernacular radio programmes on soil and water conservation in N. Ghana. Retrieved January 15, 2015 from <https://www.odi.org/publications/4200-agricultural-research-extension-network-agren-papers>

- Chess C. and Johnson B. B., 2007. Information is not enough. In S. Moser, and Dilling, L (Eds.). *Creating a climate for change*. (pp. 223-233). Cambridge: Cambridge University Press.
- Collins K., and Ison R., 2009. Jumping off Arnstein's ladder: Social learning as a new policy paradigm for climate change adaptation. *Environmental Policy and Governance*, 19(6), 358-373. doi:10.1002/eet.523
- Conley T. G., and Udry C. R., 2010. Learning about a new technology: Pineapple in Ghana. *The American Economic Review*, 100(1), 35-69. doi:10.1257/aer.100.1.35
- Creswell J. W., and Plano Clark V. L., 2011. *Designing and conducting mixed methods research*. Los Angeles: SAGE.
- Creswell J.W., 2012. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Boston: Pearson education, Inc
- Dagron A. G., and Tufte T. (Eds.), 2006. *Communication for social change anthology: Historical and contemporary readings*. New Jersey: CFSC Consortium, Inc.
- Ensor J., and Harvey B., 2015. Social learning and climate change adaptation: Evidence for international development practice. *Wiley Interdisciplinary Reviews: Climate Change*, 6(5), 509-522. doi:10.1002/wcc.348
- [FAO] Food and Agriculture Organization. (2011). *Community Listener Clubs: Stepping stones for action in rural areas*. Retrieved February 8, 2016 from <http://www.fao.org/docrep/014/am604e/am604e00.htm>
- FAO, 2006. *Report of the sensitization workshop on rural radio for policy and decision makers in East and Southern Africa*. Retrieved June 20, 2017 from <ftp://ftp.fao.org/docrep/fao/009/a0483e/a0483e00.pdf>
- Federer N. L., 2015. *The use of oral history and narrative research in broadening the historical foundation of the agricultural communication field* (Doctoral dissertation, Purdue University). Retrieved September 15, 2017 from http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1311&context=open_access_dissertations
- Ferraro G., and Andreatta S., 2011. *Cultural anthropology: An applied perspective*. Retrieved January 13, 2016 from <https://books.google.com.au/books?id=m-caiAgAAQBAJ&pg=PA172&lpg=PA172&dq=Ferraro+%26+Andreatta+maasai+kenya&source=bl&ots=AdbbMm6MoY&sig=Kl1yQs-rWgQqbQTnzVg6KvxKN6GY&hl=en&sa=X&ved=0ahUKEwiSmuehgaTOAhXGepQKHQOPCJYQ6AEIHTAA#v=onepage&q=Ferraro%20%26%20Andreatta%20maasai%20kenya&f=false>
- Figueiredo P., and Perkins P. E., 2013. Women and water management in times of climate change: Participatory and inclusive processes. *Journal of Cleaner*

- Production, 60, 188-194. doi:10.1016/j.jclepro.2012.02.025
- Fleming A., Vanclay F., Hiller C., and Wilson S., 2014. Challenging dominant discourses of climate change. *Climatic Change*, 127(3), 407-418. doi:10.1007/s10584-014-1268-z
- Gifford R., 2011. The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist*, 66(4), 290-302. doi:http://dx.doi.org/10.1037/a0023566
- Girard B. (Ed.), 2003. The one to watch: Radio, new ICTs and interactivity. Retrieved May 20, 2015 from <http://www.fao.org/docrep/006/Y4721E/y4721e00.htm#Contents>
- Glasser H., 2009. Minding the gap: The role of social learning in linking our stated desire for a more sustainable world to our everyday actions and principles. In Wals, A. E. J.(Eds) *Social learning towards a sustainable world*. Netherlands: Wageningen Academic Publishers.
- Gray D. E., 2014. *Doing research in the real world (Vol. Third)*. Los Angeles, California: SAGE.
- [IFAD] International Fund for Agricultural Development. (2008). Climate change and the future of smallholder agriculture: How can rural poor people be part of the solution to climate change. Retrieved February 8, 2016 from <http://www.ifad.org/climate/roundtable/index.htm>
- Ilboudo J.-P., 2003. After 50 years: The role and use of rural radio in Africa. Retrieved January 11, 2015 from <http://www.fao.org/docrep/006/Y4721E/y4721e00.htm#Contents>
- Ilboudo J.-P., and Castello R., 2003. Linking Rural Radio to new ICTs in Africa Bridging the rural digital divide. Retrieved from <http://www.fao.org/docrep/006/Y4721E/y4721e00.htm#Contents>
- Imhoof M., 1983. The use of Radio in Educational Development: Where are we now? Paper presented at the North-western University Program on Communication and Development research conference. Chicago, Illinois. Retrieved March 13, 2015 from http://pdf.usaid.gov/pdf_docs/PNAAQ885.pdf
- Intergovernmental Panel on Climate Change, 2014. *Climate Change 2014: Synthesis Report. (Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change)*. Retrieved February 26, 2014 from https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1
- Jaetzol R., and Schmidt H., 1983. *Farm management handbook of Kenya: Part C East Kenya (Eastern and Coast provinces)*. Nairobi: Ministry of Agriculture.
- Kamlongera C., 2001, February 19–22. Training needs for trainers in the field of rural radio in Africa. Paper presented at the International Workshop on Farm Radio Broadcasting. Rome, Italy. Retrieved September 12, 2017 from

