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LIST OF ACRONYMS

AGRITEX	Agricultural Technical & Extension Services
ATPS	African Technology Policy Studies Network
BAZ	Broadcasting Authority of Zimbabwe
CCAI	Climate Change Awareness Index
CIDA	Canadian International Development Agency
ComDev	Communication for Development
CSAG	Climatic Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
DFID	Department for International Development (UK)
DGIS	Directorate General for International Co-operation (Netherlands)
DSS	Decision Support Systems
DVD	Digital video disc player
EMA	Environment Management Agency
FEWSNET	Famine Early Warning System
GDP	Gross Domestic Product
GIS	Geographic Information System
ICT4D	Information and Communication Technology for Development
IPCC	Intergovernmental Panel on Climate Change
IS	Information System
LMWS	Last Mile Warning System
MIS	Market Information System
NCCC	National Climate Change Committee
NCCRS	National Climate Change Response Strategy
NEWU	National Early Warning Unit
NRF	National Research Foundation
NTT	National Task Team on Climate Change
PDA	Personal Digital Assistant
PNS	Post Normal Science
POTRAZ	Postal and Telecommunications Authority of Zimbabwe
PROVIA	Programme of Research on Climate Change Vulnerability, Impacts and Adaptation
PRSP	Poverty Reduction Strategy papers

SARCOF	Southern African Regional Climate Outlook Forum
SDC	Swiss Agency for Development and Cooperation
SL	Sustainable Livelihoods
SSA	Sub-Saharan Africa
TV	Television
UN/GARDRR	The United Nations Global Assessment Report on Disaster Risk Reduction
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VCR	Video cassette recorder
ZIMVAC	Zimbabwe Vulnerability Assessment Committee
ZMC	Zimbabwe Media Commission

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

This study focuses on the contribution of information and communication technologies (ICTs) to climate change adaptation amongst communal farmers in Zimbabwe. The study was conducted in two rural districts in Mashonaland East province namely: Seke and Murewa. In rural areas such as Seke and Murewa, the majority of the population depend on agriculture for survival. Agriculture is the backbone of the country's economy (Chamboko, 2007:42). Regrettably, agriculture is highly dependent on climate and weather patterns. The United Nations Framework Convention on Climate Change (UNFCCC, 2007:18) observed that many areas in Africa have climates that are among the most variable in the world on both the seasonal and decadal time scales. The vulnerability of the continent to climate variability and climate change is aggravated by the interaction of 'multiple stresses' which occur at various levels (Boko et al. 2007:435). Moreover, these impacts are worsened by the continent's generally low adaptive capacity (ibid). The Intergovernmental Panel on Climate Change (IPCC, 2007:6) defined climate change as any change in climate over time, whether due to natural variability or as a result of human activity.

Even though climate change has been projected to have both positive and negative impacts in different parts of the world, the projections for the African continent seem to suggest that the negative impacts are likely to outweigh any likely positive impacts. Christensen et al. (2007:850) asserts that the African continent is likely to experience warming that is larger than the global annual average. In addition, rainfall in Southern Africa is likely to decrease mainly in the winter rainfall region and western margins, while in East Africa there is likely to be an increase (ibid). Cooper et al. (2008:25) notes that whilst the exact nature and extent of the impacts of climate change on temperature and rainfall distribution patterns remain uncertain, it is the poor and vulnerable who will be the most prone to climate change. Admittedly, it is the poor particularly those from rural areas such as Seke and Murewa who are mainly dependant on agriculture.

The UNFCCC (2007:18) highlighted that agricultural production on the continent relies mainly on rainfall. As such, any disruption in rainfall pattern and intensity will negatively

affect the poor, particularly the smallholder farmers (ibid). The United Nations Global Assessment Report on Disaster Risk Reduction (UN/GARDRR, 2009:13) observes that rural farm-based livelihoods in Africa are generally low input and low output agriculture operations. This is due to constrained access to productive assets such as land, labour, fertilizers, irrigation facilities, infrastructure and financial services. Other limitations include lack of opportunities for processing and adding value to agricultural production due to asset constraints, and lack of access to international markets, which is exacerbated by trade barriers (ibid). Climate change is likely to (if not already) compound the problems that smallholder farmers face. As a result of climate change, agricultural seasons are most likely to be shorter and much agricultural land will be lost, with negative implications on agricultural output (UNFCCC, 2007:18). This is particularly true for those communities in sub-Saharan Africa that rely largely or totally on rain-fed agriculture or pastoralism for their livelihoods (Cooper et al. 2008:25).

Although farmers have developed several adaptation options to cope with current climate variability, such adaptation measures may not be sufficient for future changes in the climate (Boko et al. 2007:435). Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which involve changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (IPCC, 2001:879; Adger, Arnell, and Tompkins, 2005:78; IPCC, 2007:6). In other words, adaptation refers to all those responses to climate change that may be used to reduce vulnerability (Burton, Smith, and Lenhart, 1998:5-2). Adapting to climate change involves cascading decisions and involves various actions (Adger, Arnell, and Tompkins, 2005:79). These actions include building adaptive capacity through communicating climate change information, building awareness of potential impacts, maintaining well-being, protecting property, maintaining economic growth, and exploiting new opportunities (ibid).

The World Resources Institute (WRI) in collaboration with the United Nations Environment Programme (UNEP) and World Bank (WRI et al. 2011:16-17) identified five key elements in climate change decision making. The five elements are: (i) public engagement, (ii) decision making-relevant information, (iii) institutional design, (iv) tools for planning and policymaking and (v) resources. While all these elements are relevant to climate change

adaptation, it is public engagement and decision making-relevant information that are more important in the context of this study. Public understanding of risks and solutions is essential as it helps in defining adaptation needs and leads to better outcomes (ibid). The UNFCCC (2007:14) highlights that effective vulnerability and adaptation assessments to climate change does not solely rely on climate data, equally important but currently lacking, is accurate socio-economic data. In this context, the United Nations Environment Programme (UNEP), through its Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (UNEP-PROVIA, 2013:10) called for more studies on communication, participation and capacity building of local communities and institutions in responding to climate.

This study incorporates socio-economic analysis in exploring the contribution of ICTs to climate change adaptation in the agricultural sector. Adaptation in the agricultural sector is broad. It includes adaptation by farmers, by farm suppliers, by consumers of farm products, by agricultural policy makers and other stakeholders in the agricultural system (Burton, Smith, and Lenhart, 1998:5-7). As alluded to before, this study focuses on adaptation by rural communal farmers in Seke and Murewa districts. The study takes a multi-disciplinary approach, combining different aspects from a number of disciplines that include community informatics; agricultural informatics; communication for development; innovation and technology adoption; climate change and agriculture.

Community informatics focuses on the relationship between the design of ICTs and local communities, and the implementation of ICT projects in local communities (Stillman and Linger, 2009:255). Related to community informatics is agricultural informatics. Qaisar, Motasim, and Alam (2011:276) assert that agricultural informatics also referred to as e-agriculture is an emerging field. It aims to provide better agricultural services, enhanced technology dissemination, improved communication and information delivery and learning processes among relevant actors in agriculture through the advances in ICTs (ibid). According to Acunzo (2009:6), the communication for development approach is a participatory approach that integrates the use of communication strategies, media and processes to enable people and institutions to share knowledge and information and reach consensus towards common action. Having introduced and discussed the background of the study, the next section focuses on the research problem.

1.2 RESEARCH PROBLEM

Though rural communities already have a better understanding of local climate patterns, and are accustomed to dealing with them, an important consequence of climate change is that the future climate will be less familiar, more uncertain and, possibly, more extreme (World Bank, 2012a:5). At the same time, it is not certain that individuals will have the incentive, resources, knowledge and skills to adjust and adapt appropriately (Frankhauser, Smith and Tol, 1999:68). The uncertainty about climate change itself is further worsened by the uncertainty in terms of how individuals and communities would respond.

In order for rural people to adapt to and mitigate climate change, they need information and knowledge on various aspects of climate change. This includes information on the causes and effects of climate change and ways of responding to it. Climate change is an environmental risk that is often not well understood by the public (Etkin and Ho, 2007:625). In that context, Kempton (1997:14) questions, how do people form opinions on climate change if they lack detailed knowledge about it? This implies that how people understand and perceive the risk has an important bearing on how they respond. For instance, Grothmann and Patt (2005:205) highlight that cognition of an individual always depends on the socio-physical context and the social discourse. People's perceptions of risk or adaptive capacity to climate change are influenced and shaped by what they hear about climate change in the media, from friends, colleagues, neighbours, or public agencies (ibid).

Ngigi (2009:110) notes that farmers' capacity to adapt to climate change can be strengthened by awareness creation through educating farmers with tested and proven methods, and dissemination of climate change information. The importance of information and knowledge in dealing with the climate change challenge was also highlighted by Acunzo who asserted that:

> Climate change implies new challenges for research and technology development as well as knowledge and information exchange … Enhancing rural knowledge institutions to adequately generate knowledge and information related to these new challenges, and then share this with the affected people is, therefore, a strategic path for reducing vulnerability to climate change (Acunzo, 2009:5).

Indeed, farmers' ability to perceive climate change is a key precondition for their choice to adapt (Gbetibouo, 2008:1). In principle, the awareness and adaptation capacity of rural households can be enhanced by access to information. Thus, communication and information about the problem, solutions and their implications are continuously needed aspects of the adaptation process (Moser and Ekstrom, 2010:4). Raising awareness and communicating the need to adapt to climate change is crucial, especially, in marginal areas with a large adaptation deficit (World Bank, 2012a:6).

Farmers can access agricultural related information from several sources that include mass media, their own observation, farmer-to-farmer exchange, and agricultural extension services. From these sources, agricultural extension services play an important role in availing information to communal farmers in rural areas such as Seke and Murewa. In Zimbabwe, the Department of Agricultural Technical & Extension Services (AGRITEX) is mandated to provide information, training and extension services to farmers (EMA, 2010a:19). Extension services are defined as a non-formal educational function that involve the dissemination of information and advice with the intention of promoting knowledge, attitudes, skills and aspirations (Rivera and Qamar, 2003:7). Extension services that seek to address climate change adaptation might include disseminating drought-resistant crop varieties and cultivars, teaching improved management systems, gathering and disseminating adaptation information (Nelson et al. 2009:viii).

In many developing countries like Zimbabwe, the agricultural extension services system is usually not effective and efficient. Importantly, the dominant donor supported training and visit extension approach has not been very successful in delivering appropriate content and learning methods (Richardson, 2003:8; Feder, Willett and Zijp, 1999:17). In most instances, the decline of public extension services has been due to inadequate financial and human resources, coupled with poor infrastructure (Ngigi, 2009:124). Alternatively, there have been calls to complement the traditional agricultural extension services system with the use of information and communication technologies (ICTs). These can enable new practices and processes in support of belief formation, action formation, and outcome assessment (Melville, 2010:14). Qaisar, Motasim and Alam (2011:276) claim that a new concept 'agricultural informatics' has arisen following the rapid development in ICTs. It aims to provide better agricultural services, enhanced technology dissemination, improved communication and

information delivery and learning processes among relevant actors in agriculture through use of ICTs (ibid).

ICTs have become effective time and space control systems which African farmers and entrepreneurs can adopt to create new paths to efficiency, savings and profit making (Kyem, 2012:232). This places ICTs at the centre of communication strategies particularly to reach geographically dispersed rural farmers. The increased attention on ICTs has been due to the recognition that without concerted effort to ensure greater information equity, current information asymmetries could be heightened (Chapman et al. 2003:1). Moreover, Ospina (n.d.:1) reports that ICTs are enabling technologies that offer a still untapped potential to strengthen community resilience to climate change. ICTs can play an important role as a medium of information and communication in climate change awareness, adaptation and mitigation strategies. This study therefore aimed to explore how ICTs contribute to climate change awareness and adaptation amongst communal farmers in the Seke and Murewa Districts of Zimbabwe. The next section presents the research questions and objectives, followed by the justification of the study.

1.3 RESEARCH QUESTIONS

The study intends to answer the overarching question: To what extent and how are communal farmers in Seke and Murewa Districts utilising ICTs in addressing climate change? The question was answered by responding to the following three sub-questions:

1. What information and communication technologies are available and used by communal farming households in Seke and Murewa districts of Zimbabwe?
2. How do the available information and communication technologies influence climate change awareness of communal farmers in Seke and Murewa districts?
3. What is the contribution of information and communication technologies to climate change adaptation amongst communal farmers in Seke and Murewa districts of Zimbabwe?

1.4 OBJECTIVES

The main objective of the study was to analyse the contribution of information and communication technologies in addressing climate change amongst communal farmers of Seke and Murewa districts of Zimbabwe. The main objective was supported by the following sub-objectives:

1. To determine the level of access to and usage of information and communication technologies by communal farmers in Seke and Murewa districts of Zimbabwe
2. To evaluate how access to information and communication technologies influence climate change awareness of communal farmers in Seke and Murewa districts.
3. To investigate the contribution of information and communication technologies in climate change adaptation amongst communal farmers in Seke and Murewa districts of Zimbabwe.

1.5 JUSTIFICATION

Many authors have observed the lack of evidence on how ICTs are contributing to development, especially, in rural and marginal areas like those in Seke and Murewa districts of Zimbabwe. There is dearth of ICT impact research in developing countries in general and Africa in particular. How are ICTs actually impacting upon poor people's economic and social livelihoods, how is current information poverty being addressed, and how are they transforming communities (Adam and Wood, 1999:317; O'Farrel et al. 1999; Gurstein, 2001:1; Thioune, 2003; Parmar, 2009:90). Likewise, the World Bank (2011) highlights the need to assess how ICTs contribute to agricultural development. The bank states:

> The excitement generated by ICTs as they spread throughout developing countries has often masked the fact that their contributions to agriculture are both rapidly evolving and poorly understood. It is too early to have a clear idea, supported by rigorous analysis, of how ICTs support agricultural development, and under what conditions (World Bank, 2011:6).

Besides the call to assess how ICTs are actually contributing to development and transformation of communities, there has been specific calls to assess how ICTs are or can

enhance climate change responses. For example, the International Telecommunication Union (ITU) (2008:1) pointed out that a shared understanding of the greatest opportunities that ICTs offer in climate change adaptation remains elusive. Similarly, Kalas and Finlay (2009:20) observe the insufficiency of awareness and understanding among development stakeholders about the benefit of ICTs in climate change programmes. Indeed, the linkages between ICTs and climate change adaptation have only begun to be explored in depth in the last two to three years (Akoh et al. 2011:149). Therefore, research efforts have to focus on how ICTs contribute to climate change adaptation. This is a new field of enquiry and there is still much to be explored, particularly, how best to communicate climate change information and adaptation strategies, how do new ICTs catalyse or hinder change, and what potential do they have (Hasan and Kazlauskas, 2009:160; Melville, 2010:11; Ospina and Heeks, 2010a:3; Akoh et al. 2011:13; Chaudhury et al. 2012:16; UNEP-PROVIA, 2013:11).

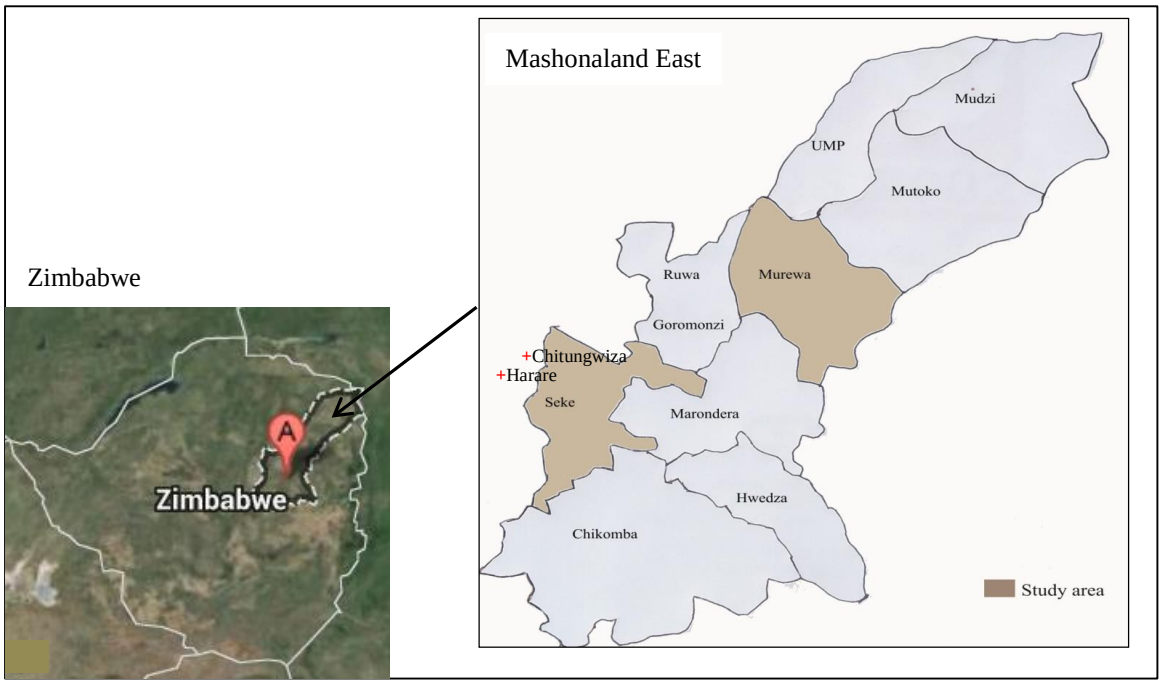
From the preceding discussion, it is evident that there is a huge research gap on how ICTs enhance agricultural development particularly in communal rural areas. More specific to this study, there is a gap in terms of how rural agricultural households adapt to climate change and in what ways ICTs assist them in adapting. Broadly, three research gaps have been identified. The first one is on climate change adaptation in general. The second gap is on how ICT enhance agricultural and rural development. The third gap is on the contribution of ICTs to climate change adaptation, specifically, among communal farmers. These gaps have neccessitated the need for this study. The next section describes the study area.

1.6 STUDY AREA

Zimbabwe has ten provinces, and from the ten provinces, one province, Mashonaland East was selected. The geographic coordinates of Mashonaland East province are: latitude: 18° 59' 06" S and longitude: 31° 03' 00" E (Collins Maps, 2013). The map of the study area is presented in Figure 1-1. In 2002, Zimbabwe had a total population of about 11 634 663 people, and Mashonaland East province had a total population of about 1 127 413 people and 309 198 households (CSO, 2004:3). About 90 percent of the population resided in rural areas. The province has 11 districts namely: Chikomba, Goromonzi, Hwedza, Marondera, Mudzi, Murewa, Mutoko, Seke, UMP, Marondera (urban), and Ruwa (CSO, 2004:3-17). From the 11 districts, two districts were selected purposively and these are: Seke and Murewa districts.

The choice of the two districts was important in evaluating the effect of proximity to urban areas in terms of access to ICTs and climate change awareness in the agriculture sector. Seke district is close to the capital city, Harare. It is a distance of approximately twenty kilometres from Harare. On the other hand, Murewa district is far away from the major urban areas. It is approximately hundred kilometres from Harare. While other provinces have similar settings of both peri-urban and rural districts, Mashonaland East was deemed more appropriate because it has a peri-urban setting which is characterised by communal rural area. Other provinces have peri-urban settings characterised by large-scale commercial farming. The selection criterion of the study area is further explained in section 3.5.1 in Chapter 3. In Zimbabwe, places referred to as rural areas include the communal areas, small-scale commercial farms, large-scale commercial farms and the resettlement areas (Chamboko, 2007:42; ZimTrade, 2012). The focus of the study was on rural communal areas, whose people are mainly dependent on subsistence farming.

Figure 1-1: Mashonaland East Province map showing Seke and Murewa districts



Source: Google (2013) and CSO (2004:1).

It is important to briefly describe the climate and the type of agriculture practised in the area selected for this study. Zimbabwe's climate is mainly semi-arid, generally characterised by limited and unreliable rainfall patterns (Chagutah, 2010:3). The two districts have climates

associated with natural agro-ecological region II, with an average rainfall of 500-700 mm. The amount of rainfall varies across and within the districts, with some parts receiving adequate rainfall while other areas receive inadequate rainfall. The main agricultural activities in the two districts are horticulture (vegetables, peas, baby corn, tomatoes, onions, cucumbers, butternut, leaf vegetables, sweet potato, sweet corn); fruits (mangoes, guavas, bananas, wild fruits- *mazhanje*, *masau*); field crops (maize, millet, tobacco, rapoko, sorghum, ground nuts, round nuts); and livestock (cattle, sheep, goats, and poultry) (ZimTrade, 2012).

1.7 LIMITATIONS OF THE STUDY

One of the limitations of the study was the lack of a sampling frame at the district level, such that the sampling approach that was used actually limits the representativeness of the sample. An additional challenge relates to the respondents' perception of climate variables particularly in terms of recalling historical events such as the occurrence of droughts and violent storms. The other limitation relates to the evaluation of climate change awareness, in which various terms that relate to climate change (such as carbon dioxide) were difficult to translate into the local language. However, besides these limitations, measures were taken to ensure that the study was not affected by the limitations.

1.8 OUTLINE OF THE THESIS

The thesis has seven chapters, which are broken down as follows:

Chapter 1: Introduction

The chapter gives the background and the overall introduction to the whole study. This is followed by the research problem, research questions and objectives. The limitations and scope of the study are presented. The chapter brings to the fore the need for the study, looking at how other studies have focused on climate change adaptation and its linkage with access to and use of ICTs. It also explicates the study area. The gaps and the justification are also discussed. All these components help to link the study with other studies that have been undertaken in other parts of the world (and Zimbabwe in particular). Overall, the chapter outlines how the whole thesis is organised.

Chapter 2: Literature review

This chapter is organised into two broad sections, the first section focuses on the theoretical foundation, and the second section focuses on the empirical literature review. The first section lays an important theoretical foundation for the study, in which many theories and frameworks are discussed. The second section on the empirical literature review started by discussing climate change in general, and then focused on adaptation in the agricultural sector. Further, it looked at the ICTs literature, including discussing the role or potential role played by ICTs in climate change adaptation.

Chapter 3: Methodology

This chapter presents the methodology that was used in the study. The methodology covers issues that relate to the type of data that was collected, how it was collected, and how it was analysed. The chapter is organised as follows, first it discusses the research paradigms relevant to the study, followed by the design of the study. It outlines the design of the instruments and variables used. The analytical methods employed are also presented and discussed. Measures that were taken to ensure validity, reliability and ethical standards in the study are also highlighted.

Chapter 4: Descriptives on general farming system characteristics and access to ICTs

This chapter presents the general description of the study area and the descriptive statistics of the key variables. The descriptive results are presented in two main sections, the first section describes the general farming system characteristics and the second section dwells on access to ICTs in Seke and Murewa districts

Chapter 5: Socio-economic determinants of climate change awareness

This chapter is organised as follows: firstly, it gives descriptive analysis of climate change awareness, and secondly, it then gives the regression analysis of the socio-economic determinants of climate change awareness. It then gives a discussion of the results.

Chapter 6: Access to early warning and weather forecasting information

The chapter is organised as follows, firstly, it presents results on perceptions on climate variables and extremes (rainfall, temperature, droughts, violent storms, and floods). This is followed by results on access to and use of climate and weather forecasting information, whereby various sources of forecasting information and the important role of weather forecasting and climate information in farm decision-making is presented. Then a general discussion of the results is the provided and the conclusion.

Chapter 7: Summary of findings, conclusions and suggestions

This chapter presents the summary of the findings, overall conclusions, and suggestions based on the findings of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Doing literature review helps to demonstrate familiarity with the body of knowledge and establish credibility, as well as, showing how the current research project is linked to past research (Neuman, 2006:111). Moreover, the literature review helps integrate and summarise what is known in an area, learn from others and stimulate new ideas (ibid). In addition, the literature review shows what research has been done in the field, the research methods used, the results generated and what was done with the findings (du Plooy, 2009:64). Therefore, all empirical studies must be connected to literature to support the need for the study and situate it in terms of previous work (Rocco and Plakhotnik, 2009:120). This chapter is organised in two broad sections, the first section focuses on the theoretical foundation, and the second section focuses on the empirical literature review.

2.2 THEORATICAL FOUNDATION

This section focuses on the theoretical dimension of the study. The importance of theory as explained by Stacks and Salwen (2009:4) is that "theory organises and refines our ideas, like a map for exploring unexplored territories". In that view, this study is multidisciplinary and as such, it combines theories and frameworks from diverse but related fields of agriculture, environment, communication, and ICTs. The theoretical dimension section is organised as follows: firstly, it presents and discusses the Agricultural Knowledge and Information System (AKIS) and the Agricultural Innovation System (AIS) (section 2.3). Secondly, it presents and discusses the Cynefin Framework (section 2.4). Finally, it discusses theories and frameworks that are specific to ICTs namely, the Information and Communication Technology for Development (ICT4D) approach (section 2.5).

2.3 The Agricultural Knowledge and Information System, and the Agricultural Innovation System

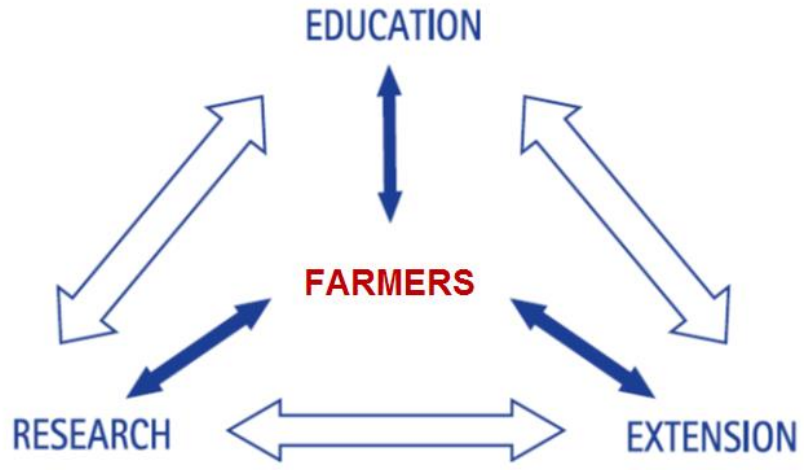
It is important to note that there are two main variations of the Agricultural Knowledge and Information System (AKIS) acronym in the literature. On one hand, AKIS refers to the

Agricultural Knowledge and Information System, while on the other hand, AKIS refers to the Agricultural Knowledge and Innovation System. The "I" in AKIS is used interchangeably in the literature to refer to either "information" or "innovation". It is worth noting that another commonly used acronym is AIS, which stands for Agricultural Innovation System. In fact, the variations of these terms are due to the different combinations of three aspects namely "knowledge, information, and innovation". The EU SCAR (2012:23) pointed out that the origin of these concepts started with the Agricultural Knowledge Systems (AKS) in the 1960s, which was replaced by the Agricultural Knowledge and Information Systems in the 1970s, and later transformed to Agricultural Knowledge and Innovation systems (ibid).

In order to avoid confusion, the acronym AKIS is used in this study, solely to refers to the Agricultural Knowledge and Information Systems (AKIS). As a corollary, the Agricultural Knowledge and Innovation System and the Agricultural Innovation System (AIS) are assumed to mean the same thing, hence, the acronym AIS. The AKIS which focuses on agricultural knowledge and information is discussed first, followed by the AIS which focuses on the broad agricultural innovation system in which knowledge and information are important sub-components.

The concept of AKIS combines agricultural research, extension, and education in one system and focuses on how the three activities generate new knowledge and information for farmers (Anandajayasekeram et al. 2009:35). The AKIS model is presented in Figure 2-1.

Figure 2-1: Agricultural Knowledge and Information System for Rural Development



Source: Rivera et al. (2005:5); Anandajayasekeram et al. (2009:35)

The AKIS links rural people and institutions to promote mutual learning and in generating, sharing and utilising agriculture-related technology, knowledge and information (FAO and the World Bank, 2000; Munyua and Stilwell, 2010:6). In addition, it provides both agricultural and non-agricultural knowledge and information which are necessary for promoting innovation in the diversified livelihoods of rural people (Rivera et al. 2005:v). According to the FAO and the World Bank (2000), the AKIS framework can help the rural people benefit more from agricultural research, extension and education programmes due to three issues. The first is the result of the changing relationships between governments and people due to economic liberalisation, democratisation and decentralisation. The second is the advance in ICTs, which provide an increased capacity for gathering, sharing and exploiting information. The third is that there are new concepts of learning and problem solving which include a range of participatory methods and tools (ibid). As highlighted previously it can be recognised that the AKIS and the AIS are closely related. The next paragraphs focus on the AIS.

Pant and Heeks (2011) discussed the importance of adopting an innovation systems perspective in understanding how ICTs enhance the capacity for climate change adaptation. They argue that climate change adaptation requires strategic application of creative thinking and innovative action (ibid). The Agricultural Innovation System (AIS) can be defined as:

> a set of agricultural organisations and/or persons, and the links and interactions between them, engaged in the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in agriculture (Röling and Engel, 1990:8; EU SCAR, 2012:23).

The three main building blocks of innovation systems including the AIS are: (i) knowledge and information flow, (ii) actors, networks, and institutions; and (iii) linkages between these entities (Malerba, 2002:2-3; Baskaran and Muchie, 2010). In general, the AIS works through both collaboration and competition in generating, diffusing and utilising knowledge and technology that has economic value within the agricultural sector (Sumberg, 2005:37; Anandajayasekeram, 2011:7). An AIS perspective provides a broad analytical framework with which to examine how knowledge is exchanged and how institutional and technological

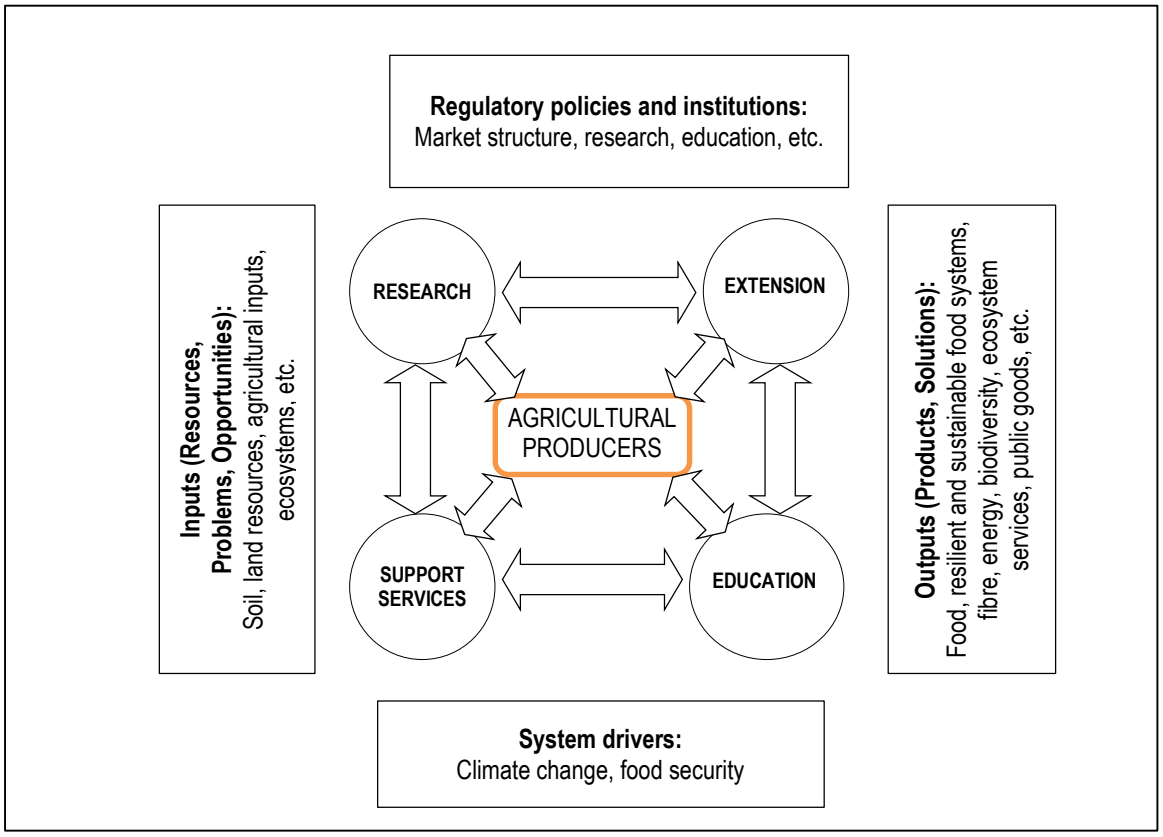
change occur in agriculture (Spielman et al. 2008:2; Dockès et al. 2011:5; Anandajayasekeram et al. 2009:88; Anandajayasekeram, 2011:8). Furthermore, an AIS framework shifts the analytical emphasis from a conventional linear model of knowledge and technology transfers to a more complex, process-based systems approach (Spielman et al. 2009:399).

Indeed, the innovation concept has not been widely applied to developing country context, particularly in agriculture and the rural sector (Hall et al. 2004:5; Spielman et al. 2008:8). Admittedly, Anandajayasekeram et al. (2009:80) claim that the adoption of the concept in the agricultural sector resulted from its successful application in the industrial sector. Nonetheless, its application in the agricultural sector has been noted to have some challenges. For example, Sumberg (2005:37-38) identified two key factors constraining the effectiveness of innovation, particularly, in many African countries. Firstly, the extent and nature of the relationships between the components are absent or highly bureaucratic and hierarchical, and secondly, the demand-side of the innovation system is absent, particularly, among poor and small-scale producers. In spite of these reservations, Spielman et al. (2009:399) observed that the application of the AIS concept so far suggests that opportunities exist for more intensive and extensive analysis.

Hall et al. (2004:9) cautioned that the promotion of the AIS concept does not necessarily imply the establishment of an administrative or bureaucratic form. Rather, it can and should be used as a policy tool to organise thinking on the analysis and understanding of how innovation can be promoted and how socio-economic change can be enhanced (ibid). The model of AIS is presented in Figure 2-2. The figure shows that within the AIS there is interaction between five components namely agricultural producers (farmers), research, extension, education, and support services. They use various inputs and resources to produce output or solve problems in the system. However, their interaction is influenced by system drivers. These are climate change and food security, and the regulatory and institutional framework, which can either incentivise or constrain their interaction towards promoting agricultural innovation or solving particular problems. Spielman et al. (2009:402) reports that the AIS framework requires an understanding of how individual and collective capabilities are strengthened, and how these capabilities are applied to agriculture. In this study, the key

issue is how farmers respond to climate change and ways in which ICTs assist them in those responses.

Figure 2-2: A model of Agricultural Innovation System



Source: Adapted from Rivera et al. (2005:6) by Dockès et al. (2011:9); EU SCAR (2012:26)

From the preceding discussion on AKIS and AIS, it can be noted that there was a general transition from a basic framework that combines knowledge and information to the broader innovation framework in which knowledge and information are important sub-components. This assessment provides two important observations. The first is the evolution of the concepts or frameworks from a narrow knowledge and information perspective to a broad innovation perspective. The second is that knowledge and information can be viewed as a subcomponent of the innovation framework. This implies that both frameworks are important and complementary rather than competing, particularly, in the context of this study. For this study, it can be argued that the AIS approach is the broad guiding framework, while the AKIS approach is a subsystem. The common aspects in all these frameworks are knowledge, information, and innovation. The next section discusses how knowledge and information

relating to complex issues such as climate change can be conceptualised using the Cynefin framework.

2.4 The Cynefin Framework

The Cynefin framework is an important framework that can help in understanding the climate change challenge. So far, research linking information systems research and climate change research is very limited. However, one of the pioneering works in this field is by Hasan and Kazlauskas (2009) who published an article titled "*Digital Ecosystems: ICT's contribution to addressing climate change*". In this article, Hasan and Kazlauskas (2009:157) suggested that different types of systemic problems require different levels of understanding and analysis as well as different types of solutions. In that context, they advocated the use of the Cynefin framework. Having discussed the rationale for adopting the Cynefin framework in this study, the next paragraphs explain and discuss the framework.

The Cynefin framework originated in the knowledge management field as a means of distinguishing between formal and informal communities, and relating the interaction of both with structured processes and uncertain conditions (Kurtz and Snowden, 2003:467). This framework has been defined as a holistic, sense-making framework that provides a perspective, language and conceptual lens that allows the characterisation of problems and the identification of suitable solutions (Kurtz and Snowden, 2003:468; Hasan and Kazlauskas, 2009:157). Snowden (2002:107) indicated that the Cynefin framework argues strongly against single or idealised models, rather it focuses on diversity as the key to adaptability. The detailed description of the Cynefin framework is given by Snowden (2002:103-107); Kurtz and Snowden (2003:467-470); and Hasan and Kazlauskas (2009:157-158). In brief, the Cynefin framework consists of five domains which reflect different relationships between cause and effect- two are ordered, two are unordered and one is the disorder (ibid).

According to Kurtz and Snowden (2003:467-470), the various domains are: (1) ordered domain with known causes and effects, (2) ordered domain with knowable causes and effects, (3) unordered domain with complex relationships, (4) un-ordered domain with chaos and (5) disorder domain. In the ordered domain with known causes and effects, the cause and effect

relationships are generally linear, empirical in nature and not open to dispute. In the ordered domain with knowable causes and effects, stable cause and effect relationships exist. However, they may not be fully known or only a limited group of people (experts) may know them. In the unordered domain with complex relationships, the cause and effect relationships exist although they are too complex to be established. Consequently, emergent patterns cannot be predicted but only perceived. In the unordered domain with chaos, the relationships between cause and effect are invisible and the system is turbulent. In the disorder domain, the relationship between cause and effect are not known, more precisely, it is a state of uncertainty about uncertainty (ibid).

Hasan and Kazlauskas (2009:158) asserted that wicked problems[1] such as climate change where the context is conceptualised as an ecosystem fall into the unordered Cynefin domains. In this case, solutions to climate change problems should rely on the detection and leveraging of emergent patterns rather than ordered pre-planning (ibid). In relation to climate change awareness and adaptation, when focusing at what is known, what is unknown, and what need to be known, it can be argued that these different aspects fit into different domains of the Cynefin framework. Climate change entails many cause and effect relationships, whereby the relationship between some variables, for instance, greenhouse gas emissions and global warming, have been clearly established and to some extent can belong to the ordered domains of the framework. On the other hand, there are a lot of uncertainties and unknowns, for example, how climate change impacts will manifest at the local level and how communities such as those in Seke and Murewa districts will respond to the impacts. It is such issues which make some aspects of climate change fit into the unordered and disorder domains.

So far the discussion has centred mainly on knowledge, information and uncertainty, these have a direct bearing on how people perceive, understand and respond to climate change. The focus of the study is to analyse the contribution of ICTs in addressing climate change amongst communal farmers. In that context, it is reasonable to look at the theoretical framework that is relevant to ICT access and use in rural areas such as the Seke and Murewa districts. The broad framework that is adopted is the Information and Communication Technology for Development (ICT4D) framework which is the focus of the next section.

[1] Wicked problems are problems that are ill-defined, with shifting definitions and multiple elements whose conflicting objectives necessitate resolution through a complex, holistic perspective (Rittel and Webber, 1975:160; Hasan and Kazlauskas, 2009:157)

2.5 Information and Communication Technology for Development (ICT4D) approach

The Information and Communication Technology for Development (ICT4D) approach is closely related to the Agricultural Knowledge and Information System (AKIS) and Agricultural Innovation System (AIS) that were discussed in section 2.3. The ICT4D field is an emerging and vibrant area of research and practice (Kleine and Unwin, 2009:1045) and it is highly multidisciplinary (Burrell and Toyama, 2009:84; Walsham, 2012:91). In simple terms, the main thrust of the ICT4D approach is to promote development through use and application of ICTs.

A number of authors have raised a number of issues that confront the ICT4D field. For instance, Raiti (2006:1) lists the epistemological shortcomings within ICT4D literature as follows: overly optimistic, highly Western, multidisciplinary while its authors are predominantly not multidisciplinary and atheoretical. Similarly, Parmar (2009:90) highlighted that there is no formal platform or framework with which to amalgamate the knowledge from the multiple disciplines. Consequently, attempts to clarify the theoretical basis of ICT4D have tended to be singular in their orientation (Heffernan, Lin and Thomson, 2012:2). In addition, Heeks (2006:1) observes that most of the ICT4D research being produced is descriptive rather than analytical. At times it lacks sufficient rigor or often is repetitive of earlier work. Moreover, the bulk of ICT4D discourse assumes that ICTs necessarily stimulate economic growth and combat poverty (Leye, 2009:30).

Despite these criticisms and drawbacks, the ICT4D conceptual framework is an important framework for this study. Admittedly, the ICT4D field has only recently seen a wider consideration of climate change issues (Finlay and Adera, 2012:9). This study looks at how rural people particularly farmers adapt to climate change and how ICTs contribute to their adaptation. Ospina, Heeks and Adera (2012:17) assert that emerging research at the intersection of climate change, ICTs and development indicates the existence of increasing linkages between use of ICT tools and efforts to mitigate, adapt, monitor and strategise in the face of climate change. Broadly, climate change has been noted to be a potential threat to development in general and agricultural dependent rural livelihoods in particular.

Accordingly, rural users need relevant, personalised information that enable them to make positive changes in their daily lives (Parmar, 2009:94).

If rural people are able to respond appropriately to climate change, it will make their livelihoods and development climate-resilient. In this context, the ICT4D approach is relevant. Heffernan, Lin and Thomson (2012:8) emphasise that in relation to knowledge-based ICT4D initiatives, the ultimate goal is to transfer information which will eventually support behavioural change. ICTs are envisaged to enhance the capacity of rural people particularly farmers to respond and adapt to climate change by availing climate and agricultural information and facilitating communication.

As highlighted in the previous paragraphs, there is not single theory in the ICT4D domain, rather, it is a combination of theories from various disciplines. Heeks (2006:2-3) categorised the ICT4D theories and frameworks as: theory-based, framework-based, model-based, schema-based, concept-based, category-based, and non-framework-based. In the same way, the impact assessment frameworks can also be categorised as: generic, discipline-specific, issue-specific and application-specific (Heeks and Molla, 2009), as shown in Table 2-1.

Table 2-1: ICT4D impact assessment frameworks

Type	**Sub-type**	**Focus**
Generic		Cost-benefit analysis
		Project goals
Discipline-specific	Communication Studies	Communication for Development
	Development studies	Capabilities
		Livelihoods Framework
	Information Science	Information Economics
		Information Needs/ Mapping
	Sociology	Cultural- Institutional
Issue-specific		Enterprise (Growth)
		Gender
Application specific		Telecentres

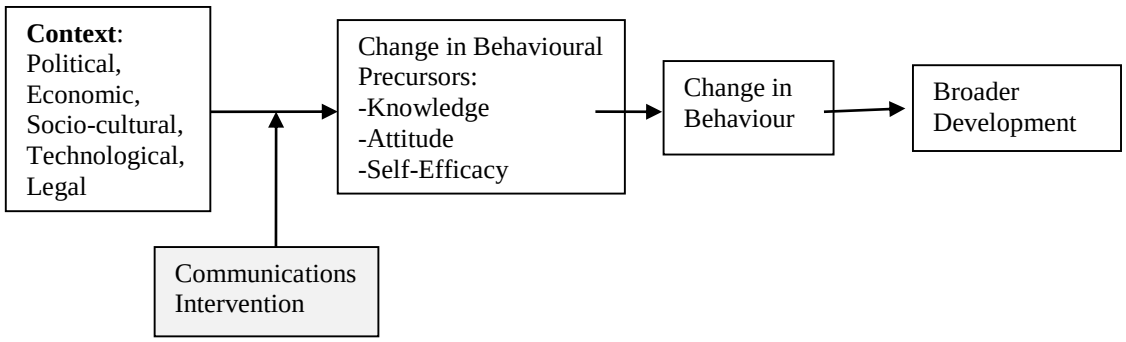
Source: Heeks and Molla (2009:7)

Table 2-1 presents the various frameworks classified according to type, sub-types and focus. There are four main framework types namely, generic, discipline-specific, issue-specific, and application-specific. Almost all the frameworks listed in the table are relevant. However, it is important to select the most appropriate framework to the theme of the study. Heffernan, Lin and Thomson (2012:3) proposed that any unifying framework for ICT4D should accommodate its three shared areas namely, development, delivery and communication. The use of multiple theories and frameworks is to ensure that they complement each other. To recap; this study aimed to analyse the contribution of ICTs in addressing climate change amongst communal farmers. From the various frameworks in the ICT4D domain, the following frameworks are more appropriate to this study: (i) the Communication for Development framework and (ii) Sustainable Livelihoods framework. The motivation for the adoption of each of the two frameworks is discussed in the next sub-sections, starting with the Communication for Development framework.

2.5.1 Communications for Development framework

The Communications for Development (C4D or ComDev) framework conceptualises the relationship between the information communicated by an ICT4D project and changes in development-related individual behaviour (Heeks and Molla, 2009:24). The ComDev approach emphasises the importance of communicating developmental information in addressing the complex dimensions of vulnerability. This includes communicating climate change information. The ComDev approach has been promoted by FAO and other development agencies. It combines participatory communication methods and processes with a variety of media and various ICTs, in responding to the knowledge and information needs of rural stakeholders, institutions and vulnerable groups (ibid). The Communication for Development model is presented in Figure 2-3. Bertrand et al. (2006:568) used a similar conceptual framework to evaluate how communication programs were expected to change HIV-risk behaviours. In this framework, Bertrand et al. noted that social, cultural, political, legal and economic factors often serve as obstacles to behaviour change, the mass media was expected to affect a series of psychosocial factors, including knowledge, attitudes and self-efficacy.

Figure 2-3: Communication for Development (C4D) model



Source: Heeks and Molla (2009:24) who adapted it from Bertrand et al. (2006:569)

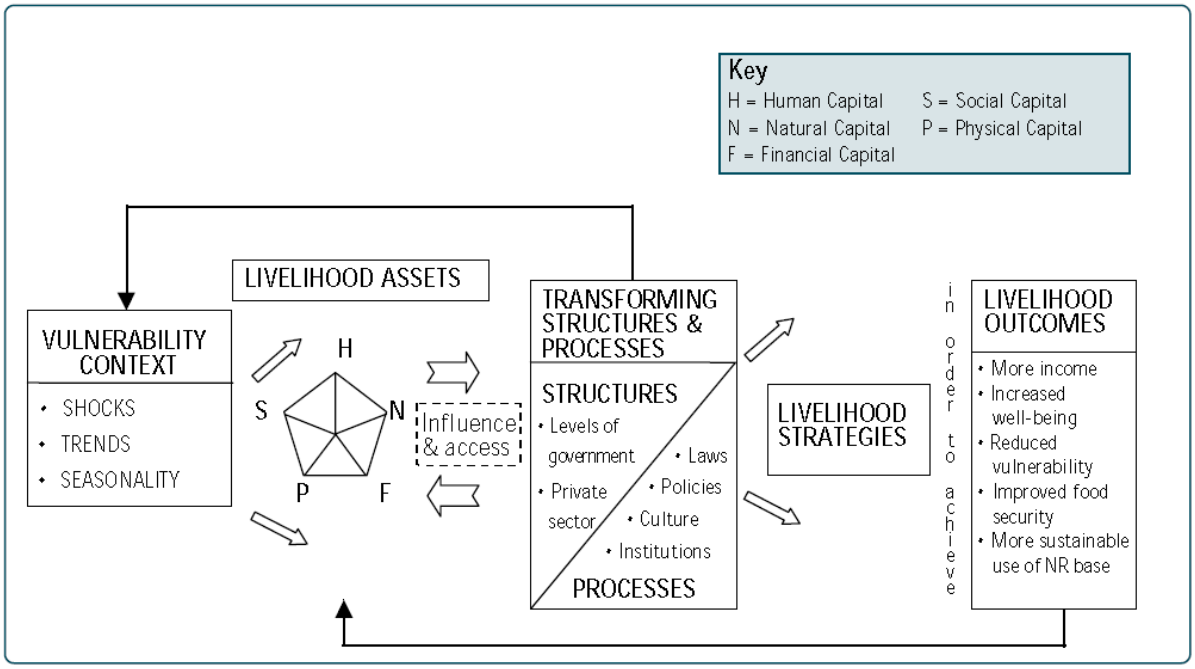
A communications for development assessment approach may thus investigate the presence or absence of those information and action resources, and the extent to which the ICT4D project has or has not helped develop those resources (Heeks & Molla, 2009:24). According to Danida (2005:3), the communication for development field is broad. Firstly, it comprises media support in the form of community media, media policy, media training and capacity building and media in conflict areas. Secondly, it includes communication strategies designed to empower and change behaviour in the field of health, livelihoods, agriculture, environment and other areas. Thirdly, it involves the exchange of information, knowledge, ideas and values among individuals and communities. Fourth, it uses the media to reach large audiences and affect public opinion, while also using advocacy to influence policy-makers and opinion leaders. Fifth, it uses communication and ICT strategies to foster mutual understanding and dialogue among different groups (ibid). The next paragraphs focus on the Sustainable Livelihoods Approach (SLA).

2.5.2 Sustainable Livelihoods Approach

The Sustainable Livelihoods Approach (SLA) is a useful tool in the assessment of ICT-related issues as it helps to think about the technologies in a more "bottom-up" way (Parkinson and Ramirez, 2006). The SL framework is presented diagrammatically in Figure 2-4. The SL framework has at its core, livelihood assets, which are comprised of five different types of capitals namely, human, social, financial, physical, and natural (DFID, 1999:5; Heeks and Molla, 2009:41). The livelihood strategies that are used by individuals,

households or communities are dependent on their livelihood assets, the vulnerability context and the transforming structures and processes which result in specific livelihood outcomes.

Figure 2-4: Sustainable Livelihoods Framework



Source: DFID (1999:1)

The SLA has increasingly been integrated into ICT4D research. For example, Duncombe (2006) used the SLA to study ICT applications for poverty reduction and micro-enterprise in Botswana. In the same way, Sife et al. (2010) employed the SLA to study the contribution of mobile phones to rural livelihoods in Morogoro region of Tanzania. According to Duncombe (2006:6) information has a dual role within the framework. Firstly, it plays an *analytical* role, which focuses on how data is accessed, assessed, and applied to understand livelihoods. Secondly, it plays a *functional* role, which focuses on how the information is used to create favourable livelihood outcomes (ibid).

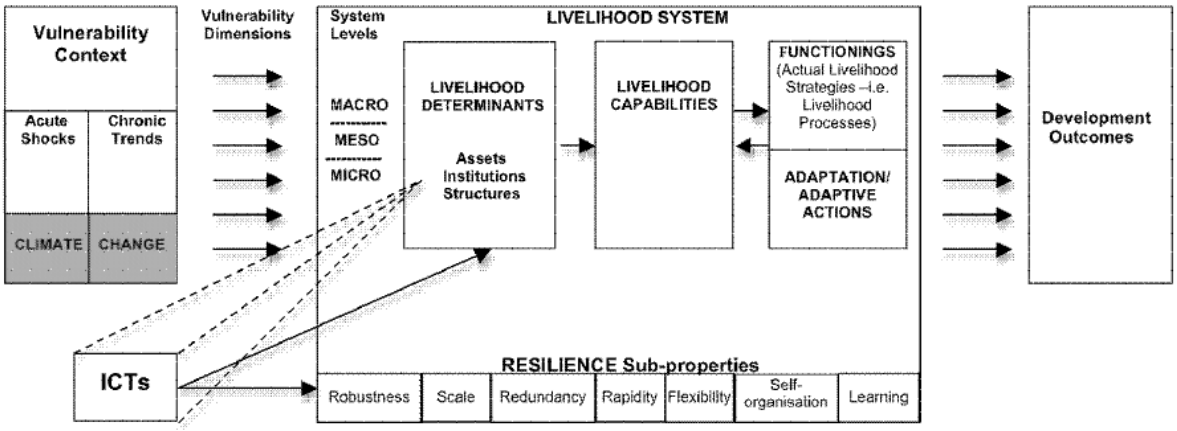
The SLA rose to ascendancy in the late 1990s and early 2000s (Heffernan, Lin, and Thomson, 2012:5). However, in recent years the SLA framework has increasingly become unpopular, partly due its failure to incorporate elements important to adoption or diffusion (ibid). Equally, Ospina, Heeks and Adera (2012:25) highlight that while the SLA provides the basis for a system-based approach to the linkages between vulnerability, adaptive capacity

and development outcomes, it fails to recognise the role of "digital capital" as part of the asset base of livelihood systems. Due to some of these shortcomings, an alternative framework called e-Resilience framework was proposed and is the focus of the next subsection.

2.5.3 e-Resilience Framework

The 'e-Resilience Framework' was developed by Ospina and Heeks (2010b). This framework links climate change, livelihoods vulnerability and the potential of ICTs in supporting systemic resilience. They defined the e-Resilience as a property of livelihood systems by which ICTs interact with a set of resilience sub-properties, enabling the system to adapt to the effects of climate change. The e-Resilience Framework is represented in Figure 2-5.

Figure 2-5: The e-Resilience Framework



Source: Ospina and Heeks (2010b:23)

This framework is built from sustainable livelihoods approach, new institutionalism and Sen's capability approach. Ospina and Heeks identify two ways in which ICTs contribute to adaptive processes. On one hand, it is through their dynamic linkages with other system components namely, assets, institutions, structures and capabilities. On the other hand, it is through the effect of ICTs on resilience sub-properties. As shown in Figure 2-5, Ospina and Heeks, highlighted seven ways in which ICTs are linked to the set of resilience sub-properties. Firstly, ICTs and Robustness- they can help strengthen the physical preparedness of livelihood systems for climate change related events. Secondly, ICTs and Scale- they can help increase the breadth and depth of assets to which households and communities have

access. Thirdly, ICTs and Redundancy- they increase the availability of resources to such an extent that there is excess or possible substitutability of assets. Fourthly, ICTs and Rapidity- they enable rapid access to financial capital and transactions and speed up access to information. Fifthly, ICTs and Flexibility- they can help identify and undertake different actions to better withstand the effect of climate change related events, and utilise the opportunities that may arise from change. Sixthly, ICTs and Self-Organisation- they can enable access to the set of resources that livelihood systems require to effectively self-organise in the event of climate change related shocks or disturbances. Seventh, ICTs and Learning- they foster new learning processes on issues that are important for the sustainability of local livelihoods within a changing climate (ibid). Starting from the next section, the empirical literature review is presented.

2.6 EMPIRICAL LITERATURE REVIEW SECTION

The empirical literature review is the second major section. It is organised into three broad themes namely, climate change literature (section 2.7), ICTs literature (section 2.8) and literature on the application of ICTs in climate change adaptation in the agricultural sector (section 2.9).

2.7 CLIMATE CHANGE LITERATURE

The literature on climate change looks at vulnerability to climate variability and change in Africa and the barriers to climate change adaptation. It then focuses on climate change in the agricultural sector and highlights the need for adaptation. It also focuses on various initiatives that have been undertaken in Zimbabwe to promote climate change adaptation and public awareness.

2.7.1 Vulnerability to climate change in Africa

Most rural communities are dependent on agriculture for their livelihood. Agriculture is an important sector, both in the formal economy and in sustaining local livelihoods (Vogel, 2005:30). As alluded to earlier, this study focuses on smallholder agriculture which can also be referred to as subsistence agriculture; as such, these terms will be used interchangeably. Many factors affect smallholder agriculture. These include climate change and climate variability, population increase, environmental degradation, poor infrastructure, poor market access and lack of access to information and resources (Morton, 2007:19681). Other factors include unfavourable input and output market conditions, diseases that affect people e.g. HIV/AIDS, diseases that affect crops and livestock, conflicts and water shortages (ibid). While all these factors affect the performance of smallholder agriculture, this study will focus mainly on climate variability and climate change. The two terms ‘climate variability’ and ‘climate change’ refer to different but related issues.

Climate variability refers to variations in the mean state of the climate and variations in other statistics (such as the occurrence of extremes) on all temporal and spatial scales beyond that of individual weather events, for example, the average range of temperature for a location, as indicated by minimum, maximum and average temperature values (Lambrou and Nelson,

2010:11). This differs from climate change which refers to a long-term change in the state of the climate and which is identified by changes in the means and changes in the variability or changes in the frequencies or intensities of extreme events (ibid; IPCC, 2007:21). A key point is that climate change can be due to natural variability or as a result of human activity (ibid). Climate change leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events (IPCC, 2012:5).

Until the start of the 21st century, climate change was perceived almost exclusively as an environmental issue, nevertheless, today it is recognised that it has developmental implications (Nhamo, 2009:122). In other words, climate change does not affect the environment alone but also affects the social, economic and political spheres, which consequently negatively affect overall development. Climate change will affect sectors, regions, communities and groups differently. In particular, Ngigi (2009:8) asserts that smallholder farmers are vulnerable to climate change as it reduces their productivity and negatively affects their weather-dependent livelihood systems. Moreover, it is the poorest countries and regions that will suffer earliest and most, even though they contributed least to the causes of climate change (Stern, 2007:vii; Chagutah, 2010:1). The remaining paragraphs in this section focuses on climate change in relation to the African continent.

The African continent is one of the most vulnerable continents to climate change (UNFCCC, 2007:18; IPCC, 2007:13). In particular, many of its areas have climates that are among the most variable in the world, both on seasonal and decadal time scales, such that floods and droughts can occur in the same area within months of each other (ibid). The IPCC's Fourth Assessment Report shows that the African continent will be negatively affected. Firstly, by 2020, between 75 million and 250 million people are projected to be exposed to increased water stress (The IPCC, 2007:13). Secondly, agricultural production is projected to be severely compromised. Thirdly, local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes. Fourthly, towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations (ibid).

The regional climate scenarios for Africa indicate that warming throughout the continent and in all seasons is very likely to be larger than the global annual mean warming (Christensen et l. 2007:850). Specifically, rainfall in southern Africa is likely to decrease in much of the

winter rainfall region and western margins, whereas for East Africa, there is likely to be an increase (ibid; UNEP, 2003:22). Consequently, food, water shortages, floods and storms are likely to increase throughout most of Africa, while desertification will remain a major threat in arid and semi-arid regions (UNEP, 2003:22). Although sub-Saharan Africa (SSA) is not the most disaster prone region, regrettably, it is the most vulnerable to the impact of disasters related to meteorological, hydrological and climate extremes which are increasing across the region (World Bank and UN/ISDR, 2007:9).

Many factors exacerbate the effects of climate variability in Africa. These factors include: poverty, diseases e.g. HIV/AIDS, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of education and health care, poor access to resources, low management capabilities, land and ecosystems degradation, trends in economic globalisation and conflicts (UNFCCC, 2007:18; Adger et al. 2007:719; Eriksen, O'Brien, and Rosentrater, 2008:5). This vulnerability is further aggravated by its predominant dependence on primary commodities, which are highly susceptible to climate variability (Ikeme, 2003:30). The next section narrows down and focuses on Zimbabwe; it starts by briefly describing the country's climate, and then discusses issues related to climate variability and change.

2.7.2 The climate variability and change in Zimbabwe

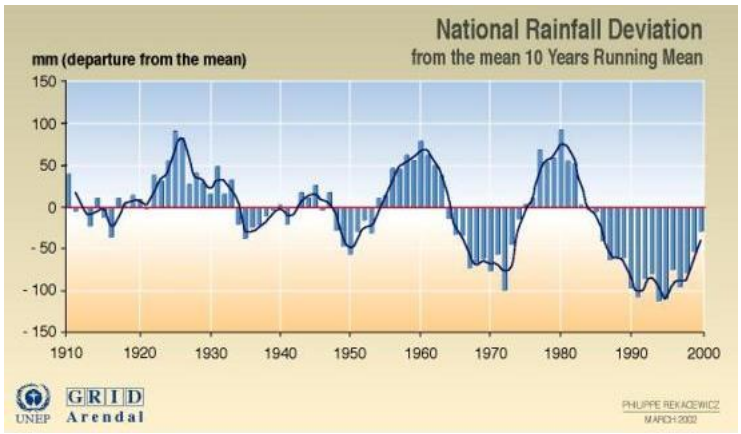
Zimbabwe is a sub-tropical country with one rainy season, which spans from November to March (Levina, 2006:15). Altitude and relief greatly affect its temperature and rainfall (Campbell, Bradley and Carter, 1997:160; Mano and Nhemachena, 2007:6). The country lies in a semi-arid region with limited and unreliable rainfall patterns and temperature variations (Brown et al. 2012:3). The mean annual temperature varies from 18°C in the highveld to 23°C in the lowveld region (Ministry of Environment and Natural Resources Management, 2013:36). In the lowveld region temperatures rarely fall below 2°C in winter but can rise to over 40°C in summer (ibid).

The mean annual rainfall varies from below 400mm in the extreme south of the Lowveld, to between 500mm to 700 mm in the Middleveld, while the Highveld receives between 800mm to 1000 mm (Mano and Nhemachena, 2007:6). The country receives an average rainfall amount of 657 mm per annum (Levina, 2006:15). In general, the rainfall pattern is erratic,

unreliable, and insufficient with only 37% of the country receiving adequate rainfall for agriculture (ibid). Actually, 75% of the country experience semi-arid conditions (Mugabe et al. 2012:1). This renders the country vulnerable to droughts.

On average, one to three droughts occur every ten years, largely due to changes in the phases of the El Niño-Southern Oscillation (ENSO) phenomenon and periodic sea-surface temperature changes (Chagutah, 2010:3). The unfavourable rainfall conditions result in crop failures that occur three out of every five years (Mugabe et al. 2013:289). Zimbabwe and other southern African countries have of late been experiencing frequent droughts alternating with periods of very high rainfall, in some cases, floods and mid-season prolonged dry spells (Mutekwa, 2009:240). Notably, the increased frequency of floods has resulted in loss of life and property especially in the low-lying areas of the Zambezi and Limpopo basins (Ministry of Environment and Tourism, 2004:15). Figure 2-6 shows Zimbabwe's national rainfall deviation from 1910 to 2000.

Figure 2-6: Zimbabwe's national rainfall deviation from 1910 to 2000

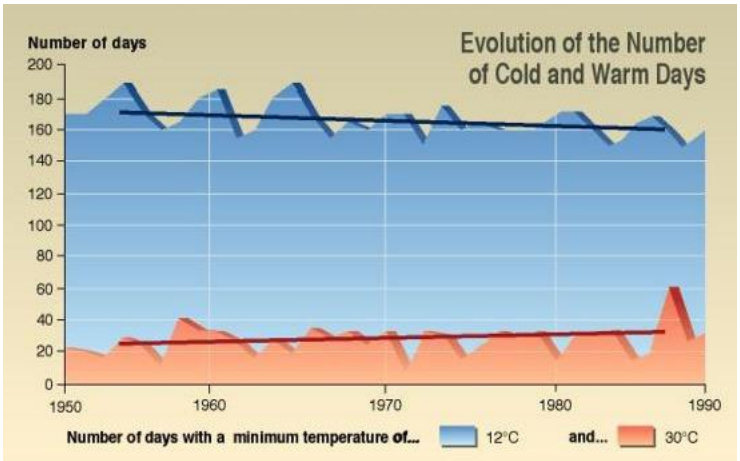


Source: Rekacewicz (2005)

Figure 2-6 shows that during the period 1910 to 2000, Zimbabwe's rainfall amount deviated from the mean more frequently (Rekacewicz, 2005). Similarly, the Factsheet on climate variability and change in Zimbabwe noted that the timing and amount of rainfall received are becoming increasingly uncertain (GoZ-UNDP/GEF, 2010a). The last thirty years (from 1980) have seen a trend towards reduced rainfall or heavy rainfall and drought occuring in the same season. However, rainfall predictions for the country are less certain, with various models suggesting that rainfall patterns are likely to change, some models predict a 10-20% decline

in rainfall by 2050 (ibid). Figure 2-7 show the evolution of the number of cold and warm days from 1950 to 1990 in Zimbabwe.

Figure 2-7: The number of cold and warm days in Zimbabwe from 1950 to 1990



Source: Rekacewicz (2005)

Figure 2-7 shows that from 1950 to 1990, Zimbabwe experienced more hot days (with a minimum temperature of 30ºC) and fewer cold days (with a minimum temperature of 12ºC) (Rekacewicz, 2005; GoZ-UNDP/GEF, 2010a). The Factsheet on climate variability and change in Zimbabwe noted that the country's annual mean surface temperature warmed by 0.4ºC from 1900 to 2000, with the period 1980 to 2000 being the warmest and the driest (GoZ-UNDP/GEF, 2010a). If greenhouse gas (GHG) emissions continue along the current increasing trajectory, the country's temperatures are expected to warm by 0.5 to 2ºC by 2030 and 1 to 3.5ºC by 2070 compared to the 1961-1990 average (ibid). A recent study based on the CSIRO MK3 Global Circulation Model shows that mean monthly temperature projections for both the worst and best case scenarios, indicate a general warming of around 2°C by 2080 (Ministry of Environment and Natural Resources Management, 2013:36). In this context, the author takes note of other regional climate models such as those produced by the Climatic Systems Analysis Group (CSAG) and also by Council for Scientific and Industrial Research (CSIR); however these models were not discussed in this study. From this discussion, it is evident that Zimbabwe will be negatively affected by climate change.

According to the IPCC, the largest decreases in runoff by the year 2050 will be in the southern Africa region, and Zimbabwe, among other countries, will shift into the high water-

stress category because of population growth and climate change (Levina, 2006:15). In addition to the likely negative impacts on agriculture and water availability, there are also health related concerns due to the potential spread of diseases such as malaria to a wider geographical area of the country. In particular, the Ministry of Mines, Environment and Tourism (1998) noted that presently, malaria tends to be a year-round problem only in low-lying areas such as the Zambezi valley. However, a warmer climate could cause the vector mosquito to migrate into higher elevated areas where malaria is presently not a serious problem (ibid). The next section focuses on the likely impacts of climate change on Zimbabwe's agricultural sector.

2.7.3 Climate change and the agricultural sector in Zimbabwe

Rain-fed agriculture is the dominant source of staple food production and the livelihood foundation of the majority of the rural people in SSA (Cooper et al. 2008:24; Hope, 2009:454). This scenario also applies to Zimbabwe, where the agricultural sector plays an important role in the economy, household income and food security (Mutekwa, 2009:240). The agricultural sector contributes about 15% each year to the country's GDP (Ministry of Environment and Natural Resources Management, 2013:6). Regrettably, agriculture is one of the sectors hardest hit by climate change (Vogel, 2005:30; Nhamo, 2009:122). Zimbabwe's agriculture is mainly rain-fed, such that any rainfall changes will have a direct impact on agricultural performance (Ministry of Environment and Natural Resources Management, 2013:36; Chagutah, 2010:5). The likely impacts of climate change in the agriculture sector include changes in the location of optimal growing areas for given crops; changes in crop yields; and changes in the type, location and intensity of pests and diseases (Parry et al. 1998:8-5).