- <http://www.fao.org/sd/2001/radio/country.html>
- Karubanga G., Kibwika P., Okry F., and Sseguya H., 2017. How farmer videos trigger social learning to enhance innovation among smallholder rice farmers in Uganda. *Cogent Food and Agriculture*, 3. <https://doi.org/10.1080/23311932.2017.1368105>
- Kenya National Bureau of Statistics, 2009. Retrieved April 2, 2014 from <https://www.opendata.go.ke/Population/Census-Volume-1-Question-1-Population-Households-a/wd27-eki2>
- Kenya National Bureau of Statistics and Society for International Development, 2013. Exploring Kenya's Inequality: Pulling apart or pooling together? Retrieved January 13, 2017 from <http://inequalities.sidint.net/kenya/wp-content/uploads/sites/3/2013/10/SID%20Abridged%20Small%20Version%20Final%20Download%20Report.pdf>
- [KCIDP] Kilifi County Integrated Development Plan, 2013. Kilifi County; First County Integrated Development Plan 2013-2017. Retrieved March 13, 2015 from <http://www.kilifi.go.ke/index.php?com=1#.V-nMzzVCx8E>
- Kristjanson P., Harvey B., Epp M. V., and Thornton P. K., 2014. Social learning and sustainable development. *Nature Climate Change*, 4(1), 5. doi:10.1038/nclimate2080
- Leeuwis C., and Van den Ban A. W., 2004. Communication for rural innovation - rethinking agricultural extension. Retrieved September 8, 2017 from <http://www.modares.ac.ir/uploads/Agr.Oth.Lib.8.pdf>
- Lobell D. B., Burke M. B., Tebaldi C., Mastrandrea M. D., Falcon W. P., and Naylor R. L., 2008. Prioritizing climate change adaptation needs for food security in 2030. *Science*, 319(5863), 607-610. doi:10.1126/science.1152339
- Lucas F. F. B., 1999. A radio broadcasting model for rural women and farm households. RAP Publication, 8. Retrieved February 8, 2016 from <http://www.fao.org/docrep/005/ac789e/ac789e00.HTM>
- Manyozo L., 2009. Mobilizing rural and community radio in Africa. *Ecquid novi*, 30(1), 1-23. Retrieved February 13, 2016 from <http://www.tandfonline.com/doi/abs/10.1080/02560054.2009.9653389>
- Markle D. T., West R. E., and Rich P. J., 2011. Beyond transcription: Technology, change and refinement of method. *Qualitative Social Research*, 12, (3). Retrieved August 4, 2015 from <http://www.qualitative-research.net/index.php/fqs/article/view/1564/3249>.
- Matha J., 2001, February 19–22. CIERRO's Experience in Rural Radio. Paper presented at the International Workshop on Farm Radio Broadcasting. Rome, Italy
- Merriam S. B., 2010. Third Update on Adult Learning Theory: New Directions for Adult and Continuing Education. Retrieved July 14, 2016 from <http://jcu>.