The vulnerability of Zimbabwe's agricultural sector to climate change was assessed using the CSIRO MK3 Global Circulation model (Ministry of Environment and Natural Resources Management, 2013:36-41). Overall, the findings show that maize is more vulnerable to rainfall variability than sorghum and cotton. In addition, future projections indicate that the proportion of the country that is considered 'excellent' for cotton and sorghum will increase from the current 20 to 50% under the worst-case scenario, while it will more than double under the best-case scenario. On the contrary, the area considered 'excellent' for maize would decrease from the current 75 to 70% under the best-case scenario, while it will go down to

55% under the worst-case scenario. In such a scenario, it is worrying to observe that in the communal areas, the area planted under maize has actually been increasing while the area under sorghum and cotton has been declining since the 1980s (ibid). In terms of adaptation, this suggests that communal farmers will be more vulnerable to climate change as they increase the proportion of a rather more vulnerable crop (maize) while reducing the proportion of less vulnerable crops (sorghum and cotton).

The high correlation between the country's agricultural productivity and climatic conditions, particularly, rainfall has been noted in the literature (e.g. Campbell, Bradley, and Carter, 1997:160; Ministry of Environment and Tourism, 2004:15; Levina, 2006:15). Droughts contribute to low yields and subsequently food insecurity in the country, in particular, amongst smallholder farmers (Mugabe et al. 2012:1). In a drought year, maize yields may fall by as much as 70% leading to about 60-70% of the country's population requiring food assistance (Ministry of Environment and Tourism, 2004:29). In fact, Richardson (2007:3) observed a strong and positive link between Zimbabwe's GDP growth and countrywide rainfall[2]; in years of good rainfall the GDP was higher while in years of poor rainfall the GDP fell. Likewise, Mugabe et al. (2013:292) claim that the percentage of GDP from agriculture has fluctuated between 10% and 20%, reaching its lowest shares during dry years (in 1991–92, 1992–93 and 2001–02).

Mano and Nhemachena (2007:2) found that net farm revenues in the country were negatively affected by increases in temperature and positively by increases in precipitation. In other words, an increase in temperature was likely to contribute to reduced farm income, while a decrease in the rainfall amount was likely to also contribute to reduced farm income. Similarly, Kurukulasuriya and Mendelsohn (2008:12) evaluated various climate scenarios using the Agro-Ecological Zone (AEZ) model. They concluded that warming will be harmful to African agriculture not because it will reduce cropland per se, but as a result of diminishing value of cropland. That is to say, high productivity agro-ecological zones will be transformed into low productivity agro-ecological zones.

[2] Discounting for major events that also influenced GDP growth such as periods during the liberation war, huge payout to war veterans and the takeover of commercial farms (Richardson, 2007).

It is important to note that most unfavourable climate change projections are mainly for the tropics and sub-tropics where most developing countries that are highly dependent on climate sensitive sectors are located (Leary et al. 2007:3). This applies also to countries like Zimbabwe; as a result of climate change, the frequency and occurrence of droughts is likely to increase. This scenario therefore paints a gloomy picture on the country's agriculture and economy. If agriculture is negatively affected, this will have negative repercussions on the economy and, vice versa. In brief, climate change actually becomes an additional constraint to sustainable socio-economic development of the country (Unganai, 2009:1).

From the preceding paragraphs, it is evident that the impacts of climate change will be far reaching for a country like Zimbabwe, particularly for its smallholder communal farmers. Their livelihoods are dependant on agriculture which is also highly dependent on rainfall and the prevailing economic conditions. This implies that variation in any of these factors in an unfavourable direction will negatively affect the livelihoods of smallholder farming households such as those in Seke and Murewa districts. Thus, two key points can be drawn from the literature. Firstly, rain-fed dependent farmers will feel the impacts of climate change most; this will overwhelm their current coping capacities (Morton, 2007:19680; Alliance of the CGIAR Centers, 2009:6). Secondly, reducing the risk associated with climate variability has a high potential for increasing productivity in Zimbabwe, hence, the need to adapt (Phillips, Cane, Rosenzweig, 1998:40; Ministry of Environment and Tourism, 2004:28). The next section focuses on the need to adapt to climate change in the agricultural sector.

2.7.4 The need for climate change adaptation in the agricultural sector

In a large-scale study that was conducted in eleven African countries, Maddison's (2007:2) found that a significant number of farmers believed that temperatures had increased and that precipitation had declined. Similarly, Gbetibouo (2008) in a study conducted in the Limpopo Basin of South Africa found out that the majority of the farmers surveyed perceived an increase in temperature and a decrease in rainfall over the past 20 years. Letson et al. (2001:62) state that while people may observe weather variability and extremes, climate is removed from direct experience because of its longer time scales. In addition, local perceptions and interpretations of climate variability can be broad and diverse among communities and within different social groups (World Bank, 2012a:5). Thus, it is difficult to classify whether these farmer perceptions point to climate variability or climate change.

However, what is evident from these studies and many others is that farmers are observing changes, which in some cases are supported by historical rainfall and temperature data that confirm changes in the climate. In this context, it is important for agricultural communities to be prepared and respond to such changes.

The United Nations Framework Convention on Climate Change (UNFCCC) identified two responses to climate change, which are mitigation of climate change by reducing GHG emissions and enhancing sinks, and adaptation to the impacts of climate change (Klein et al. 2007:748). While both adaptation and mitigation are important responses to climate change, this study will focus mainly on adaptation. Hassan and Nhemachena (2008:84) argue that the climate is already changing and mitigation efforts to reduce GHGs will take time, such that adaptation is critical and of concern in developing countries, particularly, in Africa where vulnerability is high. Likewise, even if the most ambitious mitigation plans were implemented today, they would not be sufficient to avoid changes in the global climate; hence, the importance of adaptation (Akoh et al. 2011:24). In support, Gbetibouo (2008:1) stated that the extent to which the adverse impacts of climate change are felt depend on the extent of adaptation; without adaptation, climate change would be detrimental.

The Assessments of Impacts and Adaptations to Climate Change (AIACC) project undertaken in various regions of Africa, Asia, Central and South America, the Caribbean, Indian and Pacific Oceans, found that overall there was an adaptation deficit, which is likely to be widened by climate change (Leary et al. 2007:3). Adapting to climate change will entail adjustments and changes at every level, from community to national and international levels (UNFCCC, 2007:29). Burton, Smith and Lenhart (1998:5-8) stated that adaptation can take different forms depending on the action taken in response to the external stimulus or threat. If the action is before the threat, that adaptation is anticipatory or preventive. If the action is during the time of threat, that adaptation is gradual, step-wise, and short-term. If the action is after the threat, the adaptation is reactive or corrective (ibid).

The ability of individual, households and communities to adapt to climate change depends on their adaptive capacity. Adaptive capacity refers to the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change (Eriksen, 2004:18). This capacity is dynamic and is influenced by economic and natural resources, social networks,

entitlements, institutions, governance, human resources and technology (Adger et al. 2007:719). Usually the poor and the marginalised have low adaptive capacity. Hope (2009:451) asserts that while climatic changes are harmful to the poor, it is their vulnerability to the various elements of climate change that determines whether they survive, and if they do, whether their livelihoods are destroyed or not.

Climate variability and risk have always been part of agriculture. In most cases, African farmers have survived and coped with this variability (Hassan and Nhemachena, 2008:84; Ziervogel et al. 2008:3; CCAFS, 2009:9). However, despite experience and resilience, future changes in the climate are going to be harsh (Vogel, 2005:33). Furthermore, Ziervogel et al. (2008:21) claims that agricultural adaptation taking place in Africa is responding more to perceived climate variability rather than climate change, such that these responses are likely to be overwhelmed by climate change and its longer-term implications. Likewise, Gornall et al. (2010:2974) argue that the experience and infrastructure of local farming communities are generally appropriate to particular types of farming, crops and livestock, which are productive under the current climate. Though climate change can potentially threaten these established aspects of farming systems, contrariwise, there can be opportunities (ibid:2973). In that regard, the key issue is, will there be opportunities for smallholder farmers like those in Seke and Murewa districts, and if so, are these farmers able to take advantage of such opportunities?

Leichenko and O'brien (2002:2) posit that though some farmers may be in a position to take advantage of the changes, many more are facing increased vulnerability. For instance, Maddison (2007:36) observed that while farmers were making adaptations to their agricultural practices, some of the adaptations were not appropriate. The UNDP (2012:8) made a similar observation in Rakai and Kapchorwa Districts of Uganda. Farmers in the two districts were using a range of strategies to avoid and minimize the negative impacts of climate hazards on their livelihoods, despite the fact that some of the strategies were in fact maladaptive (ibid).

Maladaptation refers to those actions that tend to increase vulnerability to climate change (Burton, Smith, and Lenhart, 1998:5-4). Examples of maladaptive responses include avoidant reactions (such as denial of the threat, wishful thinking, fatalism) and 'wrong' adaptations

that, though not intended to do so, actually increase climate change damage (Grothmann and Patt, 2005:203). Thus, current practices, processes, systems and infrastructure that are more or less adapted to the present climate will become increasingly inappropriate and maladapted as the climate changes (Leary et al. 2007:8).

Adaptation measures in the agricultural sector include crop and livestock diversification, income diversification, seasonal climate forecasting, community-based disaster risk reduction, famine early warning systems, insurance, water storage, supplementary irrigation, rainwater harvesting, water conserving techniques; agricultural insurance, adjustment of planting dates, and use of drought resistant crop varieties (Adger et al. 2007:721-722). As rainfall projections for Zimbabwe point to a drying trend, adaptation strategies in the agricultural sector should therefore focus on strategies to conserve moisture, particularly, adopting improved short-season seed varieties, drought resistant small grains, crop diversification and irrigation development involving dam construction and the use of simple rainwater harvesting technologies (Ministry of Environment and Natural Resources Management, 2013:38). One initiative that has been implemented in Zimbabwe to enhance adaptation in the agricultural sector is the Coping with Drought and Climate Change Project which is presented in Box 2-1 (section 2.7.9). As such projects are being implemented and taking shape, it remains to be seen how they actually enhance the adaptive capacity of rural communities. In other words, it takes time to have a true picture of the impacts of the project in terms of reducing both short-term and long-term vulnerability. Having highlighted the need to adapt to climate change, it is important to discuss the barriers to climate change adaptation.

2.7.5 Barriers to climate change adaptation and awareness

Climate change adaptation is a critical aspect for Zimbabwean and African agriculture. However, many factors hinder the ability of individuals, households, and communities to adapt to climate change. Such factors can be classified as physical and ecological limits, technological limits, financial barriers, informational and cognitive barriers, and social and cultural barriers (Adger et al. 2007:733-737). Physical and ecological limits relate to the critical thresholds beyond which some systems may not be able to adapt to changing climate conditions without fundamentally altering their functional state and system integrity. Technological limits are linked to how adaptations are technologically possible or how the

technologies are economically feasible and culturally desirable, which relates to its suitability or appropriateness. Informational and cognitive barriers relate to how uncertainty, perceptions, opinions and values of people influence their adaptation. Financial barriers relate to how adaptation is constrained by the lack of adequate financial resources. Social and cultural barriers are concerned with the different ways in which people and groups experience, interpret and respond to climate change (ibid). This study focuses mainly on informational, cognitive, and social factors as they relate to adaptation and awareness of climate change. Moser and Ekstrom (2010:2) observed that barriers to climate change adaptation occur at three main adaptation phases namely, understanding, planning, and managing the adaptation process.

Adaptation entails adjustments in both behaviour and in resources and technologies (Adger et al. 2007:727). At the individual level, having access to information about climate impacts, vulnerability and adaptation is a prerequisite to improving one's condition in the face of climate hazards (UNEP-PROVIA, 2013:10). In other words, change in behavior is influenced to some extent by the information and knowledge that individuals have. Equally, successful adaptation depends on three elements: timely recognition of the need to adapt, an incentive to adapt and ability to adapt (Frankhauser, Smith, and Tol, 1999:68; Ikeme, 2003:34). Timely recognition requires access to reliable and detailed information and the ability to process such information (Frankhauser, Smith, and Tol, 1999:68). For instance, Grothmann and Patt (2005:203) observed that if agents systematically underestimate their own ability to adapt, this qualifies as a more important 'bottleneck' for adaptation than the physical, institutional or economic constraints.

Adaptation to climate change involves a two-stage process; first perceiving change and then deciding whether to adopt and implement a particular measure (Maddison, 2007:27). Indeed, people have to know that there are solutions to dealing with climate change and, that they can be part of those solutions (CRED, 2009:39). This implies that perceiving and understanding is a necessary condition for action. Durmont and Fransjeska-Nicole (2008:5) stressed that in the absence of information, one cannot formulate attitudes towards an issue, whether positive or negative in content. Similarly, only those farmers who perceive climate change will consider the need to adapt (Maddison, 2007:27; Farm Radio International, 2009; Pidgeon and Fischhoff, 2011:36).

The general lack of awareness and knowledge about climate change has been emphasised by many authors. For example, Madziwa, Mabeza and Mawere (2013:28) state that smallholder farmers lack awareness and general understanding of climate change, and the technical knowhow of how to enhance the productivity of their rain-fed agriculture. Kempton (1997:14) stresses that there is a need for people to have detailed knowledge of climate change to help them form opinions on the issue. In addition, Saloranta (2001:402) suggested that the danger of making serious mistakes in decision-making can be lessened by reducing the misunderstanding in climate science. Otherwise, if people do not have the necessary knowledge, they might end up making wrong opinions and decisions. The IPCC (1990:213) states that throughout the world in whatever sphere of human activity, there is ignorance and confusion about climate change. This assertion by the IPCC, more than twenty years ago still holds. For example, Etkin and Ho stressed,

> climate change is an issue which has left the public confused … in terms of what might happen and what should be done. There is inherent uncertainty, not just within the scientific community, but also among the public (Etkin and Ho, 2007:626).

Despite the importance of information and knowledge in climate change adaptation, these factors on their own are inadequate. Adger et al. (2007:735) states that knowledge of climate change causes, impacts and possible solutions does not necessarily lead to adaptation. They are necessary but insufficient conditions for adaptation. Nevertheless, information and knowledge are one of the most important building blocks in the adaptation process. This assertion seems to have support in the literature. For instance, O'Connor, Bord and Fisher (1999:469) argue that though risk perceptions are not a surrogate to general environmental beliefs, they matter in predicting behavioral intentions. Similarly, Stamm, Clark and Eblacas (2000:220) claim that although what people think and understand about environmental problems might not necessarily be accurate or complete, these cognitive processes are likely to influence both their willingness and ability to participate in solving the problem. Furthermore, the involvement of the public in climate change issues and in undertaking environmentally friendly behaviour depends in part on the level of their knowledge of those issues (UNFCCC, 2005:12; CRED, 2009:39). In summary, information and knowledge are actually necessary conditions in the adaptation process.

2.7.6 Awareness of climate change

In Zimbabwe, awareness of climate change has been noted to be low across different levels of society (e.g. Ministry of Environment and Natural Resources Management, 2009:23-24; 2013:85; Madziwa, Mabeza, and Mawere, 2013:29). The results of a National Capacity Self Assessment (NCSA) study indicated a low awareness of climate change, its causes or possible redress mechanisms (Ministry of Environment and Tourism, 2006:48). Likewise, from the Gallup polls conducted in 127 countries in 2007 and 2008, only 52% of the respondents in Zimbabwe had knowledge of global warming (Pelham, 2009; Chagutah, 2010:24). Mutekwa (2009:252) notes that the majority of smallholder farmers were ignorant about climate change.

While low awareness of climate change has been noted, other sources indicate that there is generally high level of awareness. For instance, the ZBC (2012) reports that the levels of awareness on the issue of climate change are very high in Zimbabwe. In addition, from a large-scale study that was conducted in 11 African countries, Maddison (2007:3) asserts that the perception of climate change was high among the farmers. Similarly, Chagutah (2010:vii) highlights that many farmers in Zimbabwe are aware of climate change. However, a key challenge is the lack of clarity on the terms 'climate variability' and 'climate change' which hampers enhanced public awareness of climate change (ibid:25).

There is need to distinguish between genuine understanding of the causes and implications of climate change from superficial recognition of abstract terms (Whitmarsh, 2009:417). In other words, awareness of climate change is more than just being aware of climate change per se. Of importance also, is the awareness of the causes, effects, mitigation, and adaptive responses to climate change. Certainly, having sound knowledge of the expected impacts and the adaptive responses is important for the current and future wellbeing of individuals, and communities (Osberghaus et al. 2010:24). However, the literature indicates that people generally lack this awareness and knowledge. Agreeably, public opinion research indicates that awareness of environmental problems usually does not entail specific knowledge about the causes, consequences, or solutions to the problem (Stamm, Clark, and Eblacas, 2000:221). For instance, Lorenzoni and Pidgeon (2006:86) observes that from a number studies on public views of climate change undertaken in Europe and USA, there was limited understanding of the causes of and solutions to climate change. Other studies (e.g. Kempton,

1997:13; Stamm, Clark and Eblacas, 2000: 225) have shown that the public in the US had misconceptions about possible solutions to climate change. Similarly, in a study conducted in Kiribati (a Small Island Developing State), though about 60% of respondents were aware of climate change, their understanding of climate science was weak (Kuruppu and Liverman, 2011:663).

Despite the fact that the level of climate change is still relatively low, it has been observed that over the years, there has been a gradual increase in climate change awareness. The increased awareness of climate change has been attributed to a number of factors. In terms of research, Kellog (1987:132) states that,

> the world has progressed a long way in the century since Tyndall, Chamberlin, and Arrhenius made those first tentative suggestions about mankind's ability to change the global climate. By far the biggest advances in the evolution of an awareness that this could really be true was in the 1970s. That was when the 'level of informed public and scientific discussion' seems to have experienced a dramatic upswing, and climate research made rapid progress on all fronts.

In other words, there has been increased generation of climate change information and knowledge by researchers, this information is availed to the general public. Another important source of awareness has actually been people on their own observing and experiencing the changes in weather patterns and extreme weather events (UNFCCC, 2005:18). This is especially true among those dependent on climate sensitive livelihoods such as farmers. In that context, Dilley (2000: 69) posits that for southern Africa, the increased awareness in the 1990s was due to successive droughts and their negative impacts. For instance, the major 1997/98 El Nino event prompted efforts by governments and international organisations to improve capacity to manage climate variability through prevention and preparedness, which resulted in increased public attention (ibid). The next section reviews the determinants of climate change awareness.

2.7.7 Determinants of climate change awareness

Many factors have been found to influence public awareness of topical issues such as climate change. This section dwells mainly on climate change awareness, however, it highlights lessons from the broad agricultural field and also health related issues such as HIV/AIDS

awareness campaigns. In that context, the important role played by ICTs and media tools in promoting awareness or behaviour change have been documented (e.g. Bertrand et al. 2006:568). Reid et al. (2012:51) notes that both the electronic and print media in Zimbabwe play an important role in information dissemination and, as such, can be a crucial vehicle for gathering and disseminating information on climate change. Ospina and Heeks (2012:5) assert that there are emerging experiences in rural agricultural communities that show the use of ICTs (such as mobile phones, radio) in disseminating climate change messages to the population.

The radio is one of the most useful and largely diffused technologies for reaching the masses, especially, the poor (ITU, 2008:87). The radio plays an important role in information dissemination. Its advantage is its ability to reach illiterate farmers and provide them with information relating to all aspects of agricultural production in a language they understand (Chapman et al. 2003:2). In addition to being the most effective way to reach farmers, radio programs that provide farmers with climate change information can provide researchers with knowledge of what is happening at the field level and encourage communication between researchers and farmers (Farm Radio International, 2009).

In Zimbabwe, climate change issues are featured in various media though not prominently. Admittedly, Chagutah (2010:365) notes that despite the clear urgency for increased reportage and discussion of environment and sustainability issues in the country's media, coverage remains low and subordinate to other societal concerns. Nevertheless, there have been efforts over the years to increase coverage of issues such as climate change. These efforts include the training of journalists on climate change reporting and advocacy in the country. In particular, the Climate Change Working Group (a coalition of over 40 civil society stakeholders), has been advocating better 'climate journalism' in Zimbabwe through holding regular meetings and training of journalists, which resulted in an improvement in the number and quality of radio, television and written reports on climate change (Reid et al. 2012:52). One notable training workshop is the Media Advocacy Training Workshop that was held in 2011. Here 20 journalists from various media houses were trained on various issues including climate change journalism; climate change science; climate change politics, power, money and justice; developing strong stories; and pitching to editors (ibid). Furthermore, the Ministry of Environment and Natural Resources Management (2013:87) notes that Zimbabwe's proposed

national climate change communication strategy intends to use various media (radio, television, videos, newspapers, magazines, chat shows) to spread climate change information. This proposed communication strategy intends to establish a newsletter to be titled 'The Climate Change Communicator', which will report on the various climate change issues (ibid:91).

In terms of new and emergent technologies, Karanasios (2011:21) posits that the expected diffusion of mobile broadband actually opens a range of possibilities for climate change adaptation including capacity building, monitoring and information dissemination. Similarly, Chaudhury et al. (2012:7) notes that though it has to be determined which types of information should and could be effectively communicated, mobile phones could be used in information exchange. In developing countries, mobile telephony is more accessible than PCs and the Internet; as a result, increased access to the internet will be via the mobile phones (ITU, 2008:8).

At the global scale, Hasan and Kazlauskas (2009:160) attributed the slight increase in the attention paid to climate change to the spread of social media and technologies. However, in the context of this study, the internet may not significantly influence the level of climate change awareness probably due to the general low access in rural areas. Likewise, Karanasios (2011:18) asserts that besides the internet being a promising climate change relevant technology, particularly, for information dissemination, currently it is not expected to play any critical role due to its low penetration rate. Similarly, Saravanan (2011:7) observes that in remote rural areas of India, the web and the internet are rather "foreign" technologies that the farmers themselves are largely unfamiliar with. However, besides the current challenges of low penetration, the internet provides a platform on which various web applications can be used to share information. Such web applications include: blogging, social networking; data processing/transformation; content upload, sharing, discovery; storage, computation, messaging; identity and presence management; mashups for data sharing; wikis and innovative user-based data entry (ITU, 2008:23). While the review so far has focused on access to ICTs and the media, the next paragraphs focus on personal attributes and socio-economic variables that can influence climate change awareness and adaptation.

Age is an important personal attribute that is likely to influence climate change awareness and adaptation. It can be taken as a proxy for farming experience - that is the older the farmer is the more the farming experience. Its importance is evident in the literature. In a study that was conducted in 11 African countries, Maddison (2007:24) found that farmers that had the most farming experience were more likely to perceive climate change. Similarly, Hassan and Nhemachena (2008:98) observe that experienced farmers usually have better knowledge and information on climate change. Likewise, from a study conducted in Mozambique, Patt and Schröter (2007:17) argue that perceptions about climate change and climate risks grow out of lifetimes of experience.

Another important personal attribute likely to have a significant influence on climate change awareness and adaptation is education. Maddison (2007:3) found that educated farmers are more likely to respond by undertaking at least one adaptation strategy. Related to the importance of education are Rogers's (1983:251) generalisations about the socio-economic characteristics of adopters. Rogers state that, earlier adopters are likely to have more years of education and are likely to be literate than late adopters. It is important to note, however that being aware of something, in this case climate change, does not directly translate into early adoption of the related adaptation technologies or strategies. However, this awareness is important as it is likely to give options on how to respond when that situation arises. Related to personal attributes are socio-economic attributes, which are the focus of the next paragraphs.

The importance of interpersonal communication in the transfer of information and knowledge in agricultural communities is well documented. Farmers can learn from observing their neighbours on appropriate adaptations and methods (Maddison, 2007:37). For instance, in a study conducted in Bangladesh, Ghana and Uganda, Chaudhury et al. (2012:6) found that sharing of agricultural information within the household was very important. Adult men and women collected information on various agricultural practices from neighbouring villages, which was shared with other family members (ibid). Information sharing among agricultural communities is important in enhancing information and knowledge on climate change. Stamm, Clark and Eblacas (2000: 235) state that due to the importance of interpersonal communication, it is useful for the designers of public education campaigns to consider ways of creating community involvement in solving the problem of climate change. Interpersonal

communication involves person-to-person information exchange. In agricultural communities such as Seke and Murewa districts, this can take different forms including farmer-to-farmer interaction, and exchanges between extension workers and farmers. Opinion leadership also plays an important role in interpersonal communication and knowledge transfer. In addition, participation in farmer and developmental organisations provides platforms for the exchange of information and ideas through personal interaction. Each of these factors is discussed in the next paragraphs starting with agricultural extension.

Agricultural extension and advisory services can help farmers to respond to climate change, thereby increasing their adaptive capacity (UNDP, 2012:33). Rogers (1983:313) asserts that agricultural extension workers can be classified as change agents. A change agent is an individual who influences clients' innovation in a direction deemed desirable by a change agency; in most cases, it is done by promoting adoption of new ideas and innovations (ibid). Maddison (2007:3) found that farmers with access to extension advice were more likely to adapt to climate change. Indeed, changes in the structure of agricultural extension services worldwide have led to an increased emphasis on demand-driven, participatory and pluralistic mechanisms of information and technology transfer (Chapman et al. 2003:2). In Zimbabwe, the extension service providers include public supported, NGO supported, commodity processors, farmers' associations, and private agrochemical input suppliers (Hanyani-Mlambo, 2002:1). However, most smallholder farmers rely heavily on the public extension system (AGRITEX) which has an extensive countrywide network of provincial and district offices (Hanyani-Mlambo, 2002:1; Chamboko, 2007:7; EMA, 2010a:16). The positive influence of agricultural extension in spreading climate change information and knowledge can also be complimented by opinion leaders.

Opinion leadership is an important factor in the spread and diffusion of ideas and technologies. Rogers (1983:271) defined opinion leaders as individuals who lead in influencing others' opinions about innovations. Generally, opinion leaders have greater exposure to mass media, they tend to be more cosmopolite, and have greater change agent contact than their followers (ibid:282). Due to these attributes, opinion leaders are likely to be ahead than others in terms of being aware of new ideas, issues and technologies. In the context of this study, opinion leaders are likely to be more aware of climate change than others. Opinion leaders in communities tend to be those individuals who command some

respect from the majority of people within the community e.g. local leaders, educated people, and successful business people. While opinion leaders play an important role in influencing the spread and adoption of ideas, this aspect actually depends on the type of opinion leadership. In other words, depending on the issue at stake, different types of opinion leadership will have varied influence. This argument is suported by Anyaegbunam, Mefalopulos and Moetsabi's (2004:8) assertion that in rural areas it is common to use inappropriate communication channels, including power and authority structures which are not effective for or accessible to the majority of rural people.

Participation in farmer organisations and developmental organisations has been noted to be important in enhancing climate change awareness and adaptation. For instance, the UNFCCC (2005:15) notes that the analysis of initial communications from member countries to the UNFCCC highlight the important role that civil society and church-based groups play in raising public awareness about climate change. These organisations play a leading role in advocating policies on climate change, conducting training, facilitating the participation of various stakeholders and in implementing projects (ibid). For example, in Zimbabwe, one notable NGO mainstreaming climate change issues is the Zimbabwe Climate Change Youth Network, which was formed in 2009 (Reid et al. 2012:43). This network is a coalition of voluntary youth organisations, institutions, development agents and individuals interested in working on climate change issues. It acts as a platform for sharing climate change information with the objective of raising youth awareness on climate change and enhancing their participation in national, regional and international climate change agendas (ibid).

The factors that were discussed in this section are important variables that relate to the second objective. These factors are summarised in Chapter 3 in the methodology section 3.6.2, which gives the background to the multivariate analysis used in Chapter 5 to assess determinants of climate change awareness. Having discussed the various factors that are likely to influence climate change awareness and adaptation, the next section focuses on how perceptions on climate change are formed.

2.7.8 Understanding how perceptions on climate change are formed

Information related to climate change is generally characterised by two aspects namely, uncertainty which results from lack of information, and equivocality which results from

different interpretations of the available information. Information equivocality refers to the multiplicity of meaning conveyed by information (Daft and Macintosh, 1981:211). Information that lends itself to different and perhaps conflicting interpretations is considered equivocal information (Daft and Macintosh, 1981:210; D'ambra, Rice, and O'connor, 1998:165). Uncertainty in the context of climate change arises because there is not enough, certain information about the causes, effects, and how best to adapt to and mitigate it. For example, different climate change projections from various climate models result in varied information being available to the people, which further increases the uncertainty. On the other hand, equivocality occurs because people interpret the available information diffferently as their frames of reference are different. This is the case with farmers. They tend to interpret the climate and weather forecasting information differently. In other words, the uncertainty and equivocality that characterise the available climate change information result in people having inadequate, incomplete and at times conflicting information. Consequently, misunderstood information, unintended interpretation of conveyed information, complete lack or insufficient frequency or content of communication affects the adaptation process (Moser and Ekstrom, 2010:4). Thus, it is imperative to reduce the uncertainty and equivocality that characterises climate change information.

People take various actions in response to the information they receive. These include both desired and undesired actions. For example, Grothmann and Patt (2005:202) note that if risks alone are communicated without communicating the adaptation options, people will probably react by avoidant maladaptive responses like denial of the risk. Similarly, Pidgeon and Fischhoff (2011:36) argue that, depending on how the message is communicated, it may highlight that it is possible for people to act against climate change. However, on the other hand, it might promote fatalistic acceptance of climate change with people accepting that they cannot change their ways (ibid). For instance, Kuruppu and Liverman (2011:667) observe that in Kiribati (a Small Island Developing State) previous efforts to raise awareness which centred mainly on climatic impacts may have created a disabling message. In fact, people felt helpless, envisioning its impacts as a large flood submerging the islands, which discouraged them from anticipatory adaptation (ibid). Chagutah (2010:365) highlights that the media in Zimbabwe used frames of reference related to risk, uncertainty, fear, outrage and crisis that portrayed a sense of heightened fear due to impending environmental consequences. In that context, communication approaches should seek to influence people to behave pro-actively

by addressing maladaptive responses such as denial, wishful thinking, and fatalism (Grothmann and Reusswig, 2006:118). Having discussed the importance of climate change awareness in general, the focus now turn to how people form their perceptions.

The importance of cultural and mental models in the formation of perceptions

The discussion will mainly centre on the importance of cultural and mental models in understanding how perception on issues such as climate change are formed. Kempton (1997:14-20) emphasises the importance of cultural models[3] in trying to understand how people perceive climate change. Kempton argues that people do not just passively receive new information; rather, they actively fit that information into pre-existing cultural models and concepts. For new and complex problems such as global climate change, people often apply inappropriate cultural models such as air pollution and ozone depletion thus, end up drawing invalid conclusions (ibid). Bord, Fisher and O'Connor (1998:83) found that the public, both in the United States and in other regions had a flawed understanding of global warming due to their application of a general pollution model.

Related to cultural models are mental models. The CRED (2009) stressed the importance of understanding mental models in climate change communication. They noted that mental models[4], act as frameworks into which people fit new information (Morgan et al. 2002; CRED, 2009:3). Mental models can act as filters, resulting in selective knowledge uptake as people absorb only the information that matches their mental model and this actually acts as a potential obstacle for climate change communication (CRED, 2009:3). People often exhibit a strong preference for their existing mental models about climate change, making them susceptible to confirmation biases[5] (ibid). Therefore, it is important to discover what climate change misconceptions the audience may have in its mental models, then using a wide range of communication messages, designs and media reshape those mental models (McDaniels, Axelrod, and Slavic, 1996:171; CRED, 2009:4). The next section highlights and discusses the

[3] *Cultural models* are conceptual models of the fundamental ways in which the world works that are shared by most of the people in the culture (Kempton, 1997:14)

[4] A *mental model* represents a person's thought process of how something works (i.e., a person's understanding of the surrounding world) (CRED, 2009:3)

[5] A *confirmation bias* makes people look for information that is consistent with what they already think, want, or feel, leading them to avoid, dismiss, or forget information that will require them to change their minds and, quite possibly, their behaviour (CRED, 2009:4).

various initiatives that are/have been undertaken in Zimbabwe to promote climate change awareness and adaptation.

2.7.9 Initiatives to promote climate change awareness and adaptation in Zimbabwe

Various initiatives are being undertaken to enhance responses to climate change in Zimbabwe. The country has an array of government agencies, non-governmental organisations (NGOs), civil society organisations, academic institutions, research institutions, and private sector organisations involved in climate change adaptation and mitigation (Chimanikire, 2011:5). These organisations are complemented by the existence of various donor agencies, bilateral and multilateral institutions, which actively support climate change programmes and projects (ibid). The Ministry of Environment and Natural Resources Management (MENRM) is responsible for all environmental issues in the country including climate change coordination through the Climate Change Office within the ministry. There is a multi-sectoral National Climate Change Committee (NCCC), which provides sector-specific and cross-sector implementation, coordination advice and guidance on climate change issues. This committee is composed of members from various government departments and other organisations which include the Ministry of Environment and Natural Resources Management, the Department of Meteorological Services, the Department of Energy, the Ministry of Agriculture, the Ministry of Finance, the Confederation of Zimbabwe Industries, the Southern Centre for Energy and Environment, the Department of Natural Resources, the National Economic Planning Commission, the University of Zimbabwe, UNDP/GEF, and the civil society (Ministry of Environment and Natural Resources Management, 2013:105).

In terms of policy, there are various steps that have been taken to mainstream climate change into national programmes. In 1987, the Government of Zimbabwe produced a policy document titled the "National Conservation Strategy" which was a blue-print for the conservation of the environment (The Ministry of Mines, Environment and Tourism, 1998:65). This document paved way for most environmental programmes in Zimbabwe, including the signing and ratification of the UNFCCC by Zimbabwe in Rio de Janeiro (ibid). Currently, there is no specific policy on climate change. Nevertheless, climate change issues are addressed through the environmental legislation (Brown et al. 2012:20). Reid et al. (2012:74) note that Zimbabwe is one of the few countries in Southern Africa without a

comprehensive climate change policy. Admittedly, the government of Zimbabwe acknowledges this limitation. However, it states that despite the lack of a stand-alone climate change policy, there are various policies in place that address climate change (Ministry of Environment and Natural Resources Management, 2013:92-93). These include the National Environmental Policy of 2009, which is supported by Acts such as the Environmental Management Act (Chapter 20:27), the Forest Act (Chapter 19:05 as amended in 1999), the Communal Lands Forest Produce Act (Chapter 20 of 1 987), the Control of Hardwood Export SI 112, and the Parks and Wildlife Act (Chapter 20:14). Other supporting policies and plans are the Environmental Impact Assessment Policy of 1997, the National Environmental Education Policy and Strategies of 2003 and the National Fire Strategy and Implementation Plan of 2006 (ibid).

Important milestones in terms of responding to climate change include the submission of the first and the second National Communication on Climate Change to the UNFCCC. The first national communication was submitted on 25 May 1998 and the second[6] national communication was submitted on 31 January 2013 (UNFCCC, 2014). Some of the enabling activities outlined in the national communications that are relevant to this study include enhancing capacity in present research institutions to provide information on climate change; and reviewing, updating and systematic dissemination of climate change data (Ministry of Mines, Environment and Tourism, 1998). Though there are a number of mitigation and adaptation initiatives being undertaken in Zimbabwe, this study focuses mainly on climate change awareness and adaptation activities. In that regard, the next paragraphs discuss these issues.

Zimbabwe initiated climate change awareness workshops meant to exchange information and raise public awareness on climate change. The UNFCCC (2005:12) asserts that the primary aim of public awareness campaigns and workshops is to enable the public to participate in efforts to address climate change. Since 2006, more than fifteen of such workshops have been conducted (Ministry of Environment and Natural Resources Management, 2013:85). The workshops targeted grassroot communities, industry, schools, colleges, universities,

6 Most of the issues highlighted in this section are drawn from the Second National Communication to the UNFCCC (cited as Ministry of Environment and Natural Resources Management, 2013).

professional groups and policy makers (Ministry of Environment and Natural Resources Management, 2009).

There are efforts to develop the National Climate Change Response Strategy and the National Task Team on Climate Change (NTT) (Ministry of Environment and Natural Resources Management, 2013:xiv). The NTT will be a multi-stakeholder team that would lead the process of climate change response strategy formulation and reporting, and the formulation of the National Climate Change Awareness and Communication Strategy. The strategy intends to use a variety of approaches and tools in raising awareness about climate change, its causes, impacts and available options for adaptation and mitigation (ibid:87-89). These include the production and dissemination of information, education and communication materials (posters, pamphlets, videos, compact discs (CDs) in both English and vernacular languages); and using media (newspapers, radio and television). Other approaches include use of social gatherings; promoting drama, poetry and essay writing competitions; empowering young people; dedicating a national commemoration day for climate change; exposure; behaviour change; training; and information and networking (ibid).

Education plays an important role in ensuring the development of a critical mass of experts on climate change (UNFCCC, 2005:5). The Zimbabwean government acknowledges the inadequacy of the current school curriculum in terms of climate change content (Ministry of Environment and Natural Resources Management, 2013:83-85). Nevertheless, some subjects partly incorporate climate change issues. At the primary school level, these subjects include social studies, environmental studies and agriculture, while at secondary school level the subjects are geography, agriculture and civic education. In response to this inadequacy of the curriculum, the Ministry of Education, Sports, Arts and Culture is making efforts to integrate climate change into the school curriculum. Furthermore, there are efforts to enhance training on climate change issues at the tertiary level, particularly, at teacher training colleges, agricultural colleges and universities (ibid).

A very important initiative in addressing climate change in the country is the Coping with Drought and Climate Change Project, presented in Box 2-1. The project aimed to enhance awareness and adaptation in the country with a particular focus on Chiredzi District in Masvingo province. Other initiatives include mainstreaming of climate change issues by civil

society organisations, such as the Zimbabwe Climate Change Youth Network (Reid et al. 2012:43; Brown et al. 2012:21). The network acts as a platform for sharing climate change information in order to raise youth awareness on climate change issues and enhance their participation in national, regional and international climate change agendas (ibid).

Box 2-1: The Coping with Drought and Climate Change Project in Zimbabwe

The Coping with Drought and Climate Change Project is a Government of Zimbabwe and UNDP/GEF supported pilot adaptation project, which was implemented in support of vulnerable agro-pastoral communities in the Chiredzi district of Zimbabwe over the period 2008-2012. The objectives of the project were: to develop local capacity to expand the knowledge base on climate change for effective adaptation in the agriculture sector; to demonstrate a range of viable long-term livelihood adaptation options to manage climate variability and change among men and women agro-pastoralists; to develop local capacity to use climate early warning systems; and to disseminate project generated lessons and foster public awareness about potential impacts of climate change. Three adaptation approaches were used in the project, namely: addressing vulnerability, building response capacity and managing climate risk.

Methods and tools used in communication strategy of the project:

- Mass media: press releases, communiqués, press conferences/briefings, photography, video clips, soap opera, news and features, documentaries and TV slots, infomercials or jingles, and media packs;
- Briefings/dialogue/Extension Services: face-to-face, one-on-one or group meetings;
- Demonstrations: field visits, fairs, exhibition and learning journeys and centres;
- Education: edutainment, school clubs, school contests, speakers, educational posters, stickers, tours, in-class and field demonstrations, adult education classes, school curriculum, and workshops;
- Art and entertainment: song and drama, concerts, poetry, games, contests, films, and short stories as told by communities, DVDs, CDs;
- The Internet and telephone: web-based tools such as web and email advertisements, e-mail alerts and bulletins, newsgroups, websites, blogs, chat-rooms, online videos and podcasts (recordings); and telephonic tools such as facsimile services, sms, mms and voice communication; the freedom phone, phone data gathering tools
- Personalities: goodwill ambassadors, opinion leaders, public figures, community leaders, political figures, celebrities, musicians, respected academics and experts;
- Public events: workshops, conferences, international events, dialogues, inaugurations and launches, special and international days, marches, marathons, exhibitions or expos, and village meetings;
- Publications: Books and booklets, special/technical papers, training manuals, fact sheets, policy briefs, leaflets, magazines, newsletters, brochures, and posters;
- Document Case Studies: demonstrate indigenous knowledge and approaches to climate change, gender specific impacts of climate change, the role of women in climate change adaptation, and demonstrate how gender perspectives are being applied to adaptation responses in Africa
- Promotional: billboards, corporate merchandise (shirts, t-shirts, hats, scarves, ties, coffee mugs, pens and conference and corporate stationery - bags, note pads, pens, bills and invoices); stickers, jingles, infomercials, promotional posters, banners, transit shelter posters, ceramic tiles (with relevant messages), and mouse pads.

Source: Extracted from Unganai (2009:1) and EMA (2010b:21)

Chimanikire (2011:5) asserts that besides the progress made, there still exists challenges related to limited institutional capacity and coordination on climate change issues. Similarly, Brown et al. (2012:3) suggest the need for a national climate change framework to guide coordinated action and investment. However, these concerns might soon be taken care of, if one of the policy level recommendations in the country' Second National Communication to the UNFCCC is implemented. The recommendation calls for the development of the National Climate Change Response Strategy (NCCRS), which will map a clear way forward in terms of policy formulation, coordination and mainstreaming of climate change in various sectors. The next section review literature on the importance of climate forecasting and early warning information in climate change adaptation.

2.7.10 Weather forecasting and early warning systems

Responding to climate variability and change in agricultural communities will be incomplete without access to weather and climate forecasting and early warning information. Seasonal forecasts can provide advance information so that farmers can adjust critical agricultural decisions, thereby, improving efficiency and enabling them to adopt the most suitable coping strategies (Hansen et al. 2006:28; World Bank, 2012b:6). Early warning systems work hand in hand with the general weather forecasting. Recent advancement in the form of seasonal forecasting provides a basis for early warning (Murphy et al. 2001:172). An Early Warning System (EWS) involves the provision of timely and effective information, through identified institutions that allow individuals, communities and organisations exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response (UN/ISDR, 2009).

The importance of early warning systems in enhancing timely and effective responses to climate impacts is emphasised in the literature (e.g. Duncombe, 2006:8; Alliance of the CGIAR Centers, 2009:18; Houghton, 2009:49; Karanasios, 2011:6; World Bank, 2012b:6). Preparedness to events such as violent storms, floods and droughts is very important in reducing vulnerability. However, many of the promising opportunities provided by early warning and climate information have not been fully exploited (Vermeulen et al. 2010:7). As forecasting skills continue to improve, early warning systems will be more reliable which will help farmers to be prepared (Balling, 2005). In order for communal areas such as Seke and

Murewa to be prepared there should be early warning systems in place to disseminate information in order for the people to take necessary action.

In Zimbabwe, climate forecasts are provided by the Meteorological Service Department (Met Office), which then disseminates the information to users through four main routes (EMA, 2010a:24). Firstly, the forecasts are disseminated in the form of bulletins to the print and electronic media. Secondly, they are disseminated through agricultural extension system (AGRITEX). Thirdly, they are communicated to all stakeholders in the Southern African Regional Climate Outlook Forum (SARCOF). Fourth, they are disseminated to various Met Stations in the country (ibid). In addition, the country has a National Early Warning Unit (NEWU), which was established in 1987 (Chagutah, 2010:19; EMA, 2010a:6). Its mandate is to conduct risk analysis, interpretation, dissemination of disaster warnings and providing advance information on food security through crop forecasts and assessment of food stocks (ibid). The NEWU is complemented by the SADC Regional Early Warning Unit, Famine Early Warning System (FEWSNET), the Zimbabwe Vulnerability Assessment Committee (ZIMVAC), the Department of Agricultural Technical and Extension Services (AGRITEX) (Chagutah, 2010:19). Vordzorgbe (2007:8) highlights that in Africa, food security related early warning systems are the most developed. However, early warning systems for other major threats are undeveloped or limited to surveillance and monitoring.

Certainly, farmers require forecasting information in order for them to plan their farming activities. Dilley (2000:70) asserts that farmers thirst for advance information on the likely quality of the upcoming agricultural seasson for them to plan. Similarly, farmers in Chiredzi district of Zimbabwe indicated that they required exact information in terms of the number of days it will rain and the rainfall amount during the cropping season (EMA, 2010a:15). While farmers require forecasting information, the literature indicates that most of them do not have adequate access to this information. For instance, in a study that was conducted in Gokwe District of Zimbabwe, Gwimbi (2009:90) found that more than 70% of the farmers that were surveyed lacked access to timely weather forecasts. Furthermore, it has been noted that forecasts have not been extensively embraced and their effective utilization has lagged behind, particularly, among marginal groups (e.g. Pfaff et al. 1999:645; Goddard et al. 2001:1112; Ziervogel et al. 2004:4; Lemos and Dilling, 2007:110). In general, it can be deduced that the majority of communal farmers do not have access to timely early warning

and weather forecasting information. Regrettably, unequal access to forecasting information has equity implications as those particularly vulnerable might not benefit from forecasts (Lemos and Dilling, 2007:114).

The forecasting information has to be relevant and appropriate to the users (EMA, 2010a:9). In addition, the information has to be understandable, reliable, credible and trusted, for it to have a positive impact (World Bank, 2012b:6). In this context, Ziervogel et al. (2004:4) highlights that the reliability of forecasts is dependent on both the skill of the forecast and the credibility of the source. The skill of the forecast is also affected in part by the reliability of the equipment that is used in the forecasting process. Unfortunately, most climate observation networks in Africa are constrained by lack of stations, equipment and maintenance (The UNFCCC, 2007:13). This is the case in Zimbabwe. The country's meteorological equipment is outdated, which makes it difficult and limits the confidence of forecasters in making smart decisions especially, regarding storms, rainfall and thunderstorms (EMA, 2010a:8). The Herald (2012) concurs noting that in Zimbabwe, the current equipment is outdated and communities should avoid relying on generalised information that leaves them shortchanged. Besides having wrong forecasts, an additional challenge is the misinterpretation of forecasts (Murphy et al. 2001:192). This challenge is evident among farmers, as well as, agricultural extension workers. This was also highlighted in a Zimbabwean newspaper report:

> Government has been challenged to intensify AGRITEX (extension) officials' training on interpreting and conversion of weather data into extension messages … With the current climate change problems threatening our agriculture sector, extension workers need to be informed on the information they give to farmers…. weather forecasts from the Met Department should be converted and re-packaged into languages understandable to farmers (The Herald, 2012).

Poor forecasts may actually do more harm than good (Ziervogel et al. 2004:1). From a study that was conducted in Thailand, Srang-iam (2013:443) brought an interesting scenario, in which there can be overall reduction in the adaptability of the farming system. Srang-iam argues that as farmers observe that there is a high degree of informational certainty (as they access forecasts); they end up adopting a specific adaptation that optimises the trade-off between production and survival. This planned adaptation shifts their attention away from coping with the remaining uncertainty and improving the resilience of their systems. Such

that an incorrect prediction ends up causing more damage to their production (ibid). In other words, as farmers access rainfall forecasts and become more dependent on them, their ability and capacity to minimise risk by balancing between production and survival, is reduced. Srang-iam gave examples of the unexpected rainfall that decreased the quality of the harvested rice and unpredicted long droughts that caused farmers to bear unnecessary losses from transplanted seedlings. Similarly, in Zimbabwe, a late 1997 forecast suggesting a more severe drought than the one experienced contributed to a reduction in planting and output (Pfaff et al. 1999:646). In addition, EMA (2010a:15) asserts that farmers in Chiredzi district of Zimbabwe indicated that each time they weeded their fields and it failed to rain, many of their crops withered after weeding. In such a case if the farmers would have taken such action as a response to forecasting information that would have resulted in more harm.

In a report highlighting the general ill-preparedness to rainfall extremes in Zimbabwe, Mwando (2012) reports that, "the Met office has been off the mark many times in the past with its weather predictions, which are now questioned by farmers and disaster preparedness organisations". This can be attributed to the credibility constraint that arises from having past forecasts being inaccurate. This occurs especially, when forecasts are communicated in a deterministic, rather than probabilistic form (Patt and Gwata, 2002:186). Accordingly, for farmers to benefit from forecasts, the information must be presented in terms of impacts on production outcomes, at a scale relevant to their farming system, with uncertainties expressed in transparent, probabilistic terms (Hansen et al. 2006:28).

It is important to note that even a technically skilful forecast is not necessarily a useful forecast for the decision maker due to the multiplicity of decisions that have to be made (Goddard et al. 2001:1141). In other words, there are many decisions that farmers have to make. In the context of this study, this refers to decisions that require weather forecasting and early warning information. These decisions include adjusting planting dates to avoid water stress during the critical period of the crops (Jones et al. 2000:179). In a study that was conducted in Pergamino, Argentina, Letson et al. (2001:61) found that the respondents were most likely to change the crop mix, planting date, cultivar and fertilizer amounts based on climate forecasts. In choosing crops and their varieties the decisions might include selection of high-yielding crop varieties that are more tolerant to droughts and shorter rainy seasons, or diversification to include both food and cash crops (Ngigi, 2009:94). In terms of deciding the

amount of inputs/effort to allocate, Phillips, Cane and Rosenzweig (1998:40) note that farmers determine the amount of inputs to use based on the expected amount of rainfall. In cases of high uncertainty, they tend to minimise the risk by using less inputs, which gives them low but stable yields (ibid).

The usefulness of forecasts depends on the capacity of farmers to access and utilise the information (World Bank, 2012b:6). Moreover, the information is only important if it meets farmers' needs and contexts (Thornton et al. 2011:125). For example, if the early warning system accurately predicts drought but does not give the vulnerable people the necessary information on how to cope, then the usefulness of such information will be limited (Mudombi and Muchie, 2010:2). In addition to the availability of information, there should be complementary inputs and technologies. Indeed, the general lack of alternatives, both in terms of inputs, technology and access to financial and human resources, acts as a serious hindrance to the use of forecasts (Lemos and Dilling, 2007:111; World Bank, 2012b:6). Consequently, the greatest benefits of forecasts may go to those farmers who have the means and resources to take advantage and apply productivity-enhancing technologies (Stone and Meinke, 2006:7).

Farmers can access forecasting information through various channels. Some of the channels have been highlighted in more detail in section 2.7.7. In brief, important channels for receiving weather forecast information can include radios, newspapers, mobile phones, extension, public announcements at schools and during religious gatherings and print media (Chaudhury et al. 2012:9). These channels include ICTs and interpersonal channels. In that context, Gurstein (2005:16) asserts that though ICTs are important as enabling instruments at each stage of the early warning process, what is more important is the Last Mile Warning System (LMWS). The LMWS covers the missing links between the "professional" early warning system and the effective use of that information by local communities (ibid). Having discussed various climate change issues, the next section focuses on the literature on ICTs, starting with their definition, then discusses their importance in development in general and also in the agricultural sector.

2.8 LITERATURE ON ICTs

This section presents literature relevant to information and communication technologies (ICTs). It starts by defining the term 'ICTs'. It then gives an overview of various ICTs and their importance in the environmental sector, followed by a discussion on agricultural extension and ICTs. Further, it looks at the contribution of ICTs in climate change adaptation and awareness in the agricultural sector. Lastly, it highlights Zimbabwe's ICT policy particularly focusing on e-agriculture.

2.8.1 Defining Information and Communication Technologies

ICT refers to any device, tool or application that permits the exchange or collection of data through interaction or transmission (World Bank, 2011:3). Historically, ICT was a blanket term that simply referred to the 'technologies' that transfer information both old and new (Curtain, 2003:11; Heffernan, Lin and Thomson, 2012:3). This is supported by Greenberg (2005:16) who indicated that ICTs are often categorized based on how long they have been in common use and to some extent, the technology used for the transmission and storage of information. Greenberg identified three categories namely, new, old, and really old ICTs.

- New ICTs are mainly based on digital technology (these include computers, satellites, wireless one-on-one communications, mobile phones, the Internet, e-mail and multimedia).
- Old ICTs are mainly based on analogue technology though some are now migrating to digital technology (these include radio, television, landline telephones and telegraph). They have been in reasonably common use throughout much of the world for many decades.
- Really Old ICTs have been in common use for several hundred years (these include: newspapers, books and libraries).

It is important to note that though the term ICTs usually refers to electronic-based technologies only, for the purposes of this study, the definition by Greenberg (discussed above) which considers both electronic and non-electronic based ICTs is adopted. It is important to observe that what might be considered old in the ICT literature might not neccessarily be old in rural areas such as Seke and Murewa districts, hence the need to

consider both new and old ICTs. Having defined the term 'ICTs', the next section focuses on access to ICTs.

2.8.2 Access to ICTs

Access to and use of ICTs is of fundamental importance. The ITU (2009:2) notes that ICT access refers to availability of ICTs within the home while ICT use refers to use by one or more individuals of the household, whether at home or elsewhere. In addition, the World Bank (2011:11) states that access refers to, "not only to the physical proximity and accessibility of ICT infrastructure, tools and services but also to their affordability". Many rural areas have low access to ICTs. In other words, ICTs remain relatively new in many rural areas (Chapman and Slaymaker, 2002:27). Besides affordability issues, many other barriers in terms of access to ICTs can be identified in the literature. Some of them include lack of electricity or recharging facilities and other related infrastructure (ITU, 2003:4). Moreover, the use of ICTs requires a basic level of technical knowledge (Rathgeber, 2000:17). In this context, O'Farrel et al. (1999) highlight that not being able to read and write limit the ability of many people to exploit the opportunities presented by ICTs.

Besides these significant challenges, people can access ICTs and their services through other means. Notably, social factors such sharing technology and skills, are a central part of understanding use of ICTs in developing countries (Alampay, 2006:36). Undoubtedly, even those who do not have first-hand access to ICTs can have access through sharing (ITU, 2010:iii). ICTs can be shared through networks of relatives, family, friends, neighbours, work, school, public places such as Internet cafes (ITU, 2003:12; Alampay, 2006:33). This means that when people do not own the ICTs they can still access the services via other people who have the ICTs. Nevertheless, this dimension of access will depend on the affordability of such services if the services are paid; in cases where the services are free, accessing them will mainly depend on relations and networks. This raises the importance of social capital in the sharing and accessing of such services within communities. The next paragraphs discusses the different types of ICTs.

There are many different types of ICTs. Mallalieu and Rocke (2007:130-131) classified ICTs as: access technologies, access device technologies and application technologies. Access technologies are those that enable and act as conduits for the delivery of communications

services from service providers directly to end users. They include telephony, television and radio. Access device technologies represent the interface through which users' access information and communications services such as mobile phones, desktop personal computers and handheld devices such as laptops and tablets. Application technologies refer to the end user capabilities possible through ICTs, such as applications and software programs which run on access devices in order to enhance communications services e.g. email and web browsers (ibid). The next paragraphs dwell on access to various ICTs. The review draws examples from other developing countries in general, while focusing on Zimbabwe in particular. It starts by discussing the radio.

The ITU (2003:4) asserts that the radio can be categorised as having achieved universal service, whereby in most developing countries, household radio ownership has surpassed the halfway mark. Broadly, most areas, in particular rural areas, have low access to the TV. The low ownership of the TV in most households in different parts of the world has been strongly linked to the high cost of the TV and the unavailability of electricity (Munyua, 2000:99; ITU, 2003:4). Similarly, most areas have low access to digital satellite television and radio services. In particular, the pay-per-view (subscriptions) satellite television services remains out of reach for many. Chamboko (2007:88) observes that although digital satellite television (DStv) is available in Zimbabwe, it is relatively expensive to install and meet the monthly subscriptions. Despite the slight growth in the number of households in Zimbabwe accessing the free-to-air digital satellite television and radio services, this actually remains low, moreover, these channels have limited content and diversity.

In terms of the telephone, the EMA (2010a:7) states that Zimbabwe had a low tele-density of about three telephone lines per 100 people. In addition, Chamboko (2007:10) highlights that although Zimbabwe's telecommunications sector is deregulated, the state controlled Telone Company still has a monopoly. Virtually no other private company is actively involved in the provision of fixed telephones (ibid). Given the general low access to the telephone, the assertion by Richardson (2003:3) that most rural people in developing countries cannot make or receive a telephone call thus cannot be refuted. However, besides the low access to the telephone, the mobile phone is proving to be an important ICT in both urban and rural areas. Notably, the GoZ (2012:17) notes that there has been substantial growth in mobile cellular subscription in Zimbabwe, which increased from 338 402 subscribers in 2002 to 9 864 308

by August 2012. One of the important factors that contributed to this phenomenal growth is the rapid expansion of the mobile telephony infrastructure and availability of cheaper phones. Undoubtedly, the World Bank (2011:26) asserts that many rural users are moving from mobile phones with basic voice and text message capabilities to feature phones[7]. In particular, Chinese made mobile phones are particularly affordable and accustomed to the needs of rural users (ibid).

The role that the internet and its associated applications can play depends on their penetration within a community (Wattegama, 2009:13; Mudombi and Muchie, 2010:2). Most rural areas in many developing countries are characterised by low access to the computer and the internet. This low access is further worsened by the fact that a significant number of people are not even aware of these technologies. For example, a study conducted in South Africa and Uganda showed that awareness of computers and the Internet was found to be generally low (Parkinson, 2005:xix). Likewise, Narula and Arora (2010:231) observe that one major constraint to adoption of internet is actually the lack of its awareness. Indeed, access to a computer is important not only because it is an information device on its own, but also because it is the main tool to enable internet access (The ITU, 2003:8-12). This means that these technologies are complementary and that is why access to the internet was previously highly dependent on the availability of the computer.

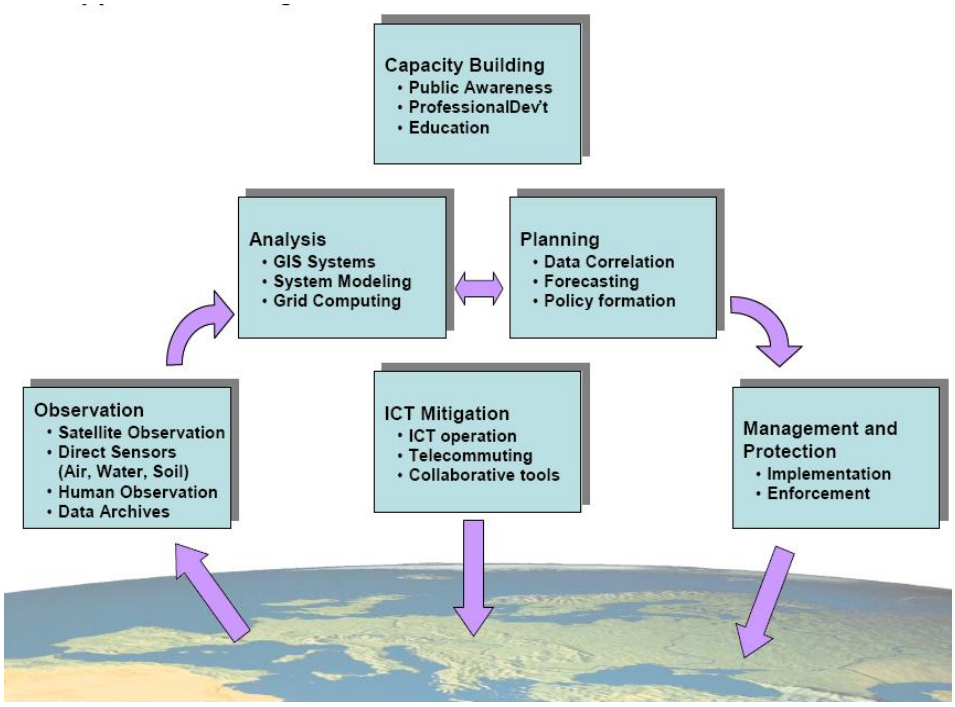
Nonetheless, there has been phenomenal advances in technology, which are enabling increased access to the internet via mobile phones. Admittedly, Akoh et al. (2011:98) state that in the near and medium term, the principal access medium for the internet in Africa for most people will be mobile devices rather than computers. In particular, mobile Internet subscription in Zimbabwe grew from 142 000 subscribers in 2009 to 2 225 895 subscribers in 2012, an average growth of over 486% per annum (GoZ, 2012:18). Nevertheless, the rapid increase in access to mobile phones and internet services in Zimbabwe has mainly been concentrated in urban areas, whereas most rural areas lack robust, fast and reliable internet infrastructure (EMA, 2010a:7). The next section discusses the importance of ICTs in the environmental, climate and agricultural sectors.

[7] Feature phones are low-end phones that access various media formats as well as offer basic voice and SMS functionality, capturing the functionalities of multiple ICT devices which include digital camera, voice recorder, flashlight, radio, MP3 player, Bluetooth, and many other features (The World Bank, 2011:26)

2.8.3 ICT applications in the environmental sector

There are many ICT applications in the environmental sector. These are presented diagrammatically in Figure 2-8. The figure shows six main areas in which ICT applications are important. These are observation, analysis, planning, management and protection, mitigating effects of ICTs and capacity building (ITU, 2008:26; Houghton, 2009:42-43).

Figure 2-8: ICTs application in the environmental, climate and agricultural sectors



Source: ITU in (ITU, 2008:25)

Each of the applications is briefly explained, drawing mainly from the ITU (2008:26) and Houghton (2009:42-43). ICT applications in *environmental observation* include terrestrial, ocean, climate and atmospheric monitoring and data recording technologies and systems. *Environmental analysis* refers to the various computational and processing tools that are used to analyse and compare environmental data. *Environmental planning* makes use of the output information from environmental analysis in policy formulation and strategic planning. *Mitigating effects of ICT utilisation* occur directly through increasing process efficiency and dematerialization and indirectly by virtue of the secondary and tertiary effects resulting from ICT use on human activities. *Environmental management and protection* in relation to

climate change includes mitigating the impacts of climate change through technologies and practices that reduce emissions, while adaptation focuses on ICT applications that reduce the vulnerability of individuals and communities. *Environmental capacity building* includes efforts to increase public awareness of environmental issues and priorities, the development of professionals and integrating environmental content into formal education (ibid). The application of ICTs in the environmental sector is closely related to their application in the agricultural sector.

2.8.4 ICTs in the agricultural sector

ICTs are being applied in the agricultural sector in many ways. These include geographic information systems (GIS), decision support systems (DSS), market information systems (MIS), distance learning, database management, land use planning, public access facilities, mobile applications, personal digital assistants (PDAs), spatial analysis, financial services, extension, education and virtual aggregation of stakeholders (Munyua, 2007:vii; Deloitte, 2012:3). The World Bank (2011:6) outlines five key drivers of the use of ICTs in agriculture. The first is low-cost and pervasive connectivity. The second is adaptable and more affordable tools. The third is advances in data storage and exchange. The fourth is innovative business models and partnerships. The fifth is the democratisation of information through the open access movement and social media. While there are many ICT applications in the agricultural sector, this study however focuses mainly on access to information, capacity building and extension.

Agricultural extension is an important source of information in rural areas such as Seke and Murewa districts in Zimbabwe. Extension can be defined as a non-formal educational function that applies to any institution that disseminates information and advice with the intention of promoting knowledge, attitudes, skills and aspirations (Rivera and Qamar, 2003:7). In particular, agricultural extension is important in providing farmers with information, new technologies and in acting as a channel that links farmers, extension and researchers (Hanyani-Mlambo, 2002:1). Extension advice includes agricultural advice, as well as advice on other issues such as nutrition, health, population, community organisation, finance, marketing, off-farm employment and many other issues (FAO and the World Bank, 2000). In other words, extension and communication activities work in tandem in supporting

both agricultural and non-agricultural income generating and livelihood activities (Rivera and Qamar, 2003:27).

Besides its importance, agricultural extension has not performed as expected. O'Farrel et al. (1999) and Deloitte (2012:18) assert that in most developing countries, agricultural extension systems are under-funded, inefficient and have inadequate capacity to share and disseminate outputs widely to small-scale farmers. As a result, recent efforts to improve agricultural extension have focused on innovations in ICTs (Chapman et al. 2003:2). ICTs are transforming and reinventing the processes by which knowledge, information and data are generated and shared (Weigel and Waldburger, 2004:20; Edge et al. 2011:32). The resultant transformation in the organisation and delivery of agricultural extension is necessary for sustainable agricultural and rural development (Narula and Arora, 2010:222; World Bank, 2011:132; Qaisar, Motasim, and Alam, 2011:276). These technologies can assist in meeting the shortage of trained extension personnel and reach large numbers of target audiences particularly in rural areas (Rivera et al. 2005:54; Deloitte, 2012:18).

In addition, ICTs can play an important role in agricultural insurance by facilitating access to weather and market price information, facilitating speedy claim servicing, and monitoring and tracking premium repayment (Deloitte, 2012:5). Furthermore, they ensure a better interface between the insurer and the insured and, they enhance improved handling of complaints and feedback. Moreover, ICTs can be used to develop databases and to analyse collected information to develop specialised and affordable rural insurance products (ibid). For example, one of the biggest mobile network service providers in Zimbabwe, Econet Wireless, launched a mobile technology-based inputs and crops insurance called EcoFarmer. This facility helps to insure farmers against drought and excessive rainfall. Subscriber farmers get daily weather data, farming and marketing tips, daily rainfall advice, farming prices, crop data, monthly market price information, crop information and financial information (Econet, 2013). However, it remains to be seen how rural farmers such as those in Seke and Murewa districts benefit from such initiatives as most of these initiatives are in the piloting stage. The next section focuses on the ICT applications in climate change adaptation in the agricultural sector.

2.9 THE CONTRIBUTION OF ICTs TO CLIMATE CHANGE ADAPTATION IN THE AGRICULTURAL SECTOR

Ospina and Heeks (2010a:5-11) identified three distinct but interrelated strands of literature on ICT applications in the climate change field. The first strand addressed broad issues concerning ICTs, sustainable development and the environment from a global perspective. The second strand is characterised by aspects of climate change mitigation, driven primarily by developed countries' priorities in the field. The third strand is characterised by incorporating adaptation issues particularly for developing countries. This includes evidence on the use of ICT applications in vulnerable contexts. This study focuses on the third strand specifically exploring the contribution of ICTs in climate change adaptation in the agricultural sector.

The potential role of ICTs in helping communities to prepare for, respond and adapt to climate change are increasingly being recognised (Finlay and Adera, 2012:9). This role depends on the degree to which these technologies help to reduce climate risks and impacts (Akoh et al. 2011:137). Climate change activities in which ICTs can be applied include climate modelling, climate change and environment monitoring, disaster management, early warning systems, climate change adaptation, mitigation, resource management, networking, monitoring and evaluation, and education and capacity building (Karanasios, 2011:4). Whereas there are many examples of the use of ICTs in climate change mitigation, there are relatively fewer examples in climate change adaptation (Akoh et al. 2011:32; Creech et al. 2012:58). Nonetheless, there is an increasing number of cases in which ICTs are being integrated into climate change adaptation and in making the agricultural sector more resilient. The next paragraphs highlight the various ways in which ICTs can enhance climate change adaptation.