- eblib.com.au/patron/FullRecord.aspx?p=484888
- Mezirow J., 1990. How critical reflection triggers transformative learning. *Fostering critical reflection in adulthood*, 1, 20. Retrieved May 19, 2016 from <http://www.ln.edu.hk/osl/conference2011/output/breakout/4.4%20%5Bref%20How%20Critical%20Reflection%20triggers%20Transformative%20Learning%20-%20Mezirow.pdf>
- Mezirow J., 1991. *Transformative dimensions of adult learning*. San Francisco, U.S.A: Jossey-Bass Publishers.
- Minnie G., and Bussiek H., 2011. *On Air Kenya. Public broadcasting in Africa series*. Nairobi: Open Society Initiative for Eastern Africa. Retrieved February 18, 2015 from https://www.researchgate.net/publication/259369222_State_and_Future_of_Public_Broadcasting_in_Kenya
- Moser S. C., 2010. Communicating climate change: History, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change*, 1(1), 31-53. doi:10.1002/wcc.11
- Muchaba T., Mungai C., Atakos V., and Radeny M., 2016. Towards excellence in climate change and environmental reporting in Africa. Retrieved September 2, 2017 from <https://ccafs.cgiar.org/blog/towards-excellence-climate-change-and-environmental-reporting-africa#.WcPQxLjHIU>
- Mwaniki F., 2016. *Kenyan farmers' perceptions of and adaptations to climate change before and after a radio program intervention (Doctoral dissertation)*. Retrieved September 26, 2017 from <https://www.jcu.edu.au/library>
- Myers M., 2008. *Radio and development in Africa; A concept paper prepared for the international*. Retrieved January 18, 2017 from http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CB4QFjAA&url=http%3A%2F%2Fwww.amarc.org%2Fdocuments%2Fmanuals%2F12481943581Radio_and_Development_in_Africa%2C_a_concept_paper.pdf&ei=gNVFVaDIKKPTmAWjxIH0Aw&usg=AFQjCNEkyUSXqWsDCfkWAPB3S83Z-9NuFzw&bv=bv.92291466,d.dGY
- National Agricultural Sector Extension Policy, 2012. *Agricultural Sector Coordination Unit*, Nairobi: Government of Kenya. Retrieved March, 2 2017 from <https://www.kenyamarkets.org/wp-content/uploads/2016/06/National-Agricultural-Sector-Extension-2012.pdf>
- Nazari, M. R., and Hasbullah, A. H. (2010). *Radio as an Educational Media: Impact on Agricultural Development*. *The Journal of the South East Asia Research Centre* 2,13-20 file:///C:/Users/Fiona/Downloads/MhmdReza(SP)K13-20.pdf
- Nerlich B., Koteyko N., and Brown B., 2010. Theory and language of climate change communication. *Wiley Interdisciplinary Reviews: Climate Change*, 1(1), 97-

110. doi:10.1002/wcc.2
- Oakley P., and Garforth, C. (1985). Guide to extension training. Retrieved, August 29, 2017 from <http://www.fao.org/docrep/t0060e/T0060E00.htm#Contents>
- Obayelu O. A., Adepoju A. O., and Idowu T. (2014). Factors influencing farmers' choices of adaptation to climate change in Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development*, 108(1), 3-16. doi:10.12895/jaeid.20141.140
- Odame H. (2007). Communicating Agricultural Research in Africa: The New Role of Rural Radio. Retrieved July 15, 2017 from <http://www.cominit.com/global/content/communicating-agricultural-research-africa-new-role-rural-radio>
- Ofoegbu C., Chirwa P., Francis J., and Babalola F., 2017. Assessing vulnerability of rural communities to climate change: A review of implications for forest-based livelihoods in South Africa. *International Journal of Climate Change Strategies and Management*, 9(3), 374.
- Otene V. A., Okwu J. O., and Gwaza, S. S., 2015. Barriers to the use of radio as a channel of agricultural information by farmers in Ushongo local government area of Benue State, Nigeria. *Journal of Agricultural & Food Information*, 16(4), 326-336
- Pahl Wostl C., and Hare M., 2004. Processes of social learning in integrated resources management. *Journal of Community & Applied Social Psychology*, 14(3), 193-206. doi:10.1002/casp.774
- Patton, M. Q., 2002. *Qualitative research and evaluation methods* (Vol. 3rd). Thousand Oaks, Calif: Sage Publications.
- Pereira J., and Aherne M., 2008. Adult learning. In W. Delcan et al (Eds.). *Palative medicine* (pp.125-131). Philadelphia: Sanders
- Perez-Teran A.S., Tiani A. M., Touko-Tchoko M., and Tchatchou B., 2015. Testing the influence of radio programs on climate change knowledge: A pilot experience from the Congo Basin. Working Paper 173. Bogor, Indonesia: CIFOR.
- Portney K. E., 2014. Developing sustainable cities indicators. *Elgar Companion to Sustainable Cities: Strategies, Methods and Outlook*, 283. doi:10.4337/9780857939999.00020
- Purcell D., and Anderson J. R., 1997. *Agricultural extension and research: Achievements and problems in national systems*. Washington DC, U.S.A: World Bank Publications.
- Rao S., 2015. Using radio in agricultural extension. Note 18. GFRAS Good practice notes for extension and advisory services. GFRAS: Lindau, Switzerland. Retrieved from <http://www.g-fras.org/en/good-practice-notes/using-radio-in-agricultural-extension.html>
- Reagan T., 2000. Non Western educational traditions: Alternative approaches to