Duncombe (2006:7) identified two key enabling applications of ICTs. First, they have an analytical role in assessing the vulnerability context. Secondly, they enable communication and transfer of information and knowledge. This study is mainly concerned with the later; it relates to the transfer of climate change information and knowledge in rural areas such as Seke and Murewa. In order for individuals and communities to adapt to climate change, the availability of climate data and information is very important. Lybbert and Sumner (2010:11) suggested that major innovations in response to climate variability will take the form of

improved information through global monitoring and forecasting. In that regard, ICTs are improving the quality and accessibility of data on agriculture and climate change (Vermeulen et al. 2010:5). ICTs are employed in climate change adaptation for three major actions (Sala, 2010:39). First, they are used to record data and information. Second, they transform the data and information into knowledge. Third, they are used to communicate the data, information and knowledge. Notably, tools such as the internet, mobile phones, Web 2.0 and social media, participatory video and community radio are being integrated into adaptation strategies, providing users with a new set of tools to address adaptation challenges (Ospina, Heeks and Adera, 2012:22). The FAO (2010a:38-39) outlined the usefulness of ICTs on each of the seven main steps in the adaptation process as shown in Table 2-2.

Table 2-2: Usefulness of ICTs in the adaptation process

Adaptation step	**Usefulness of ICTs**
Observation	ICTs are important in observation through remote sensing techniques and sensor-based networks, and also essential in the storage and sharing of data
Analysis and planning	ICTs support the analysis of climate change scenarios through software-based modelling systems, and then facilitate the design of adaptation strategies through Decision Support Systems (DSS), and Geographical Information Systems (GIS)
"Just in Time" Critical Decision-Making	ICTs can help to get the right information to the right people at the right time to enable them to respond properly to risks
Implementation and management	ICTs are important in forecasting tools, early warning systems and resource management systems
Monitoring and evaluation	ICT tools provide an effective way to analyse, store and communicate the impact of an adaptation strategy
Capacity building	ICTs can be employed for awareness raising and advocacy, and on and off-line training
Networking	ICTs play a key role in producing, storing, retrieving and comparing information related to climate change issues. They also facilitate partnerships and networking (both North-South and South-South) aimed at facing the climate change challenges in different areas of the world

Source: FAO (2010a:38-39)

Climate change adaptation especially in agricultural communities requires empowerment, mobilisation and capacity building of individuals and communities for them to act. Of importance to communities such as those in Seke and Murewa districts is the 'Just in Time' information to make critical farming decisions. This includes the provision of timely weather

information to adjust planting decisions, anticipation of the emergence of pests and diseases and implementation of control measures (UNDP, 2012:45). In other words, the strategic use of ICTs within climate change programmes can help to inform, educate, influence and change behaviours thereby reducing vulnerability (Houghton, 2009:57; Kalas and Finlay, 2009:8). In terms of capacity building, ICTs help to inform and raise awareness, raise the voices of grassroots communities and those most affected by climate change, facilitate networking and collaboration and capacity building through e-learning and knowledge sharing (Kalas and Finlay, 2009:16). Undoubtedly, enhancing communication and participation can serve as multipliers across groups and through time, thereby increasing the efficacy and impact of adaptation strategies (UNEP-PROVIA, 2013:10).

ICTs are already being utilised to enhance improved response to climate change. For example, the government of South Africa launched the climate awareness campaign as a key aspect of the communications strategy for promoting its National Climate Change Response policy (DEA, n.d.:3). The objectives of the campaign included building awareness of the causes and effects of climate change, and mobilising businesses, households and stakeholders to take action to build climate change resilience. For the campaign to be successful, they used various channels that included broadcast media (TV and radio), print media, outdoor advertising, websites and online/mobile social networking, public art, sponsorship and stakeholder engagement (ibid).

Torres (2010:22) outlined a project in Bangladesh that integrated ICTs to improve learning and adaptation to climate change. The project used low-cost ICTs such as flipcharts, timelines and charts that contributed to better understanding of concepts and processes such as climatic variability. High-end ICTs such as photo and video cameras and mobile phones were integrated into the learning process. Farmers used mobile phones for texting and calling to share and learn from each other, which extended the learning opportunities beyond the usual school and class hours (ibid). Other examples include the use of ICTs by rural communities such as those highlighted by the Technical Centre for Agricultural and Rural Cooperation (CTA) in its ICT update magazine (issue 59):

> Farmers use cell phones, radio and the web to find new markets … Teams of subsistence farmers … use handheld computers and GPS receivers to note the location of the trees and

> record all the necessary measurements. They then publish the details on the web and on Google Earth … for scrutiny by potential investors (CTA, 2011:2).

In India, ICTs have been integrated in climate change adaptation activities too. Examples include the Sustainable Civil Society Initiatives to Combat Climate Change and Vulnerability Assessment and Adaptation Planning projects implemented in central Bundelkhand region and the HighNoon project implemented in Northern India. The projects communicated modelled information to enhance adaptation decision making. These projects are each briefly discussed in the next two paragraphs.

The Development Alternatives implemented the Sustainable Civil Society Initiatives to Combat Climate Change and Vulnerability Assessment and Adaptation Planning projects in central Bundelkhand region in India (Khan, Kumar, and Lakshmi, 2012:1-7). A critical component of the two projects was to encourage better farming decisions in the face of climate change. This included provision of robust technical information (climatic and hydrological, satellite images, biophysical, socioeconomic and stakeholder data) to farming communities. The integrated forms of information generated had to be communicated to the farmers in a useable form. Communication approaches such as community-based radio rural reality show, helped farmers in the region take pragmatic steps to adapt their agricultural practices to changing climate conditions (ibid).

The HighNoon project implemented in Northern India is an EU-funded collaborative project among European, Indian and Japanese institutes (Nair et al. 2012:1-7). The project paid attention to three key uses of the information: communicating trends, envisioning the future, and exploring adaptation options. The project team developed strategies for customising modelled information for dissemination to various information users. They used iterative engagement with stakeholders through repeated consultations and development of information products relevant to specific information users. Information was localised through use of local languages in the production of information materials and site-specific information. They used brevity by making short, clear, targeted and useable information in the format of factsheets, maps and simple graphs. At the community level, simple trend lines or pictorial representations of information were effective ways to share information. Highly

technical information was tailored and communicated to specific users in a simple and easy to understand format (ibid).

In Rakai and Kachporwa districts of Uganda, stakeholders identified information and communication as one of the important themes in managing climate risks in the agricultural sector (UNDP, 2012:45). In this theme, the stakeholders identified various options as outlined in Table 2-3.

Table 2-3: Enhancing the role of ICTs in climate information dissemination in Rakai and Kapchorwa Districts of Uganda.

STRATEGIC THEME	CLIMATE RISK MANAGEMENT OPTIONS	EXPECTED BENEFITS	LEVEL
Information and communication technologies	Strengthen meteorological services to provide improved climate information/data (timeliness, specificity, and packaging for end users).	Improved disaster preparedness.	National
	Localize national information on climate risks so that farmers can understand, trust, use and benefit from it, and support the dissemination of information on climate risks among farmers through community-based information and communications technology systems.	Improved generation, dissemination and use of climate information for farmer decision-making, contributing to increased adaptive capacity.	National, district, community
	Combine local and scientific knowledge for improved local weather forecasts and early-warning systems.	Improved disaster preparedness.	National, district, community
	Establish community-based early-warning systems that are closer to communities' needs, priorities and understanding.	Increased adaptive capacity.	National, district, community
	Establish community-based early-warning systems that are closer to communities' needs, priorities and understanding.	Increased awareness-raising and adaptive capacity.	National, district
	Improve technologies to help communities adapt to climate change (e.g. post-harvesting, irrigation, soil and water management, food preservation).	Increased adaptive capacity.	National, district

Source: UNDP (2012:48)

ICTs are increasingly being used in various adaptation initiatives in many African countries, though at a small scale. For instance, Akoh et al. (2011:49) and Creech et al. (2012:60) observed that though African governments made some reference to ICTs use in their National Communications and National Adaptation Plans, these cases were few and limited. Nevertheless, despite the relatively low usage of ICTs in climate change adaptation, they are being applied in the following four main areas (Akoh et al. 2011:65). Firstly, they are applied in creating climate change projections and climate databases. Secondly, they are used in

developing and revising early warning systems. Thirdly, they are applied in creating monitoring systems for water quality, health and diseases. Fourth, they are applied in developing capacity building and awareness-raising applications (ibid).

In order to exploit fully the potential value of ICTs in climate change adaptation in Africa, Creech et al. (2012:62) identified the following as requiring more attention.

- Improving the use of ICTs in high-level meteorological and climate monitoring, and associated early warning systems.
- Promoting knowledge sharing among climate change and development professionals.
- Using locally available communications media (broadcast services and mobile phones, and internet) to support local communities' adaptation efforts, and integrating local information and knowledge more effectively into large-scale planning.
- Improving the availability and quality of communications networks.
- Commitment on the part of decision makers to integrate adaptation into development planning as well as integrating ICTs effectively in adaptation.

Having given the background on the importance of ICTs in the agricultural sector in the previous section and in climate change adaptation in this section, the next section highlights the Zimbabwe's ICT policy.

2.10 ZIMBABWE'S ICT POLICY AND E-AGRICULTURE

There are various initiatives that have been undertaken to promote the use of ICTs in Zimbabwe. At the national level these include formulating and implementing an ICT policy. The Government of Zimbabwe (GoZ, 2012:8) noted that the first National ICT Policy was finalised in 2005, and was revised further in 2012. The purpose of the policy is:

> To provide strategic direction and guidance for sustainable national development through the development and application of ICTs in Zimbabwe. This will consequently improve quality of life, the country's productivity and economic competitiveness, quality health service delivery, agricultural yields, energy efficiency, mineral beneficiation, traffic safety (ibid:22).

The GoZ (2012:16) highlighted a number of key developments that have contributed to the growth of the ICT sector in the country. These include the liberalisation of the telecommunications sector; creation of the ministry responsible for ICTs; establishment of the Cabinet Committee on Scientific Research, Technology Development and Applications, and establishment of regulatory bodies such as Postal and Telecommunications Authority of Zimbabwe (POTRAZ); Zimbabwe Media Commission (ZMC); and the Broadcasting Authority of Zimbabwe (BAZ). In addition, there was also the enactment of the Criminal Law Amendment (Protection of Power, Communications and Water Infrastructure) Act, No. 1 of 2011 to deal with the problem of vandalism of existing power, communications and water infrastructure. Other factors that further contributed to the growth of the sector are the computerisation of government ministries, general increase in the Internet Penetration Rate, and the removal of duty on ICT hardware and software (ibid). The country has two statutory regulatory authorities responsible for digital communications. The first is the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ), which is responsible for licensing telecommunications frequency spectrums and digital data. The second is the Broadcasting Authority of Zimbabwe (BAZ), which is responsible for the broadcasting transmission (EMA, 2010a:7). The figures of licensed communication providers in various ICT sectors in the country (as of September 2012) are shown in Table 2-4.

Table 2-4: Licensed Communications Providers

Provider Category	Registered Providers
Fixed Telephone Operators	1
Mobile Cellular operators	4
Public Data	2
Internet access Providers	12
Private Network Licenses	45
Broadcasting Transmission Infrastructure	1
Public Broadcasting	1
Public radio stations	4
Private radio stations	2

Source: POTRAZ telecommunications indicators database/August 2012 cited in GoZ (2012:22)

The importance of the agricultural sector and ICTs to Zimbabwe's economy and the livelihoods of its people is explicitly stated in the National ICT policy. E-agriculture is a key area that has the potential to contribute to improved and sustainable agricultural production.

The policy states that the modernisation of agriculture through the systematic adoption and use of ICTs has the potential to contribute to food security, improved agricultural production, effective land management and creation of national wealth (GoZ, 2005:21; GoZ, 2012:31). In addition, E-environment is also mentioned in the policy. E-environment is the use and promotion of ICTs for the purposes of environmental assessment and protection, spatial planning and the sustainable use of natural resources and public participation (GoZ, 2012:31). The specific policy statements on E-agriculture and E-environment are outlined in Box 2-2.

Box 2-2: National ICT Policy Statements on E-agriculture and E-environment

In terms of E-agriculture, the government should:
(a) Promote and support the development of and access to affordable ICTs in land and water utilization
(b) Facilitate the development of user friendly, accessible software and provision of ICTs-enabled infrastructure in the production, processing and marketing of agricultural products
(c) Promote the use of ICTs in environmental forecasting and prediction in support of sustainable agricultural development
(d) Promote the establishment of community radio stations that prioritise on agricultural activities
(e) Encourage and promote continuous upgrading and updating of ICTs in the agricultural sector; and
(f) Promote the use of ICTs in the provision of updated statistical information on agriculture

In terms of E-environment, the government should:
(a) Support the development of ICT infrastructure for e-environment
(b) Support the Open Government Data Initiative (OGDI), a cloud-based, open software solution that enables publicly available government data to be easily accessed using open data and open development protocols. OGDI promote access to electronically stored environmental data and information by establishing and maintaining community web access points
(c) Promote international cooperation on the Digital Earth vision and enable the Digital Earth technology to play key roles, inter alia, in economic and social sustainable development, environmental protection, disaster mitigation, natural resources conservation and improvement of human being's living standard
(d) Establish rules and regulations that protect against the dumping of sub-standard or obsolete ICT equipment within our borders and guidelines on the management of e-waste

Source: GoZ (2012:31-33)

While the National ICT Policy is comprehensive, it is important to note that there is no explicit mention of climate change issues, particularly, in relation to adaptation. Nonetheless, some policy statements on E-agriculture and E-environment partly imply such issues. Thus, there is need for future policy formulation and amendments to state clearly the importance of

ICTs in climate change adaptation and mitigation. The next section gives the conceptual framework for the study.

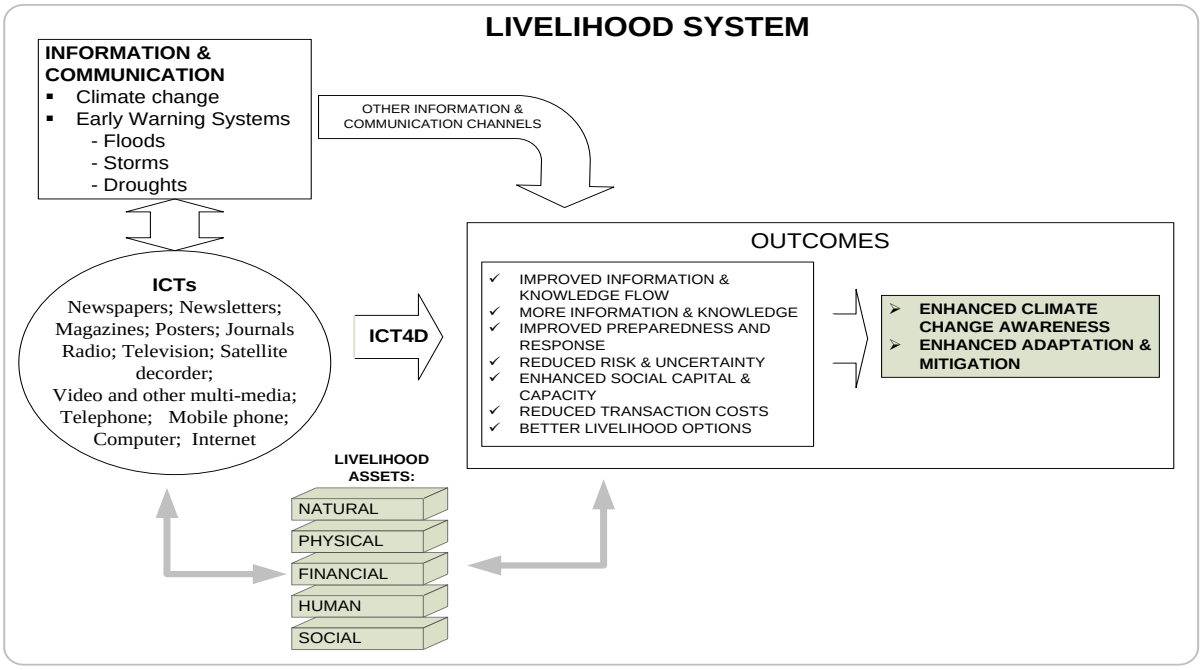
2.11 THE CONCEPTUAL FRAMEWORK

Given the importance of a conceptual framework in a research process, this section presents the conceptual framework used in this study. A conceptual framework can be viewed as providing a theoretical overview of intended research and the order within that process (Leshem & Trafford, 2007:96). It grounds the study in the relevant knowledge bases that lay the foundation for the importance of the problem statement and research questions (Rocco & Plakhotnik, 2009:126). Leshem and Trafford (2007:99) described roles of a conceptual framework as:

> "fulfilling an integrating function between theories that offer explanations of the issues under investigation…. providing a scaffold within which strategies for the research design can be determined, and fieldwork can be undertaken…. shaping how research conclusions are presented by emphasising the conceptualisation of those conclusions within their respective theoretical context…. Thus, the conceptual framework is a bridge between paradigms which explain the research issue and the practice of investigating that issue."

As highlighted in section 2.5, the study is embedded in the ICT4D field. In this regard, the following related and complementary frameworks were discussed, the Communications for Development (C4D) framework, the Sustainable Livelihoods Approach, and the e-Resilience Framework. Various elements from these frameworks were integrated to come up with a conceptual framework for analysing the contribution of ICTs in addressing climate change amongst rural farmers (Figure 2-9). The figure shows that in the context of ICT4D - ICTs are supposed to contribute to enhanced climate change awareness and the overall adaptation and mitigation capacity. According to Mudombi and Muchie (2010:2), ICTs are very important and contribute to the following. Firstly, ICTs improve the generation and the flow of climate change and early warning information. ICTs also help to improve the general preparedness and responsiveness in the system, thereby reducing the risk and uncertainty. In addition, ICTs can enhance the social capital and capacity of the community, which are important ingredients in successful adaptation. Furthermore, ICTs can also reduce transaction costs and help to widen livelihood options.

Figure 2-9: A conceptual framework for analysing the contribution of ICTs in addressing climate change



Source: Adapted from Mudombi and Muchie (2010:3)

Information has dual roles in the livelihood system - the analytical and the functional roles (Duncombe, 2006:6). These roles relate to how information is accessed, assessed and used to understand and plan livelihood strategies. The strategies are then applied into action to create favourable livelihood outcomes. In the e-Resilience framework, Ospina and Heeks (2010b) identified two ways in which ICTs contribute to adaptive processes (see section 2.5.3). Firstly, it is through their dynamic linkages with other system components namely, assets, institutions, structures and capabilities. Secondly, it is through the effect of ICTs on seven resilience sub-properties (robustness, scale, redundancy, rapidity, flexibility, self-organisation, and learning).

This study is mainly concerned with the facilitation of ICTs in the flow of climate change information and communication, which contributes to climate change adaptation. Thus, from Ospina and Heeks' e-Resilience Framework, this study focuses on some of the resilience sub-properties rather than all - of particular importance to this study are the following. ICTs facilitate *learning*, which enhances climate change awareness and the overall adaptation process. This is related to the second objective of the study, which seeks to evaluate how access to ICTs influence climate change awareness of communal farmers in the two districts (Chapter 5). Three other resilience sub-properties namely robustness, flexibility, and rapidity

are closely associated with the third objective of the study. This objective seeks to investigate the contribution of ICTs in climate change adaptation among the communal farmers in the two districts by focusing on access to early warning and weather forecasting information (Chapter 6). In this context, ICTs improve *robustness* by strengthening the physical preparedness of livelihood systems for climate change related events; they influence *rapidity*, as they enable rapid access to information; and they enhance *flexibility*, as they help to identify and undertake various adaptation actions to reduce the negative effect of climate change related events (Ospina and Heeks, 2010b).

2.12 CONCLUSION

The chapter is divided into two main sections, the first section focused on the theoretical foundations and the second section focused on empirical literature review. The first section laid an important theoretical foundation for the study, in which many theories and frameworks were discussed. The frameworks that were discussed include the AKIS and AIS frameworks, the Cynefin Framework, and the ICT4D approach. The second section focused on the empirical literature review on vulnerability to climate change. The literature showed that smallholder farmers are highly vulnerable to climate change, hence the need for them to be prepared and to adapt. However, a number of barriers were identified which include the lack of information, knowledge, and complementary inputs and technologies that are essential in the adaptation process.

In addition, the literature review showed that ICTs can contribute positively to climate change adaptation in the agricultural sector. However, the majority of the literature is based on theoretical assertions, with few sources having empirical support. This highlights a very huge gap that needs to be filled by undertaking more empirical studies in the field. In that regard, this study is based on empirical data and as such the next chapter presents the research methodology that was used to obtain the empirical data.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodology that was used in the study. Methodology is the science of finding out and it is a subfield of epistemology, which is the science of knowledge (Baxter and Babbie, 2004:4). Indeed, utilising an appropriate methodology is not only the right path to the truth, but also the duty of every researcher (Damian and David, 2007:54). Moreover, the ability to blend and use methods, which are appropriate, is an important issue for researchers to realise and incorporate into their research (Knox, 2004:124). The methodology covers issues that relate to the type of data collected, the way it was collected, and analysed. The chapter is organised as follows, first it discusses the research paradigms relevant to the study, followed by the design of the study. It outlines the design of the instruments and variables used. The analytical methods employed are also presented and discussed. Measures that were taken to ensure validity, reliability and ethical standards in the study are also highlighted.

To recap, the research objectives of the study are stated again. The first objective was to determine the level of access to and usage of ICTs by communal farmers in Seke and Murewa districts of Zimbabwe. The second objective was to evaluate how access to ICTs influence climate change awareness amongst the communal farmers. The third objective was to investigate the contribution of ICTs in climate change adaptation amongst these communal farmers. Based on these objectives the next section presents the research paradigms.

3.2 THE RESEARCH PARADIGM

du Plooy (2009:19) defined a research paradigm as "a set of shared basic beliefs about how researchers view that which they study". Morgan (2007:50-54) identified four different versions of the paradigm concept, which are paradigms as worldviews, as epistemological stances, as shared beliefs among members of a specialty area and as model examples of research. All versions treat paradigms as shared belief systems that influence the kind of knowledge researchers seek and how they interpret it, however, what distinguishes them is the level of generality of that belief system (ibid). This study adopts and discusses three

relevant paradigms namely, the post normal science (PNS), pragmatism, and mixed methods. Each of these is discussed in the next sections.

3.2.1 Post Normal Science (PNS)

Post-Normal Science (PNS) is a new conception of the management of complex science-related issues, which focuses on aspects of problem solving in which there are high stakes and uncertainty, decisions are urgent, and there are plural and conflicting value systems (Funtowicz and Ravetz, 2003:1). This research paradigm grew out of the realisation that the traditional scientific paradigm had inadequacies. For example, Westra (1997:238) noted that complexity and unpredictability are here to stay, and PNS makes the previous paradigms obsolete. Funtowicz and Ravetz (2003:2) further argue that the expectations of regularity, simplicity and certainty in the traditional 'normal' scientific mind-set, could inhibit our understanding of new problems and appropriate methods for their solutions. PNS is relevant for seeking to understand complex natural and social systems, moreover, it is an appropriate methodology when there are system uncertainties or when decision stakes are high (Funtowicz and Ravetz, 1991; Tognetti, 1999:691; Funtowicz and Ravetz 2003:2; Ravetz, 2004:347). PNS brings 'facts' and 'values' into a unified conception of problem solving, and its principle of the plurality of legitimate perspectives leads to a focus on dialogue, mutual respect and learning (Funtowicz and Ravetz, 2003:4).

Rodela, Cundill and Wals (2012:18) asserted that a PNS approach tends to be issue-driven, policy relevant, trans-disciplinary and emphasises issue improvement. In all that, the researcher recognises the value of different ways of knowing and different types of knowledge hence is engaged in boundary crossing and collaboration (ibid). The approach embodies the precautionary principle, and depend on public debate and engagement of extended peer community (Ravetz, 2004:347; Rodela, Cundill and Wals, 2012:18). As alluded to earlier, the focus of this study is climate change adaptation in the agricultural sector. In that context, Saloranta (2001:400) suggests that the climate change issue fulfils the attributes needed to belong to the domain of PNS. Saloranta claims that the enhanced problem solving in the climate change issue has been facilitated by use of such approaches, for example, in the Second Assessment Report of the IPCC.

Similarly, Etkin and Ho (2007:627) gave four reasons why climate change is an example of a problem that fits into PNS paradigm. Firstly, the linkages between science and society are profound. Secondly, the problem must be viewed holistically, with consideration of feedbacks between the climate system, the human system and ecosystems. Thirdly, there is large uncertainty and a plurality of legitimate perspectives with respect to risk. Fourthly, the climate change issue is complex, difficult or impossible to fit into a traditional linear problem-solving model. In addition, Westra (1997:238-239) postulates that the PNS comprises of at least three compatible aspects.

- The increased relevance of values, ethics and social aspects, hence the need for public discourse and debate.
- The switch from the expectations of the Newtonian scientific paradigm to the complex systems theory.
- Recognising that the ecological/ biological point of view may foster several possible developmental paths that may result in different configurations for ecosystems (ibid).

The discussion above highlight that the PNS paradigm is relevant to this study. The main thrust of the thesis is to assess climate change awareness and adaptation amongst smallholder farmers, and how ICTs contribute to this. Undoubtedly, there is a lot of uncertainty about climate change itself, which is compounded by the uncertainty in terms of how climate change will affect smallholder farmers such as those in Seke and Murewa districts and how they will respond. How people perceive, understand and adapt to climate change can be interpreted differently by different people. Furthermore, different methods can result in varied findings and outcomes thus the relevancy of the PNS paradigm.

3.2.2 Pragmatism

Another relevant paradigm to the study is pragmatism. Morgan (2007:48) highlights that much of the recent discussion in social science research methods has focused on the distinction between qualitative research and quantitative research. Likewise, Clark and Creswell (2008:7-11) observe that paradigm wars between qualitative (constructivist) and quantitative (positivist) researchers led to the emergence of pragamatism, which considers the importance of what works. Pragmatism research paradigm argues that the only way we can acquire knowledge is through a combination of action and reflection (Tashakkori and

Teddie, 2010:112). Whereas the connection of theory to data for qualitative approaches is inductive reasoning and for quantitive approaches is deductive reasoning, contrariwise, the pragmatic approach uses abductive reasoning which moves back and forth between induction and deduction (Morgan, 2007:71; Clark and Creswell, 2008:58-59). Morgan (2007:71) highlighted the main differences between quantitative, qualitative, and pragmatic approaches as shown in Table 3-1.

Table 3-1: Main differences between quantitative, qualitative, and pragmatic approaches

	Qualitative approach	**Quantitative approach**	**Pragmatic approach**
Connection of theory and data	Induction	Deduction	Abduction
Relationship to research process	Subjectivity	Objectivity	Inter-subjectivity
Inference from data	Context	Generality	Transferability

Source: Morgan (2007:71)

A key issue that can be drawn from the above discussion is that pragramatism emphasises flexibility, due to need to focus on what works. This study is multidisciplinary, hence, the relevancy of pragmatism. It combines aspects from many disciplines which demands a combination of diverse methods. This requires the need to move back and forth between qualitative and quantitative methods, combining methods that are complementary and most appropriate. Having discussed pragmatism the next section focuses on the mixed methods approach.

3.2.3 Mixed methods approach

A mixed method approach involves the use and combination of various quantitative and qualitative data collection and analytical methods in a single study in which the data are collected concurrently or sequentially and involves the integration of the data at one or more stages in the process of research (Clark and Creswell, 2008:165). If researchers focus on one approach, there is a possibility of failing to capture the bigger picture (Knox, 2004:123). Hence, the need to employ a mixed methods approach. There is a close link between pragramatism and the mixed methods approach. Pragmatism is generally regarded as a

philosophical base for mixed methods research (e.g. Johnson and Onwuegbuzie, 2004:16; Denscombe, 2008:273; Feilzer, 2009:14; Tashakkori and Teddie, 2010:96).

The general characteristic of mixed methods approach is the methodological eclecticism (Tashakkori and Teddie, 2010:8). This involves selecting and synergistically integrating the most appropriate techniques from qualitative and quantitative methods to investigate thoroughly, a phenomenon of interest (ibid). Feilzer (2009:6) posited that mixed methods research "has been hailed as a response to the long-lasting, circular, and remarkably unproductive debates discussing the advantages and disadvantages of quantitative versus qualitative research". The goal of mixed methods research is not to replace either of these approaches but to exploit the strengths and minimize the weaknesses of both (Johnson and Onwuegbuzie, 2004:14; Brewer and Hunter, 2006:63). Thus, it combines the rigor and precision of quantitative methods with deep understanding provided by qualitative methods (Rudestam and Newton, 2001:45).

The mixed methods approach is used for many reasons, which include the need to improve the accuracy of the data, to produce a more complete picture, and to avoid biases intrinsic to single-method approaches (Denscombe, 2008:272). It is more advantageous as each approach brings special strengths, and each compensates for the weaknesses of the other (Baxter and Babbie, 2004:65). The approach enables triangulation, which involves analysing something from multiple viewpoints (combination of two or more data collection methods and multiple sources of information to obtain data) which improves accuracy and validity (du Plooy, 2009:40; Neuman, 2006:149; Yeasmin and Rahman, 2012:156). Despite the relatively high cost of triangulation in terms of time, money and energy, it leads to synergy, enrichment and complementarity of data (Munyua and Stilwell, 2010:15). As a result, this allows for newer or deeper dimensions to emerge which enrich our understanding (Clark and Creswell, 2008:107). Brewer and Hunter (2006:39) argue that the mixed methods approach is more than just triangulation; it is a perspective that permeates all stages of the research process.

It is important to note that both triangulation and the mixed methods approach have some drawbacks. For instance, Tashakkori and Teddie (2010:9) asserts that even though triangulation has generally been associated with convergence of results, it is important to realise that results from different sources can also diverge. Furthermore, Yeasmin and

Rahman (2012:160) maintain that triangulation demands creativity and ingenuity in the collection and interpretation of data for it to produce a satisfactory outcome. In addition, Denscombe (2008:280) criticise the mixed methods approach, arguing that the combination of quantitative and qualitative methodologies is liable to be fragmented and inconsistent due to lack of an overarching philosophy. Besides the criticisms the mixed methods is of relevance to this study, what matters is the appropriate combination of the methods. Tognetti (1999:701) emphasised that, "what is important is not which perspective dominates, but how diverse kinds of knowledge can all contribute not only to the decision process, but also towards a new shared understanding".

In sum, three complementary paradigms were discussed. The PNS provides the overall guidance on understanding issues related to perceptions, information and knowledge of climate change. Pragmatism is closely related to the mixed methods approach - they emphasise flexibility and a combination of various methods that work best to achieve the desired outcome. The actual mixed methods used in the study are explained in the next section.

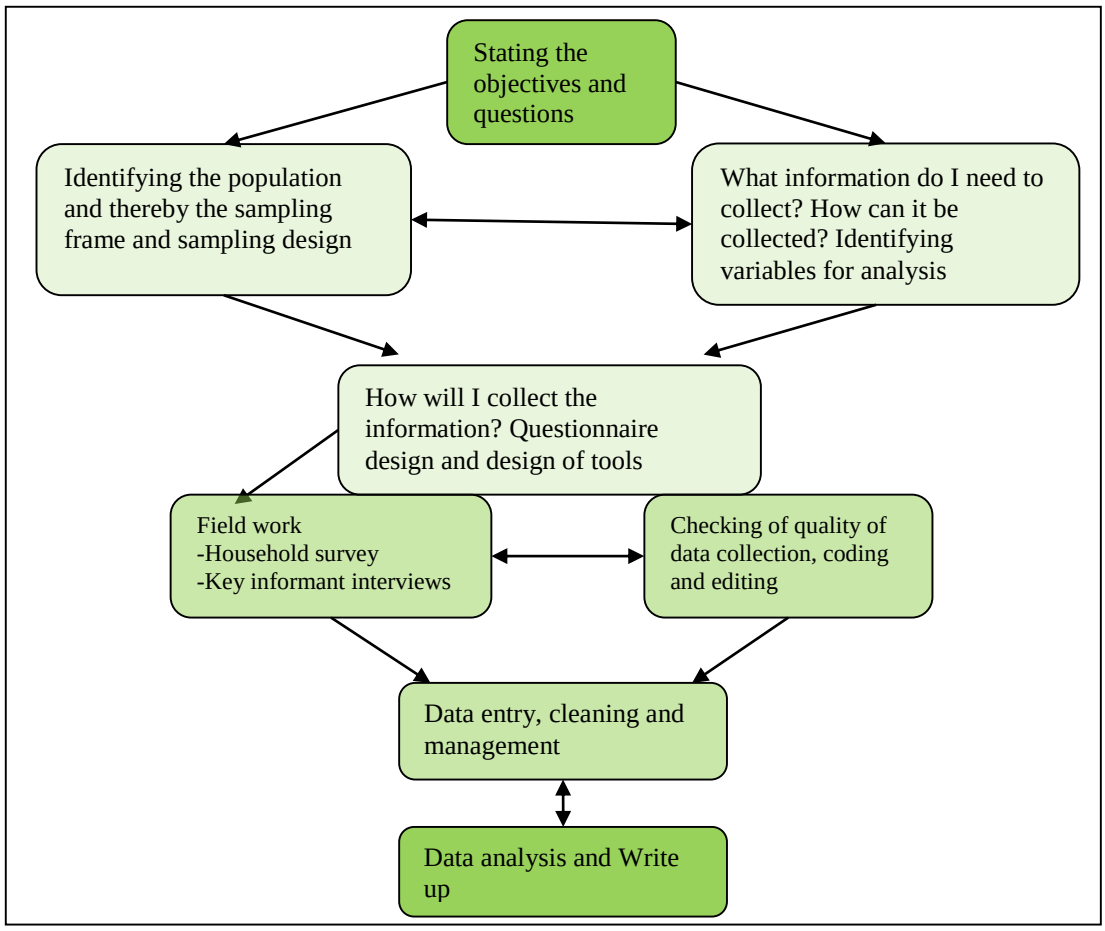
3.3 DESIGN OF THE STUDY

The data are only as good as the instruments that were used to collect them and the research framework that guided their collection (Pallant, 2011:3). As a result, measures were taken to ensure that the study and instrument design would produce data of highest quality to meet the objectives of the study. To recap, the main objective of the study was to analyse the contribution of ICTs in addressing climate change amongst communal farmers in Seke and Murewa districts of Zimbabwe. In order to meet the research objectives, it is important to state the research approach.