- educational thought and practice. (2nd Ed.). New jersey. U.S.A: Lawrence Erlbaum associates.
- Rivera W., Quamar M., and Crowder L., 2001. *Agricultural and rural extension worldwide: Options for institutional reform in the developing countries.* Rome: Food and Agriculture Organisation.
- Scott W. and Gough S., 2003. *Sustainable development and learning: Framing the issues.* London: Routledge Falmer
- Sokol A. V., and Cranton P., 1998. Transforming, Not Training. *Adult Learning*, 9(3), 14-16. Retrieved January 13, 2016 from <http://eric.ed.gov/?id=EJ564849>
- Soniia D., 2007. Learning to think for ourselves: Knowledge improvement and social benefits among farmer field school participants in Cameroon. *Learning*, 14(2), 35-50.
- Stevenson R.B., and Stirling C., 2010. Environmental learning and agency in diverse educational and cultural contexts. In R.B. Stevenson and J. Dillon (Eds.), *Engaging environmental education: Learning, culture and agency* (pp. 219-237). Netherlands, Sense Publishers
- Sullivan B., 2011. The new age of radio: How ICTs are changing rural radio in Africa. Retrieved February 18, 2017 from <http://www.farmradio.org/wp-content/uploads/farmradioictreport20111.pdf>
- Sweeney W. O., and Parlato M. B., 1982. *Using radio for primary health care.* Washington, D.C.: American Public Health Association.
- Taiwo O., and Asmah E., 2012. Extending the learning community: Rural radio, social learning and farm productivity in Ghana. Retrieved August 4, 2017 from <https://www.brookings.edu/research/extending-the-learning-community-rural-radio-social-learning-and-farm-productivity-in-ghana/>
- Tesfaye W., and Seifu L., 2016. Climate change perception and choice of adaptation strategies: Empirical evidence from smallholder farmers in east Ethiopia. *International Journal of Climate Change Strategies and Management*, 8(2), 253-270. doi: 10.1108/IJCCSM-01-2014-0017
- Tobey J., Rubinoff P., Robadue D., Ricci G., Volke R., Furlow J., Anderson G., 2010. Practicing coastal adaptation to climate change: Lessons from integrated coastal management. *Coastal Management*, 38(3), 317-335
- UNESCO, 2014. *International assistance from the intangible cultural heritage fund.* Retrieved March 2, 2017 from <http://www.unesco.org/culture/ich/en/USL/traditions-and-practices-associated-with-the-kayas-in-the-sacred-forests-of-the-mijikenda-00313>
- Wals A. E. J. and Leij T., 2009. Minding the gap: The role of social learning in liking our stated desire for a more sustainable world to our everyday actions and principles. In Wals, A. E. J.(Eds) *Social learning towards a sustainable world.* Netherlands: Wageningen Academic Publishers.

- Wals A., and Noorduyn L., 2010. Social learning in action: A reconstruction of an urban community moving towards sustainability. In R.B. Stevenson and J. Dillon (Eds.), *Engaging environmental education: Learning, culture and agency* (pp. 219-237). Netherlands, Sense Publishers
- Weber E. U., and Stern P. C., 2011. Public understanding of climate change in the United States. *American Psychologist*, 66(4), 315-328. doi:10.1037/a0023253
- Wibeck V., 2014. Enhancing learning, communication and public engagement about climate change - some lessons from recent literature. *Environmental Education Research*, 20(3), 387-411. doi:10.1080/13504622.2013.812720
- Zossou E., Vodouhe D. S., Van Mele P., Agboh-Noameshie A. R., and Lebailly P., 2015. Linking local rice processors' access to rural radio, gender, and livelihoods in Benin. *Development in Practice*, 25(7), 1057-1066. doi:10.1080/09614524.2015.1069261

Appendix

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 or from an iron sheet - harvesting water from rock catchments -digging dams	-MoA extension officer	2, 5 & 9 July 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

Appendix continued

		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 climate change	-planting drought tolerant cassava varieties such as “Tajirika”, “Nzalauka”, “Shishibe”, “Siri” bred by KALRO -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	-KALRO	31 July, 4 & 7 August 13 & 18 September

Appendix continued

NO	TOPIC	SUMMARY OF CONTENT	EXPERTS	DATES AIRED 2014
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