Generally, there are four common and useful approaches to research, which are exploration, description, causal/functional explanation, and understanding (Baxter and Babbie, 2004:30-31). From these approaches, the most appropriate approach for this study was exploratory. Baxter and Babbie advised that an exploratory approach is suitable when the researcher examines a new interest or when the subject itself is relatively new. This study analyses the contribution of ICTs in climate change adaptation in the agriculture sector, which is a relatively new field of enquiry (as highlighted in section 1.5 in Chapter 1). Now it is

important to discuss the design of the study, methods and instruments. The steps undertaken in designing the study are shown in Figure 3-1.

Figure 3-1: Design of the study



Source: Adapted from Patel et al. (2004:159)

Figure 3-1 shows the various steps undertaken in designing the study. Based on the research objectives and research questions, the steps included deciding which information to collect (variables), where was it going to be collected from (study area), from who (the target population), how was it going to be collected (methods), and how was it going to be analysed (data analysis). This study is a cross-sectional one, as it investigates the state of affairs in a population at a certain point in time (Adèr and Mellenbergh, 1999:110). As mentioned before, a mixed methods approach was adopted, particularly, the *dominant-less dominant* mixed methods approach (as explained by Rudestam and Newton, 2001:45). For this study, the quantitative method based on a general household survey targeting individual farmers was

the dominant method, while the qualitative method based on key informant interviews was the less dominant method. The next section talks about the variables used and the design of the questionnaires.

3.4 VARIABLES USED AND QUESTIONNAIRE DESIGN

Recommendations and guidelines from various books and manuals were followed to properly structure and design the survey questions for the study. Some of the guidelines that were followed include use of simple language, mutually exclusive and exhaustive response categories, avoiding using vague and emotionally loaded words and avoiding double-barrelled, complex, incomplete, and ambiguous questions (du Plooy, 2009:126-161; Pallant, 2011:10; Stopher, 2012:188-197). The choice of variables and the design of the questionnaire were guided by conceptual framework outlined in section 2.11 (some of the variables are further discussed in detail in section 3.6.2). An important step was to operationalise the constructs in the study in order to accurately measure the desired aspects (du Plooy, 2009:71). Operational definitions describe how the concept will be measured (Black, 1999:35; du Plooy, 2009:65).

The main purpose of the questionnaires in this study was to measure perceptions, views, and opinions of respondents (Black, 1999:215). In that regard, the questions and statements were formulated in an easy-to-understand way for both enumerators and respondents. Various types of questions were used in the questionnaires. These included binary questions (which required yes/no responses); rating scales; Likert scales; and open-ended questions. Likert scale questions involved asking respondents to rate a particular statement by selecting one of these responses: strongly agree, agree, neutral, disagree, or strongly disagree (du Plooy, 2009:142). The study used two questionnaires, one for the general household survey and the other for key informants (attached in Appendix 1 and 2). The next subsections describe how the ICT and climate change variables were formulated.

3.4.1 ICT use and access variables

The ITU (2003:4) highlights the importance of understanding who has access, where and how people use ICTs. Access to ICTs can be measured at different levels; individual, household, and the community (ITU, 2003; Alampay, 2006:2). In this study, access to ICTs was mainly

evaluated at two levels namely the individual level and the household level. The study analysed ownership and access to both old and new ICTs, namely, radio, television, video cassette recorder (VCR), digital video disc (DVD) player, fixed telephone, mobile phone, satellite decoder, computer, and internet. The really old ICTs were also included (outlined in Section 2.8.1 in Chapter 2). These are the traditional print media namely, newspapers, farming/environmental magazines, business magazines, entertainment magazines, church magazines, and posters. It is important to note that the term ICT largely refers to electronically based technologies, nonetheless, in this particular study, it was deemed necessary to include even those in print format. Various questions were formulated to explore ways in which ICTs were contributing to climate change adaptation amongst rural households. The questions included those related to basic knowledge of ICTs, ownership of ICTs in terms of who owned and the number owned per household, access to and use of ICTs within the household, issues to do with sources of energy power for the ICTs, perceptions related to maintenance and accessibility costs, perception of importance of various ICTs to livelihoods, climate information, and climate change awareness and adaptation.

3.4.2 Climate change related variables

The main issues that were evaluated include respondents' perceptions on rainfall and temperature trends, climate change awareness and adaptation, as well as rainfall forecasting and early warning systems. Elicitations of views on climate change which rely on past events can serve as analogues for future changes and as a means of stimulating critical consideration of impacts (Lorenzoni and Pidgeon, 2006:81). In addition, the perceptions are important in developing an effective strategy to climate change adaptation (Ruddell et al. 2012:581). Moreover, studying the use of forecasts provides a more detailed view of the forecast process, which helps to anticipate use patterns and increase the effectiveness of forecast dissemination (Pfaff et al. 1999:649; Letson et al. 2001:59). Furthermore, there is need to identify key farming decisions that would be sensitive to climate and weather information (Stone and Meinke, 2006:18).

In evaluating climate change awareness and knowledge, the aim of this study was not to ask respondents, scientific definitions or technical aspects of climate change, but to evaluate their basic knowledge on various climate change aspects. Myers (2005:13) notes that research that measures knowledge, attitude, behaviour and practice (KABP) is useful for finding out what

your target audience already knows and practices. Similarly, Grothmann and Reusswig (2006:118) emphasise the importance of studying people's own perceptions and assessments of these aspects. However, the challenge with asking people about climate change is that most of them would not have thought about the issue at any length and thus cannot give meaningful responses (Kempton, 1997:13). Thus, extra effort was taken in order to evaluate climate change awareness.

Questions were presented as statements designed to elicit attitudes and opinions. Marshall et al. (2010:4) used the same approach in assessing awareness and attitudes of environmental conditions and climate change issues of dive tourists and dive operators in the Egyptian Red Sea. Marshall et al. (2013:31) also examined the influence of climate change awareness on the capacity to adapt to climate risks of peanut growers in Queensland, Australia. Likewise, Stamm, Clark and Eblacas (2000:223) measured the breadth of knowledge by counting the number of items each respondent had heard about global warming, and depth of concern by counting the number of the causes or solutions considered important or helpful by the respondents. Following the procedures used in the studies, the next paragraph outlines what was done in this study.

First, respondents were asked a yes/no question on whether they were aware of climate change or had some knowledge about it. This initial question separated those who were aware and those who were not aware of climate change. For the respondents who had indicated that they were aware of climate change, they were asked to rate how strongly they agreed with each of the 11 statements that covered various aspects of climate change including causes, effects, adaptation and mitigation. The statements were based on a five-point Likert scale (1= strongly agree, 2= agree, 3= undecided, 4= disagree, 5= strongly disagree). In addition to evaluating climate change awareness, other questions focused on sources of the climate change information, adaptation and access to rainfall forecasting information. The next section explains the data collection process and methods employed in the study.

3.5 DATA COLLECTION AND METHODS

The choice of data collection methods is directly related to the research topic and available resources (Fowler, 2009:69). As discussed before, a household survey and key informant

interviews were used in the study. On one hand, the household survey was undertaken to get quantitative data from individual farmers, and on the other hand, the key informant interviews were used to map the institutional context in which farmers made their decisions and to cross-reference the information provided. The next sub-section discusses the study area, target population and the sampling methods used in the study.

3.5.1 The study area, Population and Sampling

As highlighted before the study was conducted in Seke and Murewa districts situated in Mashonaland East Province of Zimbabwe. The general description, map and more details of the study area have been presented in section 1.6 in Chapter 1. According to the census of year 2002, Zimbabwe had a total population of about 11 634 663 people and Mashonaland East province had a total population of about 1 127 413 people and 309 198 households (CSO, 2004:3). Most of the population in the province is rural, accounting for about 76 percent of the total population (ibid). The target population were rural households whose livelihoods were mainly agricultural dependant. The next section discusses the sampling approach employed in the study.

3.5.2 Sampling

A multi-stage sampling was used for the survey. It is a sampling approach that involves selecting a sample of clusters and, within each cluster, further selecting a sample of study units (Patel et al. 2004:162). The multi-stage sampling approach falls under qausi-probability sampling which is similar to a probable sample except that the procedure used to draw the sample differs (du Plooy, 2009:118). This approach is appropriate when drawing a true probable sample is unfeasible, when there is no adequate list of the individuals in the population and there is no way to get to the populations directly (Fowler, 1993:18; Black, 1999:118; Fowler, 2009:28, du Plooy, 2009:120). It allows the researcher to avoid the need to create an expensive sampling frame when there is no sampling frame (Stopher, 2012:305). It is important to note that for this study, the sampling frames were unavailable at the district, provincial and national level, they were only available at the village level. Admittedly, Stopher (2012:266) observes that sampling frames for human populations are usually difficult to obtain in most countries due to non-existence of the lists or their unavailability to researchers.

The sampling process undertaken in the study is as follows. The multi-stage sampling involved a combination of purposive and cluster sampling approaches. Purposive sampling involves handpicking subjects based on specific characteristics, while, cluster sampling involves random samples of successive clusters (Black, 1999:118). Purposive sampling was used to select the province and the subsequent selection of the two districts. One of the desired characteristics was to have two rural districts, one of which was supposed to be closer to a major urban area while the other district was a bit far. The districts' proximity to urban areas was important, as there was a need to evaluate how such differences could influence access to ICTs and climate change awareness.

For the reasons that have just been discussed, Mashonaland East province was selected. The province has Seke (rural) district, which is closer (adjacent) to the major urban centres namely, Chitungwiza town and Harare the capital city. Murewa district is relatively far from these urban centres (about 100 kilometres). Having selected the province and the two districts, three wards were purposively selected in each district based on the criterion of geographical spread across each district (using district maps). Cluster sampling was then used to select five villages (clusters) in each of the three wards. Bluman (2004:11-13) suggests that cluster sampling is used when the population is large or when it involves subjects residing in a large geographic area. At the village level, the sampling units were selected systematically according to the sampling frames that had complete list of all households in the village. In terms of key informant interviews, a snowballing sampling approach was used. This involved identifying and interviewing initial key informants, who also identified other key informants. The next section discusses the sample size for the survey.

3.5.3 Sample size

Black (1999:110) posits that an appropriate sample size depends on the original research question and the design chosen. While it is desirable to have a large sample which is representative of the population, this may not always be possible due to constraints such as limited resources (Fowler, 1993:10; Black, 1999:136; Brewer and Hunter, 2006:80). Consequently, a compromise between greater representativeness of a sample and the higher cost can be reached at relatively modest sample sizes (Stopher, 2012:65). Furthermore, there are occasions when the goal of the study is not to generate statistics about the population but

to describe a set of people in a more general way (Fowler, 1993:10; Black, 1999:136). du Plooy (2009:113) gave recommendations on sample sizes for simple random sampling with tolerated error at 95% and 99% confidence levels as shown in Table 3-2.

Table 3-2: Simple random sample sizes

Tolerated error	Confidence	
	95%	**99%**
1%	9604	16587
2%	2401	4147
3%	1067	1843
4%	600	1037
5%	384	663
6%	267	461
7%	196	339

Source: du Plooy (2009:113)

Though this study did not use simple random sampling, du Plooy's sample size recommendations were used as a rough guide. Hence, a relatively modest sample size of 300 was chosen. This sample size is closer to a sample size of 267, which has a tolerated error of 6% with a 95% confidence interval (shown in Table 3-2). Due to unavailability of a sampling frame at the district level, a sample size of 150 households per district was deemed reasonable given the resources that were available. Related to the sample size is the sampling interval. du Plooy (2009:119) indicated that the sampling interval is calculated by dividing the total population by the desired sample size. In this study, the desired sample size per village was ten. The actual breakdown of the sample used in the study is shown in Table 3-3, it is categorised by district, ward and village.

The sampling units were selected based on the sampling interval and the starting point was randomly selected. The sampling unit in the study was the rural household[8]. Fowler (2009:35) suggested that the best decision on choosing who will be a respondent depends on

[8] A household constitutes a person or group of persons, irrespective of whether related or not, who normally live together in the same housing unit or group of housing units and have common cooking arrangements (Stork and Stork, 2008)

what kind of information is being gathered. If the information is general then any household member can be a respondent, however, for more specialised information, the household member who is most knowledgeable is the appropriate respondent (ibid). The respondents in this study were the household heads in the households that were selected. The main reason for choosing the household head was because generally he/she makes most of the decisions regarding agriculture and other livelihood activities within the household. In this study a household head is defined as that member of the household who is regarded as such by those who stayed with that member and can be either male or female (CSO, 2004:25).

Table 3-3: The sample breakdown by district, ward, and village

Seke District			**Murewa District**		
Ward	**Village**	**Number of units**	**Ward**	**Village**	**Number of units**
1	Chitsvatsva	10	1	Chitengu	10
	Jaure	10		Gandazha	10
	Mhundwa	10		Gatsi	10
	Rusirevi	10		Guzha	10
	Zin'anga	10		Sadza	10
2	Chitate	10	16	Chinake	10
	Huni	10		Chinondo	10
	Mudimu	10		Choruwa	10
	Rubatika	10		Makore	10
	Zhanje	10		Zvomuya	10
5	Kondo	10	6 *(did not have individual villages)*	Chitowa Small-scale farming area	50
	Mushonga	10			
	Ndoro	10			
	Sengu	10			
	Zhakata	10			
	Total	**150**		**Total**	**150**

3.5.4 The data collection, entry, and cleaning

In line with standard procedure, before commencing the data collection process, clearance to undertake the research was sought from the Government of Zimbabwe through the Ministry of Local Government, Rural and Urban Development. The clearance was approved on 16 May 2011 (the approval letter is attached in the appendix 4). At the district level, clearance to undertake the data collection was also granted. In Murewa district, an approval letter was issued (attached in the appendix 5). In Seke district, the district administrator indicated that

there was no need for an additional clearance letter as there was already another one from the parent government ministry.

Both the survey of the individual farmers and the key informant involved face-to-face interviews conducted by trained enumerators. In a face-to-face interview, the interviewer has a script for the interview and a method to record the answers provided by the respondent (Stopher, 2012:105). The advantage of face-to-face interviews is that they have the highest response rate and permit the longest questionnaires while the disadvantage is the high cost of conducting the interviews (Neuman, 2006:301). The data collection process started with the selection of candidates who were suitable to do the enumeration. The selected candidates had a minimum qualification of a diploma in agriculture, which made it easier for them to understand the objectives of the research and to interpret the questionnaires. Two training workshops for the enumerators were conducted. The first training workshop was conducted for Seke district at Seke Rural district council offices at Dema Business Centre on the 16th of June 2011. In this workshop nine enumerators and one data collection supervisor were trained. The second training workshop was conducted for Murewa district at the Agricultural Technical and Extension Services (AGRITEX) offices at Murewa Business Centre on 22nd of June 2011. In this workshop ten enumerators and one supervisor were trained.

The training ensured that enumerators followed standard procedures in undertaking data collection especially in administering the interview questions, responding to questions, and in maintaining ethical standards. The training process involved going through the whole questionnaire discussing each question and clarifying the coded responses. This was then followed by the piloting of the questionnaire, whereby each enumerator interviewed two respondents from households that were in villages adjacent to the offices where the training took place. Pilot surveys and pre-tests are the procedures that are used to test and refine the survey before it is actually fielded (Stopher, 2012:251). After pre-testing, the responses were discussed and sections that were not clear were clarified, particularly on the operational definitions of terms such as climate change, as there are no proper terms to describe such terms in local language (NB. the filled-in pretesting questionnaires were not included in the final dataset).

The actual data collection (field survey) commenced soon after training the enumerators. It started towards the end of June 2011 up to the end of August 2011. 300 respondents were interviewed in the general household survey and 20 respondents in the key informant interviews. The data collection process was overseen by two supervisors, while this researcher gave overall management. The role of the supervisors was to coordinate and supervise the entire data collection process at the local level. They supervised on four aspects: costs, rate of response, quality of completed questionnaires and quality of interviewing (Fowler, 2009:136). The supervisors cross-checked and verified every questionnaire to ensure that it was filled-in correctly, and took the appropriate action such as seeking clarification from the enumerators or revisiting the respondent to cross-check. The next paragraph talks about data entry.

The researcher created a data entry template in the Statistical Package for Social Scientists (SPSS 17.0) package for capturing the completed questionnaires from the survey. Some responses on the questionnaires were pre-coded, while others were post-coded. Stopher (2012:74) suggested that coding is a step in which responses in the questionnaire are converted into codes that permit computer based analysis to be undertaken. The researcher then trained two research assistants to assist with data entry. The actual data entry started soon after the filled-in questionnaires were cross-checked for errors and completeness. The process took about two months. After the completing the data entry process, the data was then cleaned and checked for outliers, wrong spellings and any other errors.

3.6 DATA ANALYSIS

Preliminary analysis was conducted to explore the data and check the general distribution of the variables. Coe et al. (2002:13) remind that it is impossible to do a sound analysis without knowing what you wish to achieve. In that context, it was important to find appropriate analytical methods for the research questions and respective research objectives. The summary of the analytical methods employed in the study are presented in Table 3-4. The analytical methods used are broadly classified as descriptive statistics and multivariate analysis, each discussed in the subsequent sub-sections.

Table 3-4: Summary for analytical methods used for each objective

Research Question	Research Objective	Analytical method
What information and communication technologies are available and used by communal farming households in Seke and Murewa districts of Zimbabwe?	To determine the level of access to and usage of information and communication technologies by communal farmers in Seke and Murewa districts of Zimbabwe	Descriptives: -Univariate analysis (frequencies, means, percentages, graphs, charts)
How do the available information and communication technologies influence climate change awareness of communal farmers in Seke and Murewa districts?	To evaluate how access to information and communication technologies influence climate change awareness of communal farmers in Seke and Murewa districts.	Multivariate analysis: -Ordered Multinomial Regression model
What is the contribution of information and communication technologies to climate change adaptation amongst communal farmers in Seke and Murewa districts of Zimbabwe?	To investigate the contribution of information and communication technologies in climate change adaptation amongst communal farmers in Seke and Murewa districts of Zimbabwe.	Descriptives: -Univariate analysis (frequencies, means, percentages, graphs, charts)

3.6.1 Descriptive statistics

Descriptive statistics are used to describe the characteristics of the sample, to check the variables for assumption violation and to address specific research questions (Pallant, 2011:53). The aim of undertaking descriptive statistics was to establish patterns, relationships and to describe variables. The patterns and structures in the data are discovered through the distribution of single variables and by relationships between variables (Adèr and Mellenbergh, 1999:135). Descriptive analysis provides summaries to meet the research objectives and to show the general picture from the data (Coe et al. 2002:25). Simple exploratory and descriptive analysis provides much of what is needed to complete data analysis (ibid). In this study, the preliminary analysis and descriptive statistics were performed using Statistical Package for Social Scientists (SPSS 17.0) package. The descriptive statistics comprise univariate analysis in which data for single variables are analysed on their own (Cramer, 1994:15). These include frequencies, proportions, means, percentages, graphs, and charts. These statistics were used to describe all the important

variables in the study (the results are presented in the following chapters). The key informant interviews were analysed by collating the information from the filled-in checklists in Excel.

3.6.2 Multivariate analysis

Until recently, the greatest obstacle in using models for categorical and limited variables was the lack of software that was flexible, stable, and easy to use (Long, 1997:3). Statistical programs allow statistics to be calculated quickly and accurately (Cramer, 1994:45). The data was incorporated into Stata package for higher-order econometric analysis. The aim was to explore and discover the relationship between ICT variables and climate change variables.

Evaluating determinants of climate change awareness

A regression model was used to evaluate the determinants of climate change awareness. Cramer (1994:242) asserts that one of the main purposes of multiple regression is to determine the variables which are strongly related to the criterion. However, before discussing the regression model that was used, it is important to discuss first, how the dependent variable was computed. This gives an important background on why that particular regression model was selected. The next paragraph highlights other studies that have formulated indices and categorisations similar to the one used in this study.

A study by Nagenthirarajah and Thiruchelvam (2008) assessed farmers' knowledge about pest management practices in Vavuniya District in Sri Lanka. In that study, Nagenthirarajah and Thiruchelvam categorised the respondents' knowledge of pesticides use into three groups (low, medium and high level of knowledge) based on a knowledge scale they computed by summing response scores from five-point Likert scale based statements concerning the pesticide use in vegetable cultivation, environment and health. Similarly, Cankurt et al. (2008) assessed the level of awareness to environmental pollution in Turkey using five-point Likert scale statements on soil, air and water. Likewise, Osberghaus et al (2010) measured the personal perceived risk to climate change by constructing an index by aggregating 17 five-point Likert scale items. The next paragraph discusses how the climate change awareness dependent variable in this study was computed.

To recap, section 3.4 has a subsection, which outlines how the climate change awareness variables were operationalised. From the data, a climate change awareness index (CCAI) was formulated as follows. The scores from the 11 questions were added to get total scores that ranged between -22 and 22. In order to get an index between -1 and 1, the total score for each respondent was then divided by 22. From this index, respondents were then categorised into three categories namely, not aware; low awareness; and high awareness (further explained in Chapter 5, section 5.3). This gave an ordered variable, which was used as the dependent variable. When variables are structured in a logical order, they are referred to as ordinal or ordered categorical variables (Coe et al. 2002:119). After having formulated the dependent variable, it was important to select the appropriate regression model, which is the discussion of next paragraphs.

When the dependent variable is not continuous or not observed for all cases or is ordinal, the linear regression model is inappropriate (Long, 1997:1; Long and Freese, 2006:183). Furthermore, Long (1997:3) states that if the model chosen assumes a wrong level of measurement, the estimator could be biased, inefficient or simply inappropriate. This implies that the linear or binary regression models are inappropriate models for this dependent variable as it is ordered. The dependent variable cannot just be treated as an ordinary binary outcome (yes/no) because people's levels of awareness differ hence the need for ordering. In such a case, Nagenthirarajah and Thiruchelvam (2008:83) suggest that a multinomial model for discrete choice of ordered data is more applicable. In addition, Cameroon and Trivedi (2005:519) explain that an ordered multinomial model is appropriate, more parsimonious and sensible for such dependent variables as it takes into account the ordering. The next paragraphs discuss the type of multinomial regression model used in the study.

Cameroon and Trivedi (2005:490-528) discuss various multinomial models which can be grouped into models for unordered outcomes and models for ordered outcomes. As highlighted in the previous paragraph, an ordered multinomial model is more appropriate for this study. Before describing the model specifications, it is important to highlight related studies that have applied such models. These studies are presented in Table 3-5.

Table 3-5: Related studies that have applied ordered logit and ordered probit models

Authors	Year	Model used	Study
Torbett et al.	2007	Ordered logit model	Perceived importance of precision farming technologies in improving phosphorus and potassium efficiency in cotton production
Nagenthirarajah and Thiruchelvam	2008	Ordered probit model	Knowledge of Farmers about Pest Management Practices in Pambaimadu , Vavuniya District : An Ordered Probit Model Approach
Cankurt et al.	2008	Ordered logit model	Awareness to Environmental Pollution in Turkey
Ngo, West, and Calkins	2009	Ordered probit model	Determinants of environmentally responsible behaviours for greenhouse gas reduction
Ziegler, Schwarzkopf, and Hoffmann	2009	Ordered probit model	Stated Versus Revealed Knowledge : Determinants of Offsetting CO 2 Emissions from Fuel Consumption in Vehicle Use
White and Hunter	2009	Ordered logit model	Public Perception of Environmental Issues in a Developing Setting: Environmental Concern in Coastal Ghana
Osberghaus et al.	2010	Ordered logit model	Individual adaptation to climate change: The role of information and perceived risk

Table 3-5 shows that there are a number of environmental and agricultural based studies that have actually used the ordered multinomial models. The model specification of the ordered multinomial model as outlined by Cameroon and Trivedi is shown by Equation 3-1 to Equation 3-3.

Equation 3-1: The basic model

$$y_i^* = x_i'\beta + u_i$$

From Equation 3-1, as y^* crosses a series of increasing unknown thresholds we move up the ordering of alternatives. The general form of an ordered model (with *m*-alternatives) is shown by Equation 3-2.

Equation 3-2: General form of an ordered model

$$y_i = j \quad if\ \alpha_{j-1} < y_i^* \leq \alpha_j$$

Where $\propto_o = -\infty$ and $\propto_m = \infty$. Then

$$Pr[y_i = j] = Pr[\alpha_{j-1} < y_i^* \leq \alpha_j]$$

$$= \Pr[\alpha_{j-1} < x_i'\beta + u_i \leq \alpha_j]$$

$$= \Pr[\alpha_{j-1} < x_i'\beta < u_i \leq \alpha_j - x_i'\beta]$$

$$= F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta),$$

where *F* is the cumulative distribution function of u_i. The regression parameters β and the (m-1) threshold parameters $\alpha_1, \ldots, \alpha_{m-1}$ are obtained by maximising the log-likelihood shown in Equation 3-3.

Equation 3-3: Maximising the log-likelihood

$$\mathcal{L} = lnL_N = \sum_{i=1}^{N}\sum_{j=1}^{m} y_{ij} ln\, p_{ij}$$

It is important to realise that there are two models that are classified as ordered multinomial models; these are the ordered logit model and the ordered probit model. For the ordered logit model u is logistic distributed with $F(z) = e^z/(1 + e^z)$. For the ordered probit model u is standard normal distributed and $F(\cdot)$ is the standard normal cumulative distribution function. The sign of β is interpreted as as determining whether or the latent variable y^* increases with the regressor (ibid). This study used the ordered logit model.

Estimation of the Ordered Logit regression model

The dependent variable was the ordered climate change awareness variable (0= not aware; 1= low awareness; 2= high awareness), which was explained at the beginning of this section. The independent variables comprised ICT access variables and other socio-economic characteristics. The inclusion of socio-economic factors in the regression model was necessitated by the fact that it is not only ICT access variables that can influence climate change awareness. The ITU (2003:18) state that it is difficult to quantify and separate the impact and influence of ICTs from those of other factors. Hence, it is important to understand

the relationship between ICTs and socio-economic factors when considering their use in climate change adaptation (Akoh et al. 2011:28). The variables used in the model are presented in Table 3-6. All these factors were drawn from the literature review (Chapter 2, mainly section 2.7.7) and the conceptual framework presented in section 2.11.

Table 3-6: Variables used in the Ordered Logit regression model

Independent variables	Variable name in the model	Expected relationship
Gender of the household head	Gndrhhd	-/+
Age of the household head	Agehhd	-/+
Education level of the household head	Edhhd	+
land size	lnd_mnld	-/+
Agricultural income	y_agrc	+
Access to extension	Accextn	+
Cosmopoliteness	Vsttown	+
Position of authority	Potnaut	+
Participation in farmer organisations	Partcpfr	+
Participation in developmental organisations	Partcpdv	+
Access to radio	Ownrad	+
Access to TV	Owntv	+
Access to mobile phone	Ownmobl	+
Access to newspapers	Rdnwpp	+
Access to farming/ environmental magazines	Rdenvr	+
Ever talked about climate change	Talkdcc	+

The conceptual framework shown Figure 2-9 is centred on the livelihoods framework. Some of the main components of the framework are the livelihood assets (human, social, natural, financial, and physical) which influence the livelihood strategies that are adopted and the outcomes thereof. These strategies and outcomes in turn also determine the livelihood assets, whether they depreciate or appreciate. As highlighted before, this study seeks to analyse the contribution of ICTs in addressing climate change amongst rural farmers with a particular focus on the importance of information, communication, and knowledge. Thus, the variables included were mainly determined by and related to livelihood assets that influence access to and usage of information, communication, and knowledge.

From the variables listed in Table 3-6, there are personal variables such as gender, age, and education level, which in terms of livelihood assets are mainly associated with human capital. Land size and agricultural income are very important in rural areas – they relate to financial capital, which has a direct and indirect influence on the ownership of other assets. Agricultural extension is closely related to human capital, as its main objective is the transfer of knowledge and skills. Position of authority, and participation in farmer and developmental organisations tend to be positively related to access to various assets including access to information and knowledge – these variables relate to human and social capital. Access to various ICTs tends to have a positive relationship with access to information, communication, and knowledge – they relate to physical capital and their ownership and access is strongly influenced by financial and social capital.

3.7 RELIABILITY AND VALIDITY ISSUES

Important steps were taken to ensure that the data was of good quality. This was done by ensuring validity and reliability at various stages of the research process. Validity relates to how the study accurately assesses the specific concept that the researcher is attempting to measure (Bailey, 1994:120; du Plooy, 2009:135; Pallant, 2011:7). There are different types of validity. These include construct validity, face validity, content validity, internal validity and external validity. Reliability relates to how data collection instruments give consistent readings (Brewer and Hunter, 2006:110; du Plooy, 2009:131; Pallant, 2011:6).

Bias in research can arise from errors that occur during measurement when the measuring device is not accurate, when the sample is not representative and due to procedural bias (Stopher, 2012:74; Yeasmin and Rahman, 2012:157). Measures were taken to reduce both the sampling and non-sampling errors and bias. Some errors were avoided by taking preventive measures at the design stage, while others such as measurement errors, processing errors, and over-coverage were corrected through data editing (Adèr and Mellenbergh, 1999:126). During data collection, sampling frames were updated by comparing household lists from the village heads and the household lists from the agricultural extension agents to come up with comprehensive lists. Moreover, the instruments were validated by other experts in the field (also known as expert-jury validity) (Black, 1999:199; du ploy, 2009:136). Experts who were consulted included researchers within and outside the university working on climate change

and ICT issues. In addition, the pilot testing of the questionnaire also ensured the correction and adjustment of certain parts of the questionnaire to improve its reliability and validity.

Adèr and Mellenbergh (1999:128) identified three groups of non-respondents: refusers (those who do not co-operate), not contactable (not available), and not able (e.g. due to language problems). In this study, various ways were used to overcome non-response from respondents. For respondents who were not available during the first visit, follow-up visits were made to get the respondents. In cases where some respondents experienced language problems, this was overcome by using local language and terms. However, none of the respondents refused to co-operate, though the tentative plan was to select other sampling units based on the replacement criteria.

The Likert scale questions/statements on climate change awareness were checked for their internal consistency using the Cronbach's Alpha (du Plooy, 2009:134; Pallant, 2011:97; Marshall et al. 2013:32). The Cronbach's alpha measures reliability by establishing the consistency with which respondents reacted to the items on the measure (Black, 1999:274; du Plooy, 2009:134; Pallant, 2011:6). In other words, the scale's internal consistency refers to the degree to which the scale items 'hang together' (Pallant, 2011:97). Coefficient values above 0.7 are considered acceptable; however, values above 0.8 are preferable (ibid:100). The Cronbach's Alpha for this study is reported in section 5.2.

3.8 ETHICS

Ethics in surveys have to do with what is morally and professionally appropriate on the part of the researchers. This gives assurance to potential respondents that the survey will be conducted according to the highest professional standards (Stopher, 2012:90). Prior to commencing data collection, ethical clearance was sought from the university. In addition, clearance to undertake data collection in the study area was sought from the Government of Zimbabwe through the Ministry of Local Government, Rural and Urban Development, and the respective offices of the District Administrators in the two districts. The clearance letters are attached in the appendix.

Steps were taken to avoid risk and harm to participants, non-participants, and organisations involved. Firstly, participants were briefed about their involvement in the research and were assured that the information collected was purely for research purposes and its confidentiality was guaranteed. Secondly, potential respondents were briefed on their right to decline participation in the study, if they chose to do so. Thirdly, all the information and data that was collected was, is and will be kept safe and used for research purposes only.

3.9 CONCLUSION

The chapter presented various issues related to the methodology and the research methods used in the study. These include the research paradigm, research design, data collection methods, and analytical approaches. Various research paradigms namely post normal science, pragmatism, mixed methods were discussed. The close link between pragramatic paradigm and the mixed methods approach was explored. The chapter also discussed the key variables in the study and how the data collection instruments were designed and used. Further, the data analysis approach and the observation of ethical standards were discussed. The next chapters present the results.

CHAPTER 4: DESCRIPTIVES OF FARMING SYSTEM CHARACTERISTICS AND ACCESS TO ICTs

4.1 Introduction

The chapter presents the preliminary analysis of the study. This is composed of descriptive results of key variables, which are presented in two main sections. The first main section describes the general farming system characteristics (from section 4.2 to section 4.10). The second main section dwells on access to ICTs (from section 4.11 to section 4.16). The general farming system characteristics are presented in the following order: household demography, marital status, education, land ownership, sources of income and agricultural production, participation in organisations and positions of authority, farmer-to-farmer input exchange and interaction, access to agricultural extension and farmer training. The presentation of the results is done concurrently with the discussion.

4.2 Household demography

Various demographic factors such as gender and age of the household head, and household size were analysed. 150 respondents were interviewed in each of the two districts to give a total of 300 respondents. The composition of the sample (both Seke and Murewa) is as follows, 32% were female-headed households and 68% were male-headed households as shown in Table 4-1.

Table 4-1: General household characteristics by district

		District		Total
		Murewa	**Seke**	
Gender of Household head	Female	31%	33%	32%
	Male	69%	67%	68%
Age of household head		51	53	52
Household size		5.9	5.8	5.8

Source: Survey data

The average age of the household head was 51 years in Seke district and 53 years in Murewa district. The minimum and maximum ages of the household head in the two districts were 23 and 98 years respectively with a mean age of 52 years. In addition, the minimum and maximum household sizes were 1 and 18 respectively, and an average household size of approximately 6 members.

4.3 Marital status

On average, most of the respondents in the two districts were monogamously married (63%). This was followed by those who were widowed (24%), while 5% were in polygamous marriages, 3% were single, and another 3% were either divorced or separated as shown in Table 4-2.

Table 4-2: Marital status by district

Marital status	District		Total
	Murewa	Seke	
Single	3%	3%	3%
Monogamously married	63%	64%	63%
Polygamously married	7%	5%	6%
Widowed	23%	25%	24%
Divorced/separated	4%	3%	3%

Source: Survey data

4.4 Education

Education is very important in enhancing the knowledge of people. It is through education that a person is able to read, write and understand the diverse information including agricultural and climate change information. The majority of the household heads had some basic education while only 4% of the household heads did not have any form of formal education as shown in Table 4-3. Close to half of the respondents had attended post primary education which included secondary and some tertiary education.

Table 4-3: Education level by district

Level of education	District		Total
	Murewa	Seke	
no formal education	5%	3%	4%
Adult education	5%	7%	6%
Primary	43%	34%	39%
Secondary	43%	52%	48%
College and university	3%	1%	2%

Source: Survey data

4.5 Land ownership

The general land ownership in the two districts was mainly communal, except in Ward 6 (Chitowa Small-scale farming area) which is an old resettlement area in Murewa district. In Zimbabwe, there are various land tenure systems depending on the area. They are classified as communal areas, small-scale commercial farms, large-scale commercial farms and the resettlement areas. The communal land ownership which is common in Seke and Murewa districts is characterised by traditional or community ownership of land. This way, the landowner has the right to use the land with limited power to transfer the landholding except to close family members and relatives.

Households in Murewa districts generally had relatively larger land sizes in terms of the homestead fields (land surrounding the homestead), garden land and mainland (Table 4-4). The mainland in this study refers to that land or fields that are considered the main fields by the household. The mainland area is relatively larger than fields surrounding the homestead. The average mainland size for Seke district was 1.5 hectares, while for Murewa district the communal based wards had an average of 2.2 hectares. However, the average land size for Murewa was very high at 14.9 hectares when including Ward 6, which is comprised of Chitowa small-scale resettlement farming area, which had land sizes of 40 hectares and above. The average land sizes for the homestead fields and gardens for Seke was 1.8 hectares and for Murewa district, was 2.2 hectares.

Table 4-4: Average land sizes

Variable		District		Total
		Murewa	**Seke**	
Land size	Mainland	2.2 (Communal lands only) 14.9 (resettlement area included)	1.5	8.2
	Homestead and garden	2.2	1.8	2.0
	Cultivated area 2010/2011	6.7	2.1	4.4
	Cultivated area 2009/2010	5.1	2.2	3.6
Percentage using irrigation		11%	4%	7%
Number of years household has been farming		24	20	22

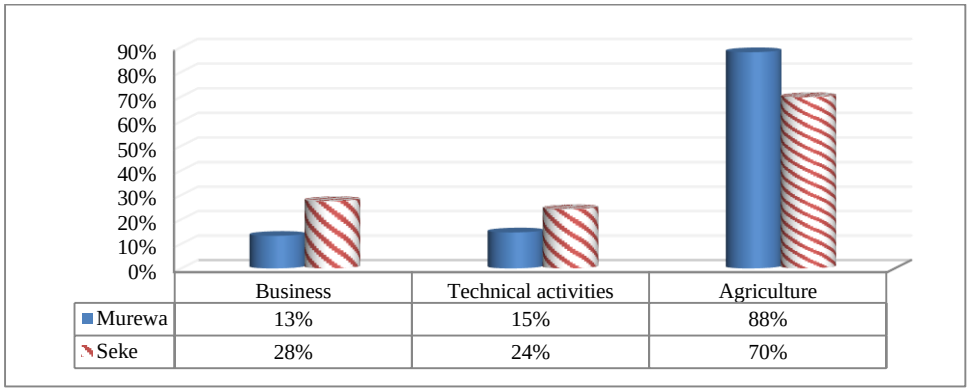
Source: Survey data

Households in Murewa district cultivated larger land sizes (above 5 hectares) while in Seke district the households cultivated an average of less than 3 hectares. There was low use of irrigation in the two districts. In Murewa district, only 11% used irrigation, while in Seke district it was only 4%. On average about 7% of the households in the two districts used irrigation. The average number of years the household had been farming (with the current household head as the household head) was higher in Murewa with an average of 24 years whereas Seke had an average of 20 years.

4.6 Source of income and agricultural production

The main income source for households in the two districts was agriculture as shown in Figure 4-1.

Figure 4-1: Various income sources

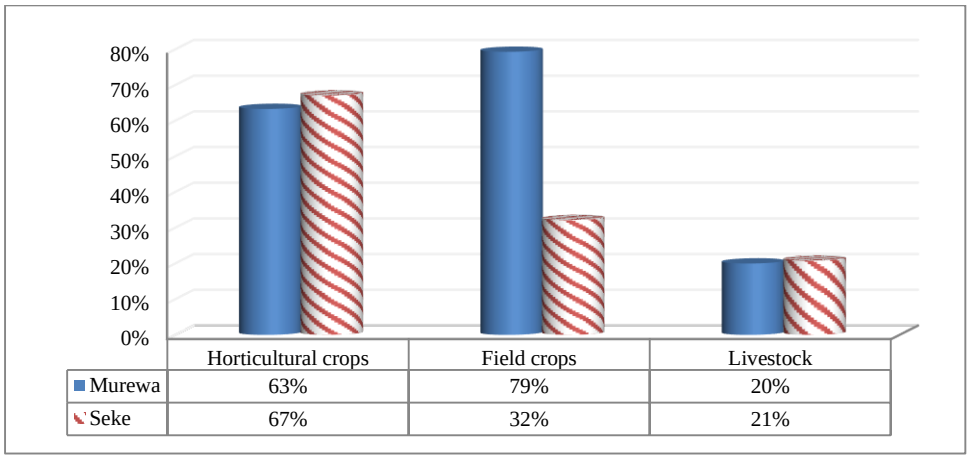


Source: Survey data

Agriculture was an important source in about 88% of households in Murewa district and 70% of households in Seke district. In addition, the households also got income from business and technical activities (e.g. brick moulding; building; carpentry). In Seke district, 28% and 24% of households got income from business and technical activities respectively. In Murewa district, 13% and 15% of households got income from business and technical activities respectively.

The breakdown of the agricultural income sources is presented in Figure 4-2. The figure shows that in Murewa district, the majority of households got agricultural income from selling both field crops (79%) and horticultural crops (63%). In Seke district, the majority of the households got the income from selling horticultural crops (67%) and a smaller percentage (32%) got income from selling field crops. Around 20% of households in the two districts got agricultural income from livestock production.

Figure 4-2: Percentage getting income from various agricultural products



	Horticultural crops	Field crops	Livestock
Murewa	63%	79%	20%
Seke	67%	32%	21%

Source: Survey data

The main food crops in both districts were almost the same; these included maize, rapoko, groundnuts, sorghum, sweet potato, beans, sugar beans and cowpeas. The main cash crops included soya beans, tobacco, rapoko, vegetables, groundnuts, maize, tomato, beans, potato, sunflower, cowpeas, peas, cotton and paprika. It is important to note that most of the food crops were also important cash crops as farmers sold excess output, especially, horticultural produce to markets in the capital city Harare and other nearby towns.

4.7 Participation in organisations and positions of authority

Participation in organisations is very important in enhancing social capital and networking. Broadly, the household heads in the two districts participated in various organisations as shown in Table 4-5. The majority of household heads participated in farmer organisations (81%), religious organisations (71%) and developmental organisations (56%). However, there was less participation in professional organisations. About 36% of the household heads in the two districts had some form of position of authority in any of the farmer, developmental, professional and religious organisations.

Table 4-5: Membership and position of authority in organisations

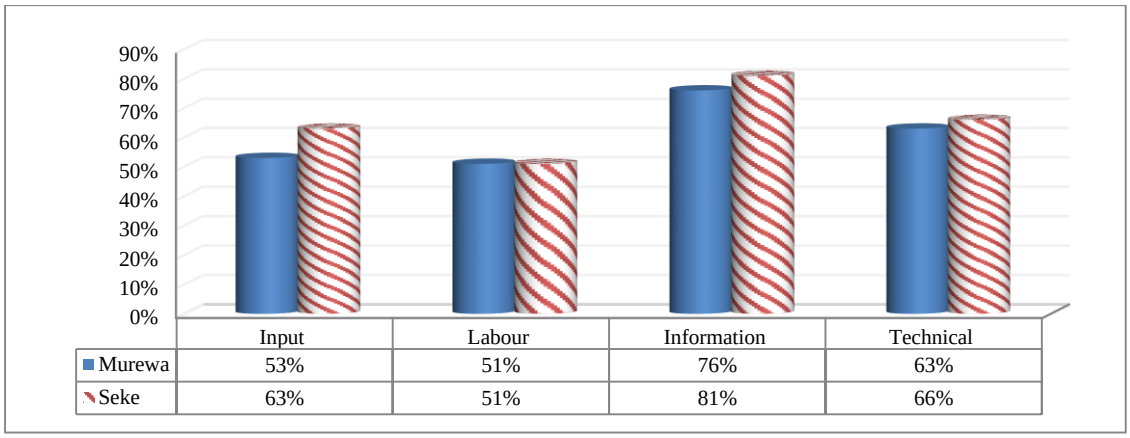
	District		Total
	Murewa	**Seke**	
Farmer organisations	79%	83%	81%
Developmental organisations	50%	63%	56%
Professional organisations	16%	34%	25%
Religious organisations	62%	79%	71%
Had a position of authority in any of the organisations	30%	42%	36%

Source: Survey data

4.8 Farmer-to-farmer input exchange and interactions

Farmer-to-farmer input and information exchange is an essential element in agricultural communities such as Seke and Murewa districts. This complements the formal system in ensuring that farmers have access to the necessary inputs and information. In this study, farmer-to-farmer interaction was assessed on four aspects namely input (e.g. exchange of inputs such as seeds and fertilizers), labour, technical (e.g. exchange of farming equipment), and information (Figure 4-3). As can be seen from the figure, more than half of the respondents indicated that they engaged in all aspects of farmer-to-farmer interactions under consideration. Information exchange was the greatest form of farmer-to-farmer interaction, followed by technical, input, and then labour exchange.

Figure 4-3: Farmer-to-farmer exchange



	Input	Labour	Information	Technical
Murewa	53%	51%	76%	63%
Seke	63%	51%	81%	66%

Source: Survey data

4.9 Agricultural extension

Agricultural extension is also important in information and knowledge transfer. Access to extension was evaluated in terms of the type of extension accessed, the frequency of accessing the extension, and ways of accessing the extension services. The findings are presented in Table 4-6. The majority of respondents had access to extension, with 95% of respondents in both districts indicating so. Though extension is mainly concerned with agricultural activities, it also includes other non-agricultural developmental information and knowledge transfer. This might include health and sanitation information on clean water access, waste disposal, and disease prevention. For those that indicated that they had access to extension, more than half of them indicated that they accessed both agricultural and non-agricultural information (61% for Murewa and 51% for Seke). Others indicated that they received agricultural information only (36% for Murewa and 48% for Seke). Annually, the majority of the respondents (80% in Murewa and 61% in Seke) met extension workers for about six times and above. This frequency refers to the frequency of being in contact with an extension worker and receiving extension information and advice.

Accessing extension services was a two way process whereby both the extension agents and farmers visited each other, in either seeking or disseminating information. More than 70% of respondents in the two districts indicated that it was a two-way process, thus both farmers and extension agents visited each other. This was followed by about 22% in Murewa district and 13% in Seke district indicating that it was a one-way process in which only the extension

agents visited the farmers. Very few respondents indicated that it was a one-way process in which only the farmers visited the extension agents.

Table 4-6: Access to extension

	Response	District		Total
		Murewa	Seke	
Access to extension	Yes	95%	95%	95%
Type of extension	Agricultural	36%	48%	42%
	non-agricultural	3%	1%	2%
	both agricultural and non-agricultural	61%	51%	56%
Extension frequency	5 times and below	20%	37%	29%
	6 times and above	80%	61%	70%
How do you access extension services	only the extension agents visit us	22%	13%	18%
	only us visit the extension agents	7%	4%	5%
	both us and the extension agents visit each other	71%	82%	77%

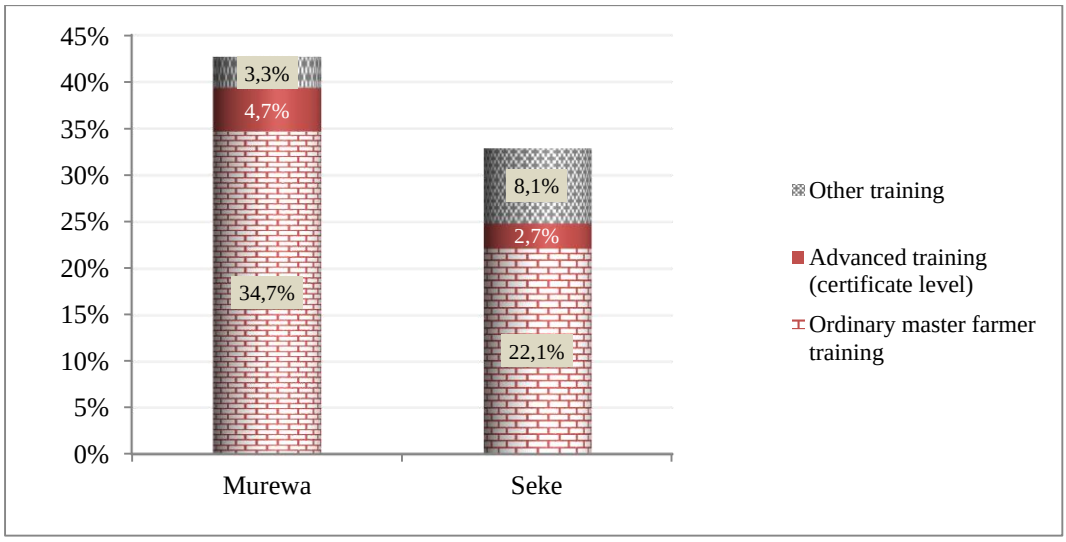
Source: Survey data

Altogether, the majority of the respondents indicated that they accessed various types of information. This included information on fertilizer use, improved crop varieties, pest and disease management, soil management, agricultural marketing, agricultural credit, livestock management, natural resource management, weather information and climate change information. Furthermore, the majority of the respondents indicated that the extension services they received were adequate.

4.10 Farmer training

Farmer training leads to improved knowledge and skills of farmers. It is closely related, and works in tandem with agricultural extension. About 33% of the respondents in Seke and about 43% of the respondents in Murewa indicated that they had at least one household member who had some form of agricultural farmer training. The breakdown of the type of agricultural training that these members had is presented in Figure 4-4.

Figure 4-4: Type of agricultural training



Source: Survey data

It is apparent in Figure 4-4 that in both districts, the majority of those who had training had the ordinary farmer training. Murewa had a greater percentage than Seke. The ordinary farmer training is generally referred to as the Master Farmer certificate training. Very few members in both districts had advanced agricultural training in the form of college certificates, diplomas or degrees. Other forms of training included short training courses, which spanned a few days. These short training programmes were provided at events such as agricultural field days where there were exhibitions of specific crops, livestock or technologies. Having presented the descriptives of the farming system and agricultural variables, the next section presents descriptives on access to ICTs.

4.11 ICT ownership, access and usage

This section is intended to meet the first objective of the study, which was to determine the level of access to and usage of ICTs by communal farmers in Seke and Murewa districts of Zimbabwe. In this context, Gilligan (2005:161) notes that rural communities are very diverse in terms of social composition, economic structure, history and culture, which also affects how ICTs are adopted and used. The section is organised as follows, it starts by assessing ownership and access to ICTs, then usage of ICTs, access to print media, general access to ICT services, language aspects, energy issues and the affordability of ICTs.

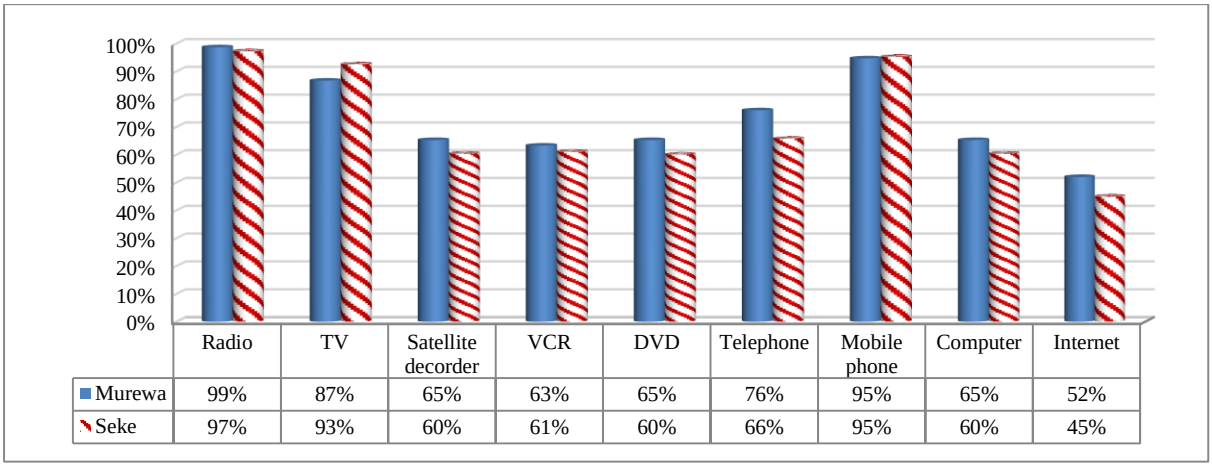
4.11.1 ICT ownership and access

Ownership and access to ICTs was evaluated on many aspects which include knowing or being aware of the ICT, ownership of ICTs in terms of who owned and the number owned per household, access to and use of ICTs within the household. Other issues that were assessed include sources of energy power for the ICTs, perceptions related to maintenance and accessibility costs, and perception of importance of various ICTs to livelihoods, climate information and climate change awareness. According to the ITU (2003:4), a more precise way of measuring access is to examine the availability of ICTs in households. In this study, each ICT was evaluated on three aspects namely knowledge of the ICT, number of the ICTs in the household, and who owned the ICT within the household. The knowledge of ICTs is shown in Figure 4-5 and the ownership of the various ICTs is presented in Figure 4-6.

As can be seen from Figure 4-5, almost all respondents in the two districts knew the radio. Murewa had 99% and Seke had 97%. In addition, the majority of the households owned a radio, with 78% in Murewa and 72% in Seke as shown in Figure 4-6. Despite the fact that Murewa had a slightly greater number of households who owned a radio than Seke, in terms of the average number of radios per household, Seke had a slightly higher average of 0.91 radios per household compared to Murewa's average of 0.89. Radio ownership in the majority of households was by the household heads (in more than 70% of households in both districts), followed by joint ownership between the household head and the spouse. This finding is in agreement with the observation in the literature (Section 2.8.2) that the radio is one of the most common ICTs.

The majority of respondents knew the TV with about 87% in Murewa and 93% in Seke. About half of the households in Seke owned a TV (52%) while in Murewa it stood at 42%. The average number of TVs per household was 0.65 in Seke and 0.42 in Murewa. Just like radio ownership, TV ownership was mainly in the hands of the household heads followed by joint ownership between the household head and the spouse. Besides being categorised as an old ICT, the ownership of the TV is still relatively low. The literature (section 2.8.2) also shows that there is low ownership and access to the TV particularly in the rural areas.

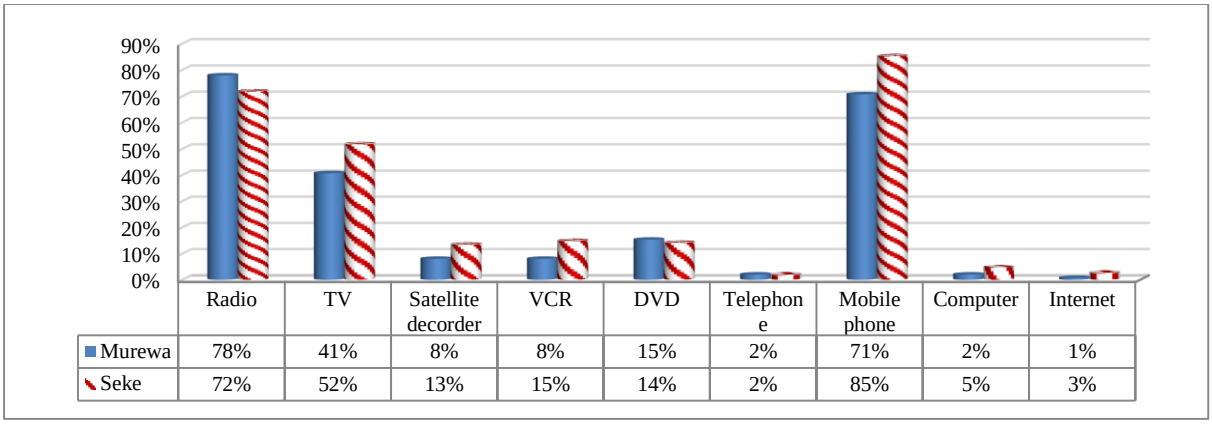
Figure 4-5: Having knowledge of the various ICTs



	Radio	TV	Satellite decorder	VCR	DVD	Telephone	Mobile phone	Computer	Internet
Murewa	99%	87%	65%	63%	65%	76%	95%	65%	52%
Seke	97%	93%	60%	61%	60%	66%	95%	60%	45%

Source: Survey data

Figure 4-6: Ownership of various ICTs



	Radio	TV	Satellite decorder	VCR	DVD	Telephone	Mobile phone	Computer	Internet
Murewa	78%	41%	8%	8%	15%	2%	71%	2%	1%
Seke	72%	52%	13%	15%	14%	2%	85%	5%	3%

Source: Survey data

Around 60% of the respondents in both districts knew the satellite decoder. A smaller percentage of households owned satellite decoders. An estimated 8% and an average number per household of 0.08 in Murewa, while in Seke a slightly higher number of households, about 13% owned a satellite decoder with an average of about 0.17 per household. In about half of the households in both districts, the satellite decoders were owned by the household heads. In Seke this was followed by ownership by an adult son in about 40% of the households that owned satellite decoders. In Murewa, this was followed by joint ownership between household head and spouse in about 25% of the households that owned the satellite decoders. For those that had satellite decoders, they mainly accessed the free-to-air satellite television services rather than the pay-per-view satellite televisions services such as DStv.

This service is out of reach for many people particularly those in rural areas. This finding corroborates the observation in the literature that digital satellite television is out of reach for the majority of people in Zimbabwe (section 2.8.2).

About 60% of the respondents knew the VCR in both districts. However, few households owned the VCR, with about 8% in Murewa and about 15% in Seke. In about 40% of households that owned a VCR in both districts, the ownership was by the household head. Joint ownership was in about 50% of the households in Murewa district, and about 14% in Seke district, while ownership by an adult son was 10% in Murewa and 32% in Seke. The VCR plays video cassettes, and is closely related to the DVD, which plays video discs. The DVD was known by about 60% of the respondents in both districts. Few households owned a DVD, with about 15% of households in both districts. These were owned by household heads in about half of the households that owned DVDs in both districts. In Murewa, this was followed by joint ownership between household head and spouse in about 29% of the households. In Seke, it was followed by ownership by an adult son in about 30% of the households that owned the DVD.

Up to 76% of respondents in Murewa knew the telephone (landline) while in Seke it was about 66%. Very few households owned a telephone, with about 2% of households in both districts. In Murewa, ownership of the telephone was 33% by the household heads, 33% in joint ownership, and 33% ownership by any other member of the household. In Seke, the ownership was 50% by household heads and 50% by an adult son. This finding on low ownership of the telephone in the two districts is consistent with observations in the literature (see section 2.8.2) that Zimbabwe has a low tele-density.

About 95% of respondents in both districts knew the mobile phone. In addition, the majority of the households owned a mobile phone, with about 71% of households and an average of 1.16 per household in Murewa, and 85% of households and an average of 1.56 per household in Seke. The ownership of the mobile phone within the household was mainly by the household head in the majority of the households (72% in Murewa and 77% in Seke). The ownership of the mobile phone in the remainder of the households varied between joint ownership, adult-son ownership, and ownership by any other household member. The ownership of the mobile phone was relatively high which is consistent with the literature (see

section 2.8.2) that there has been phenomenal growth in the ownership and access to mobile phones both in urban and rural areas.

About 60% of the respondents in both districts knew the computer. However, very few households owned a computer, with about 2% in Murewa and about 5% in Seke. In both districts, ownership of the computer was mainly by the adult son, followed the household head in about 33% of households. The internet was the least known in both districts, with about 52% in Murewa and 45% in Seke. The ownership of the internet (having a device/gadget/facility on which the individual accessed the internet) was also very low with about 1% in Murewa, and 3% in Seke. In Murewa, household heads only owned the internet facility/gadget while in Seke it was spilt between the household head and adult son. The findings in this study are in agreement with a study that was conducted in South Africa and Uganda as discussed under Section 2.8.2. The next section focuses on the usage of ICTs.

4.11.2 Usage of ICTs

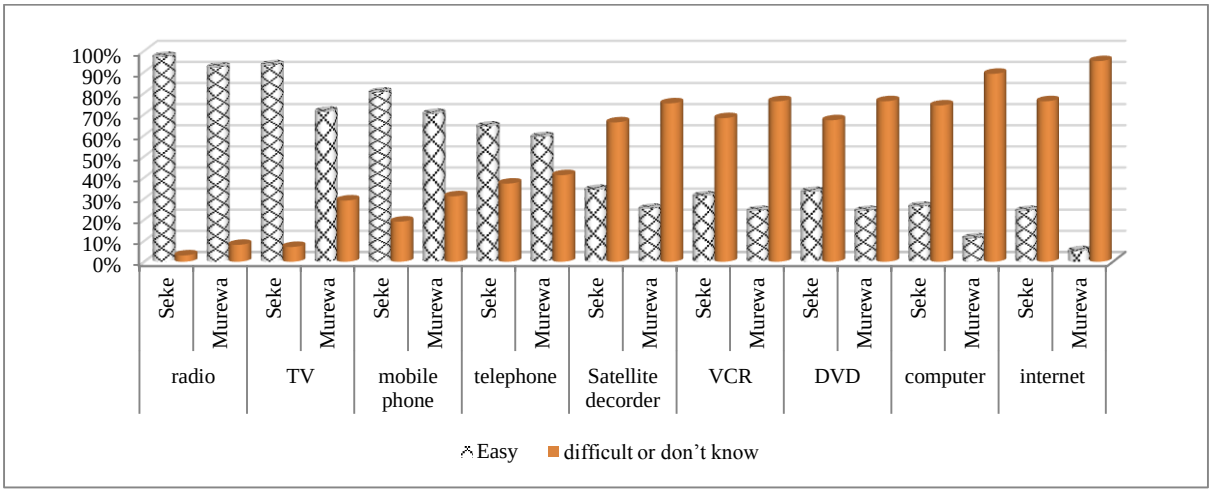
Access to and usage of ICTs was assessed in terms of the respondents' ability to operate or use the ICT gadget. This included whether the respondent had ever used the ICT; if yes, was the ICT used daily; in what language/s was the ICT accessed or used; and was this language or were these languages understood? The results on each of these are presented and discussed in the following subsections.

Ability to operate the ICTs

The majority of the respondents in both districts were able to operate the radio, mobile phone, and TV, while, most of them were not able to operate the computer and use the internet. In Seke, over 90% of the respondents were able to operate the radio and the mobile phone, followed by the TV with slightly over 80%, while telephone was close to 70%, VCR and DVD were close to 60%, and the satellite decoder was around 50%. Fewer respondents were able to operate the computer and the internet with about 30% and 16% respectively. In Murewa, slightly over 90% were able to operate the radio, followed by slightly above 60% for the TV and the mobile phone. Fewer respondents were able to operate the VCR, DVD, and satellite decoder with around 20%, while both the computer and the internet were below 10%. Overall, Seke had more respondents who indicated that they were able to operate each

of the ICTs than Murewa. The respondents were further asked their perception on the easiness of using the ICTs. The results are presented in Figure 4-7.

Figure 4-7: Perception on the easiness to use the ICTs



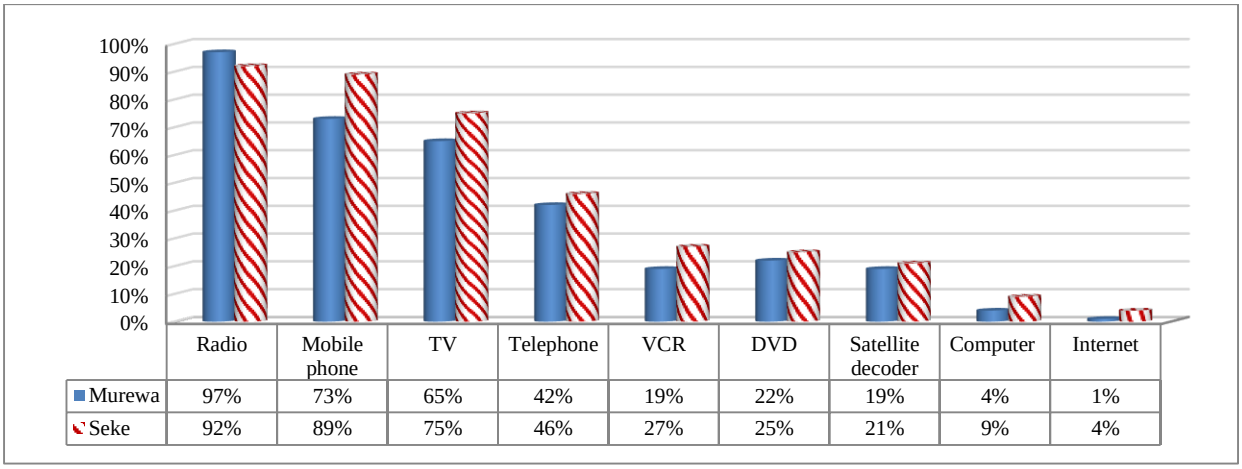
Source: Survey data

As can be seen in Figure 4-7, more than half of the respondents in both districts indicated that the following ICTs were easy to use, the radio, TV, and mobile phone (fewer respondents perceived that they were difficult to use). However, for the following ICTs namely, the satellite decoder, VCR, DVD, computer, and the internet, the opposite is true. A greater percentage of respondents perceived them to be difficult to use or did not know the ICTs (hence could not perceive the easiness of using the ICT). This is important because the ability to operate the ICTs and the perception thereof affects the adoption and usage of the technologies.

Usage of ICTs

Respondents were asked if they had ever used the ICTs and the results are presented in Figure 4-8. The figure shows that the most commonly used ICTs were the radio with over 90% in both districts, the mobile phone had over 70% in both districts, TV had over 65% in both districts and telephone had slightly below 50% in both districts. The VCR, DVD and satellite decoder were around 20-30%, while the computer and the internet were the least used with less than 10% in both districts. Altogether, Seke had a greater percentage of respondents who had used the ICTs than Murewa for almost all the ICTs, except for the radio.

Figure 4-8: Ever used the ICT

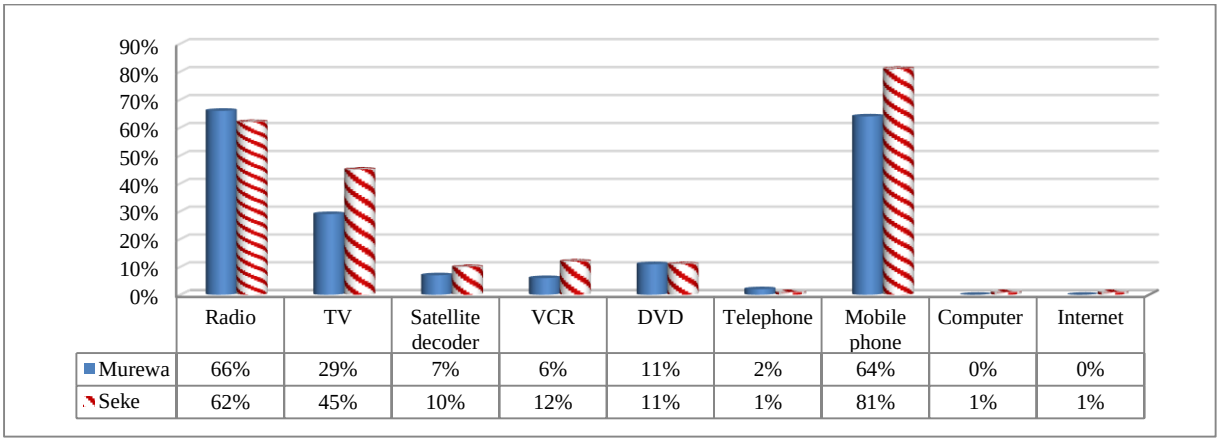


	Radio	Mobile phone	TV	Telephone	VCR	DVD	Satellite decoder	Computer	Internet
Murewa	97%	73%	65%	42%	19%	22%	19%	4%	1%
Seke	92%	89%	75%	46%	27%	25%	21%	9%	4%

Source: Survey data

Respondents were further asked whether they used the ICTs on a daily basis. The results are presented in Figure 4-9. In Seke, the most commonly used ICTs on a daily basis were the mobile phone with about 80%, followed by the radio with about 60%. In Murewa, the most commonly used ICTs on a daily basis were the radio with about 66% and the mobile phone with about 64%. The third most commonly used ICT on a daily basis in both districts was the TV with slightly above 40% in Seke and slightly below 30% for Murewa. Very few respondents (about one fifth and below) in both districts used the satellite decoder, VCR, and DVD on a daily basis. The least used were the computer and the internet as only 1% of respondents in Seke used them on a daily basis while in Murewa none of the respondents used them on a daily basis.

Figure 4-9: Percentage of respondents using the ICT daily



	Radio	TV	Satellite decoder	VCR	DVD	Telephone	Mobile phone	Computer	Internet
Murewa	66%	29%	7%	6%	11%	2%	64%	0%	0%
Seke	62%	45%	10%	12%	11%	1%	81%	1%	1%

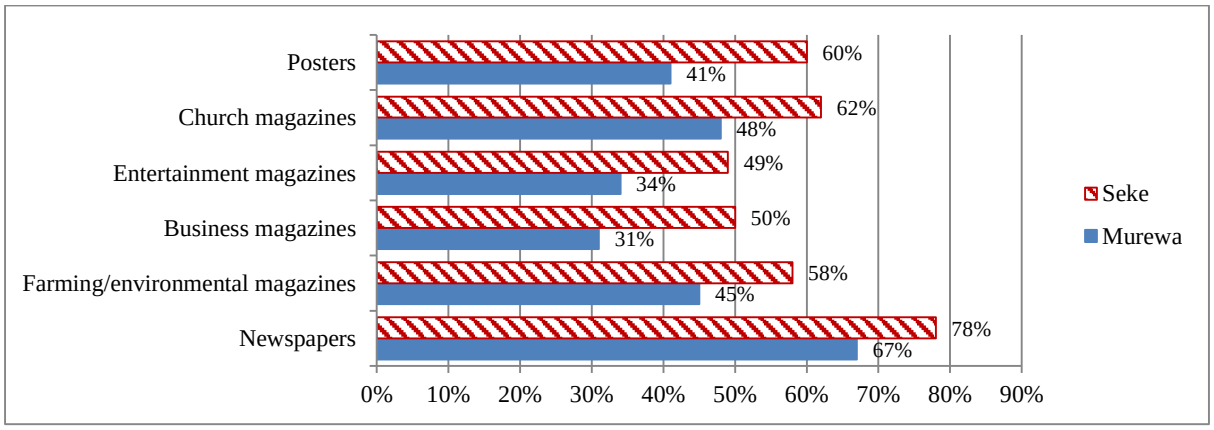
Source: Survey data

4.12 Access to print media

4.12.1 Readership of the various print media

Access to and use of various technologies is negatively affected by illiteracy. Respondents were first asked whether they were able to read and to write. The majority of the respondents (over 85%) in both districts were able to read and write. The respondents were then asked whether they had access to the various print media namely, newspapers, farming/environmental magazines, business magazines, entertainment magazines, church magazines, and posters. The results are presented in Figure 4-10.

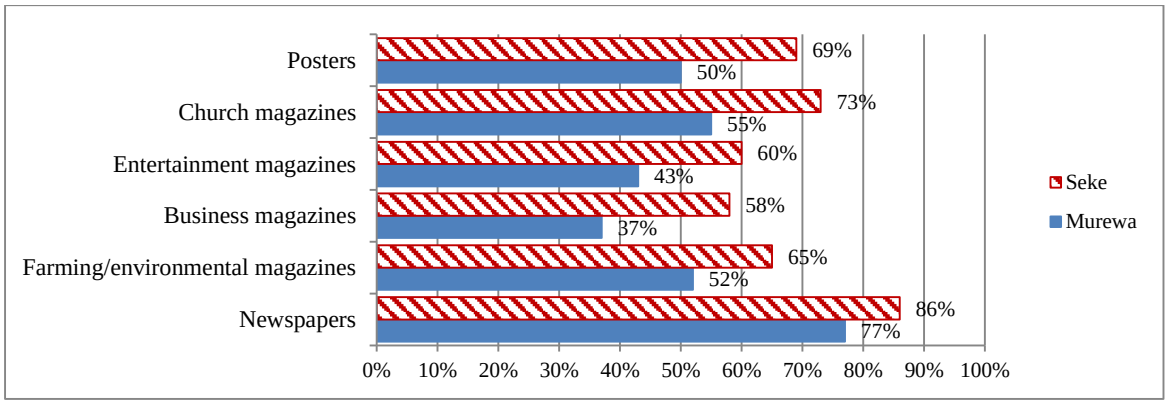
Figure 4-10: Percentage of respondents reading the various print media



Source: Survey data

As Figure 4-10 shows, overall, Seke had a greater percentage than Murewa of respondents who read the various print media. In Seke, most of the respondents read the newspaper, followed by church magazines, then posters, and farming/environmental magazines. In Murewa, most of the respondents read the newspaper, followed by church magazines, then farming/environmental magazines, and posters. The least read were business and entertainment magazines, each with close to 50% in Seke, while in Murewa each was close to 30%. Respondents were then asked whether there had any other household member who read these print media. The findings are presented in Figure 4-11.

Figure 4-11: Percentage of households with any other household member reading the print media



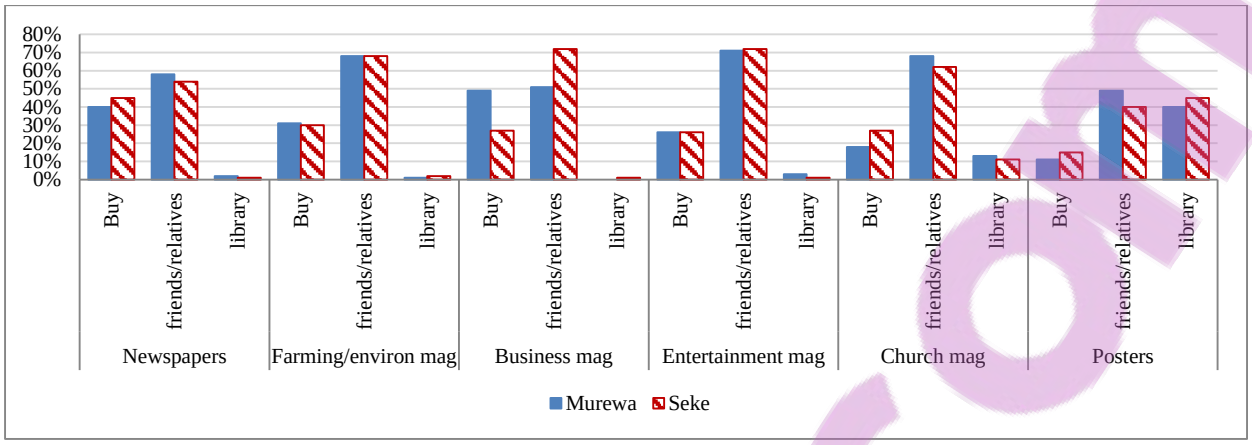
Source: Survey data

It is apparent from Figure 4-11, that Seke had a greater percentage than Murewa of households that had members (other than the household head) who read the various print media. In Seke, most of the households had members who read newspapers, followed by church magazines, then posters, and farming/environmental magazines. In Murewa, most households had members who read the newspapers, followed by church magazines, then farming/environmental magazines, and posters. The least read were the business magazines, with 58% in Seke and 37% in Murewa.

4.12.2 The sources of the various print media

For each print medium that the respondents indicated that they had access to, they were asked to indicate the source or how they accessed that medium. The results are shown in Figure 4-12. The figure shows that for almost all the print media in both districts, the main source of the print media was through friends and relatives. The second most important source for the print media in both districts was buying (by the respondents or the readers themselves), which was also the case for almost all the media. The only exception was for the posters in which the library or public places were important sources, in Seke this was actually the most important source, while in Murewa it was slightly below friends and relatives. An important aspect of accessing the print media is the frequency of accessing them.

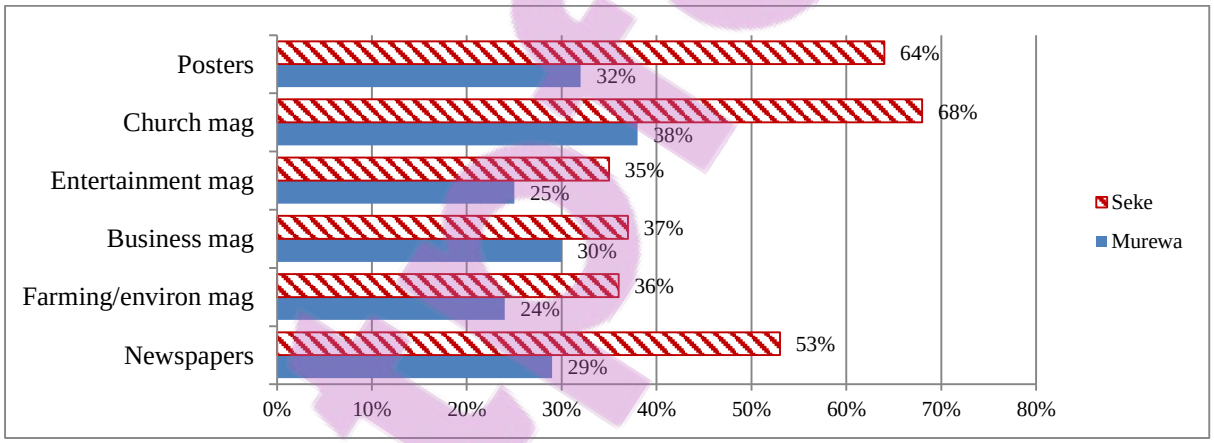
Figure 4-12: The sources of the various print media



Source: Survey data

Respondents were further asked whether they accessed various the print media more the once a week. The results are presented in Figure 4-13.

Figure 4-13: Percentage accessing more than once a week the various print media



Source: Survey data

Figure 4-13 shows that Seke had a greater percentage than Murewa of respondents who accessed more frequently the various print media. The two most frequently accessed media in both districts were church magazines and posters. They were accessed more than once a week by over 60% of respondents in Seke, while in Murewa it was close to 35%. The newspaper was accessed more than once a week by around 53% and 29% in Seke and Murewa respectively. However, other respondents accessed these media less frequently, with about

30-40% accessing them at least once in a month, while around 20% of the respondents accessed them at least once in six months.

4.13 Access to ICT services from other community members and through shared facilities

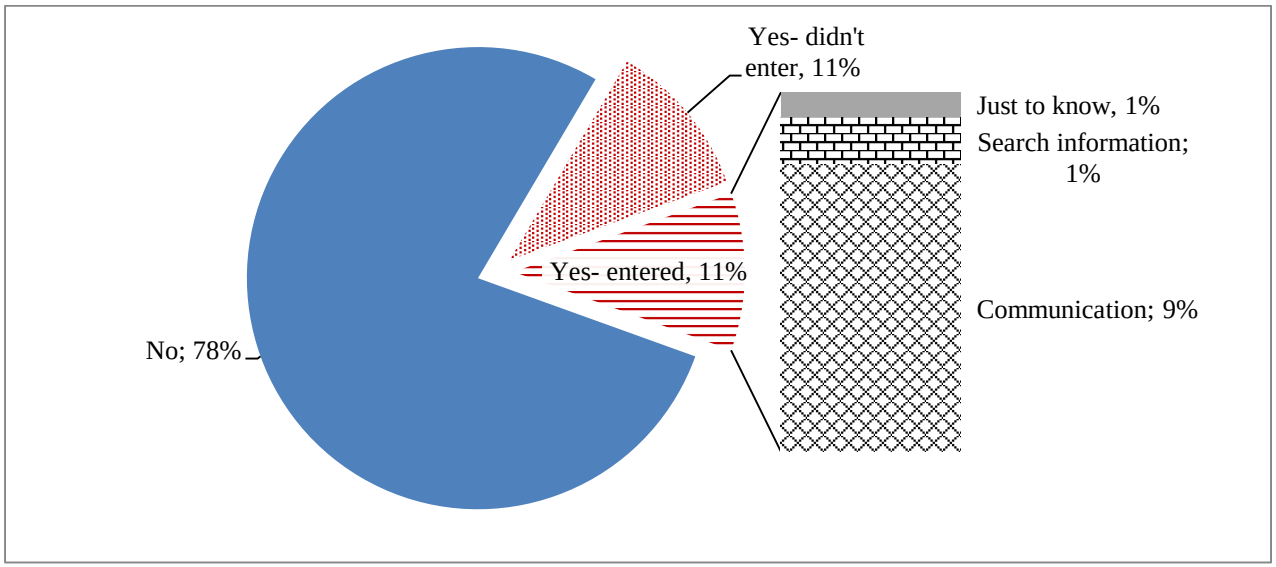
In this study, sharing of ICTs and their services were evaluated mainly on two aspects. Firstly, whether there were people within the community offering such services. Secondly, whether there were facilities such as information centres or telecentres within the community or at the nearest business centres. On the first aspect, few respondents indicated that they accessed ICT services from other members within their community. About 29% of respondents in Murewa and 24% in Seke indicated that they could access the phone service from other people within their community. Of these respondents, about three quarters of them in Murewa and about half of them in Seke indicated that these phone services were free. However, none of the respondents in both districts indicated that they could access services such as internet, typing and faxing, and audio and video services from other people within their communities.

In terms of the second aspect on information centres or telecentres, respondents were first asked whether they had such facilities within their community. All the respondents indicated that they did not have such facilities. Respondents were further asked whether they had such facilities at nearest business centre, and their responses are presented in Figure 4-14 for Murewa and in Figure 4-15 for Seke.

Figure 4-14 shows that in Murewa, about 22% of respondents indicated that such facilities were present at the nearest business centre, and only half of those who were knew such facilities, had been in (entered) such facilities. Figure 4-15 shows that in Seke, about 24% of respondents indicated that there were such facilities at the nearest business centre, with more than three quarters of these respondents having been in (entered) the facilities. In both districts, the majority of the respondents who had been in the facilities indicated that their main purpose was to get communication services, and to a lesser extent to search for information or just to know the activities done in those facilities. In addition, 67% in Murewa

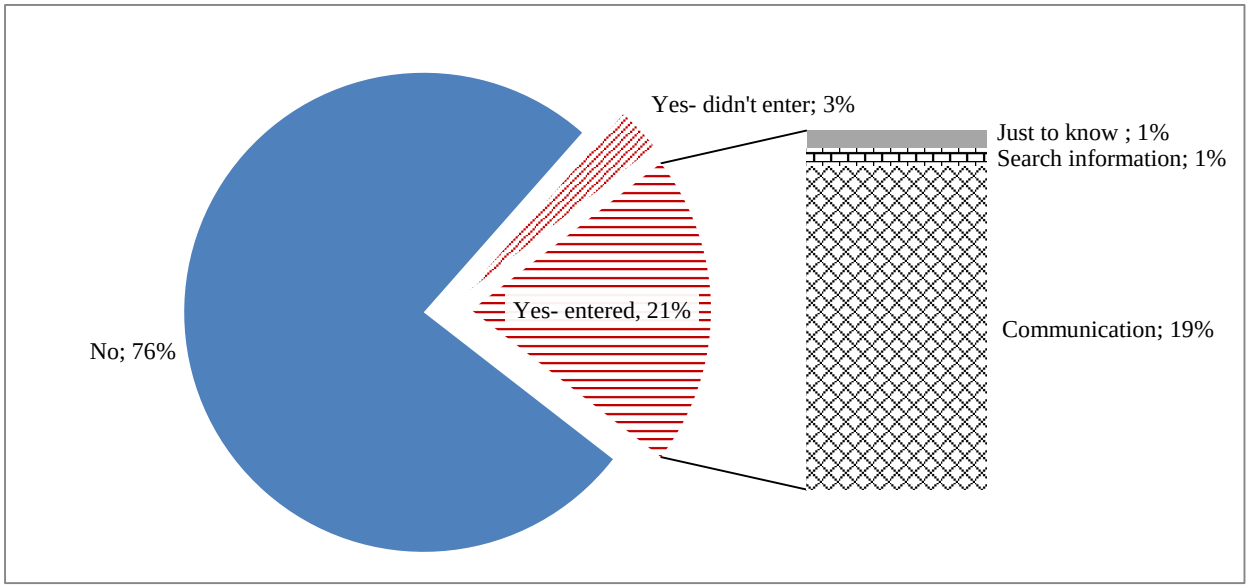
and 41% in Seke of the respondents who had visited the facilities indicated that their intended purpose was fulfilled.

Figure 4-14: Percentage of respondents aware of information centres at the nearest business centre in Murewa



Source: Survey data

Figure 4-15: Percentage of respondents aware of information centres at the nearest business centre in Seke



Source: Survey data

Having presented findings on access and usage of ICTs, it is important to explore aspects that relate to appropriateness of the technologies to rural settings. Appropriateness of the technology is an important determinant on the use and adoption of that technology. There many factors that influence whether a technology is appropriate or not. In terms of ICTs, some of factors include the language used, energy sources, and affordability. The results on each of these factors are presented in the next sections.

4.14 Languages in which the various ICT services are accessed

The language used in communicating or the language in which the information is conveyed by the ICT is important as the people who access such ICT services are supposed to understand the message. In that context, the respondents who indicated that they had access to the various ICTs were asked the main languages in which they accessed the services offered by the ICTs. The majority of respondents (over 80%) in both districts indicated that they accessed radio services in local languages (mainly Shona) while the remainder accessed the services in English. The majority of the respondents who communicated using the telephone and the mobile phone used local languages (however, the applications on these gadgets are in English). About 40-50% of respondents in Murewa and around 20% and below in Seke indicated that they accessed services offered by the TV, satellite decoder, VCR, and DVD in local languages while the remainder accessed them in English. All the respondents who accessed services offered by the computer and the internet indicated that they accessed the services in English. The majority of respondents indicated that they understood the local language that was used in or conveyed by some of the ICTs. However, some respondents indicated that they did not understand or understood the language with difficulties, for ICTs services that were accessed in English. Seke generally had a greater proportion than Murewa of respondents who indicated that they did not understand or understood English with difficulty.

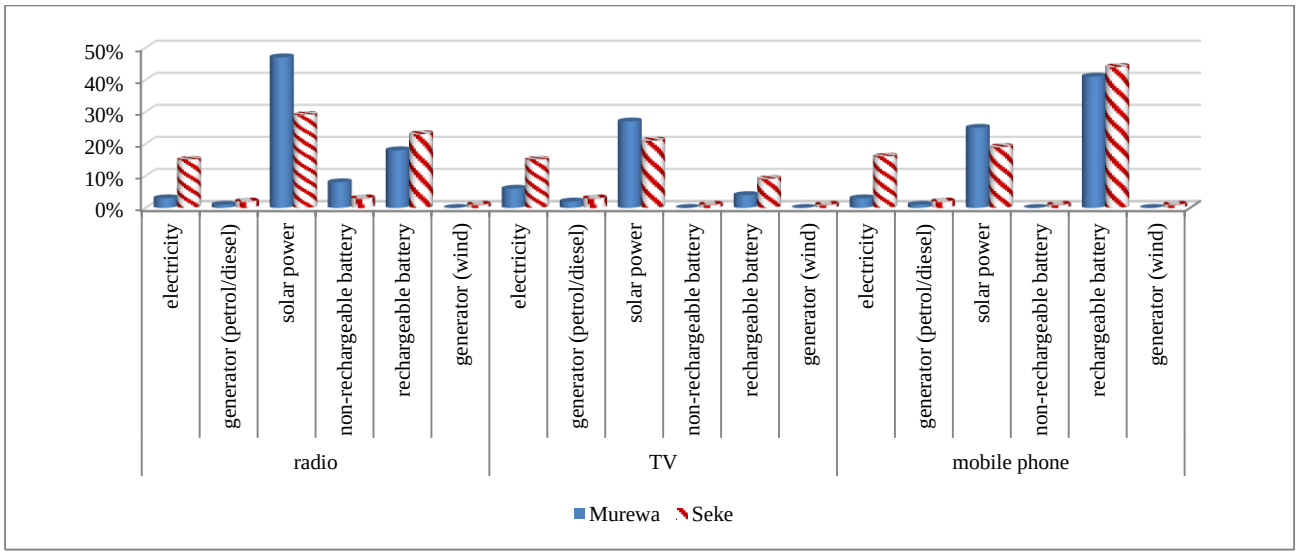
In terms of the print media, the majority of the respondents (over 70%) in both districts indicated that they accessed newspapers in the English language with the remainder accessing them in the local language (Shona). This was also the case with the magazines and the posters. However, generally there was a greater percentage in Seke than Murewa of respondents who indicated they accessed the media mainly in English. In sum, fewer

respondents accessed the print media in local language. The respondents were then asked how well they understood the main language used in the print media. The majority of the respondents (around 50% and above) in both districts indicated that they understood the language used in the various print media. The percentage of those who understood the languages with some difficulty were around 30% in both districts and while those who did not understand the language at all were around 10% in both districts. Generally, there was a slightly greater percentage in Murewa than Seke of respondents who indicated that they understood the languages in the print media very well. Seke had a greater percentage than Murewa of respondents who indicated that they understood the language with difficulty. However, in terms of those who did not understand the language at all, Murewa had a greater percentage than Seke. The respondents that had difficulties in understanding English highlighted lack of formal education as the main reason.

4.15 Energy sources for the ICTs

The type and availability of energy sources is an important determinant of the ICTs that can be adopted and used. Respondents were asked what were the main power sources for the ICTs that they had. The results are presented in Figure 4-16 and Figure 4-17.

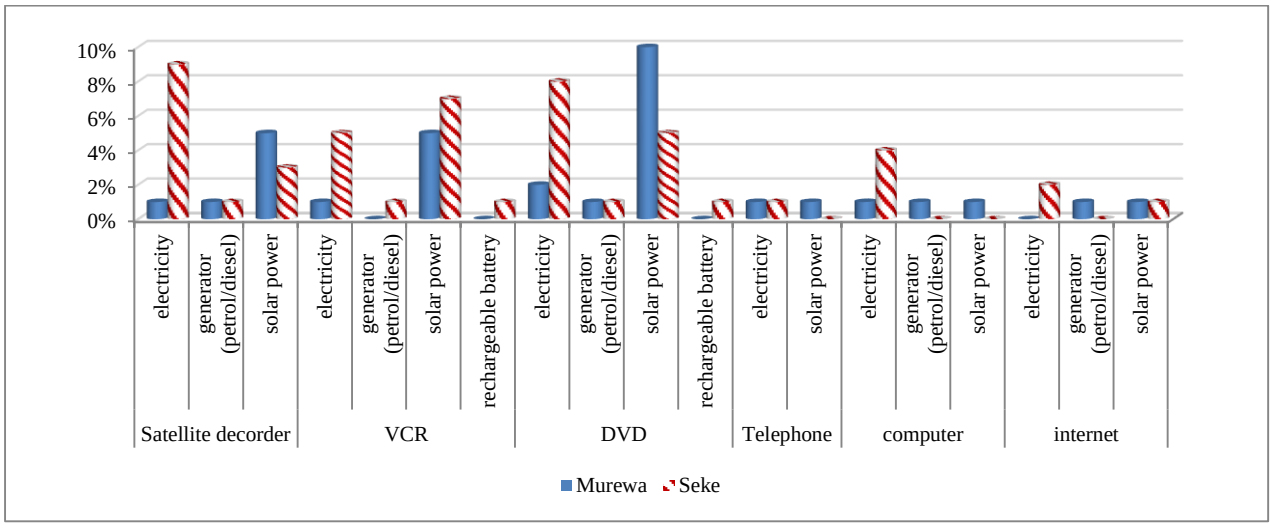
Figure 4-16: Power sources for the radio, TV, and mobile phone



Source: Survey data

Figure 4-16 shows that the main power sources for those who had radios in both districts were solar power, followed by rechargeable battery. In Seke, this was followed by electricity and then non-rechargeable battery, while in Murewa this was followed by non-rechargeable battery and electricity. The main power source for the TV was the solar power; followed by electricity and rechargeable battery. For the mobile phone, the main power sources were rechargeable battery, solar power and electricity.

Figure 4-17: Power sources for the satellite decoder, VCR, DVD, telephone, computer, and internet



Source: Survey data

Figure 4-17 shows that for the few households that owned the satellite decoder, the main power sources in Seke were electricity, then solar power and the petrol/diesel generator, while in Murewa they were solar power, then electricity and the petrol/diesel generator. The main power sources for the VCR in Seke were solar power and electricity, while in Murewa it was mainly solar power. The main power sources for the DVD in Seke was electricity followed by solar power, while in Murewa it was solar power, followed by electricity. Though very few households owned telephones, computers and the internet, their power sources included electricity, solar power, and the petrol/diesel generators. Overall, there was low usage of petrol/diesel generators and almost none of the respondents used the wind generators.

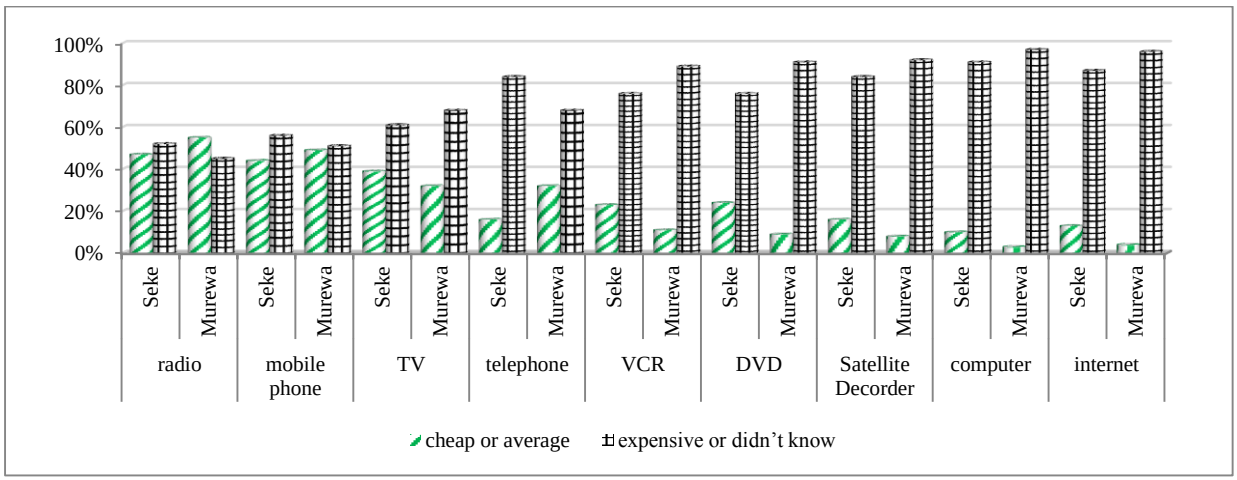
Seke seems to have more households that were electrified than Murewa as shown by a greater proportion of respondents in Seke than in Murewa, who indicated that electricity was their

power source for the ICTs. Overall, the main power sources for the ICTs were solar power and electricity. Another important power source was the rechargeable battery. However, the rechargeable battery was actually dependent on the availability of solar power and electricity (whereby the battery was charged from another power source at the household, neighbours or at the nearest business centre). Overall, there was low access to reliable energy sources for the majority of households, which confirms the observation in the literature (see section 2.8.2) that a serious challenge to the penetration of ICTs in developing countries is lack of the electricity or recharging facilities.

4.16 Affordability of ICTs

Respondents who were aware of the ICTs were asked how they perceived the maintenance and accessibility costs of the various ICTs. In this question, the maintenance and accessibility costs referred to the general cost of having the ICT to work or perform the required task or the general cost of accessing the ICT service. The results are presented in Figure 4-18. Broadly, for all ICTs in both districts (except for the radio in Murewa) there was a greater proportion of respondents who perceived that the cost of maintenance and accessibility of the ICTs was expensive (or who did not know) than respondents who perceived that it was either cheap or average.

Figure 4-18: Perceptions on the maintenance and accessibility costs of ICTs



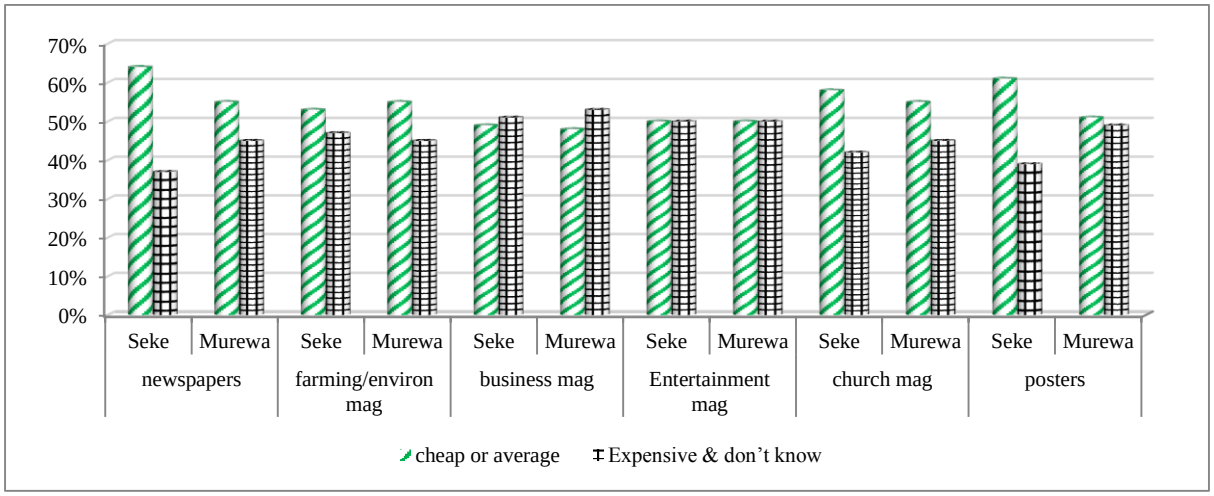
Source: Survey data

ICTs that had least proportion of respondents (around half of the respondents) who perceived them as expensive were the radio and the mobile phone. All the other ICTs were perceived as

expensive by between 60-100% of the respondents. For the majority of ICTs, there was slightly a greater proportion of respondents who perceived that the ICTs were expensive (or who did not know) in Murewa than in Seke.

In the case of the print media, respondents were asked how they perceived the affordability of various print media. The results are presented in Figure 4-19. In both districts, there was a slightly greater proportion of respondents who perceived that newspapers, farming/environmental magazines, church magazines and posters were relatively cheap and affordable than the proportion of respondents who perceived that they were expensive (or who didn't know). However, for the business magazines and church magazines there was roughly an equal proportion of respondents who perceived that they were cheap and affordable and those who perceived that they were expensive (or who did not know).

Figure 4-19: Perceptions on the affordability of Print media



Source: Survey data

4.17 Conclusion on access to ICTs

The first objective was to determine the level of access to and usage of ICTs by communal farmers in Seke and Murewa districts of Zimbabwe. All in all, most of the respondents in both districts knew and owned the radio, the mobile phone and the TV. Other ICTs such as satellite decoder, the VCR, the DVD, the telephone, the computer and the internet were relatively less known and a few households owned them. The ownership of the various ICTs in most households was mainly by the household head, then in some cases they were owned

jointly (household head and spouse) or ownership by the adult son. Mostly, Seke had a greater percentage of respondents who had used the ICTs than Murewa, for almost all the ICTs, except for the radio. In terms of usage of the ICTs on a daily basis, the mobile phone, followed by the radio and then the TV were the most frequently used in both districts. The main power sources for the ICTs were solar power, electricity, and rechargeable batteries.

Most of the respondents in both districts read the newspaper, followed by church magazines. These were then followed by posters and then farming/environmental magazines in Seke, while, in Murewa, it was vice versa. The least read were business and entertainment magazines. Generally, Seke had a greater percentage than Murewa of households that had members who read the various print media. In terms of the reading frequency per week, church magazines and posters were the most commonly read in both districts. For almost all the print media in both districts, the main source of the media was through friends and relatives, followed by buying. An important source for the posters was mainly in libraries or public places. The print media had the advantage that they could keep it for future reference.

The majority understood the language used in various ICTs. Nonetheless, in some cases, there was a significant proportion that had difficulties in understanding the English language, mainly due to lack of formal education. Few respondents accessed ICT services from other members within their community but for those that did, the main service that they accessed was the phone service. However, services such internet, typing and faxing, audio and video services were not available within their communities. While, there were no telecentres (information centres) within the community, about one quarter of the respondents in both districts indicated that they had such facilities at nearest business centre. In both districts, the majority of those respondents who had accessed the facilities indicated that their main purpose was to get communication services and to a lesser extent to search for information or just know the activities done in those facilities. Largely, it can be concluded that communal farmers in Seke and Murewa districts had relatively good access to old ICTs in particular, the radio and the TV, and for the new ICTs they had good access to the mobile phone. Due to the advances in mobile phone technology, the convergence of various applications such as radio and the internet can help to improve access to such services by rural people. Nevertheless, having such mobile phones will not help much unless the necessary infrastructure is made available in these rural areas.

CHAPTER 5: SOCIO-ECONOMIC DETERMINANTS OF CLIMATE CHANGE AWARENESS

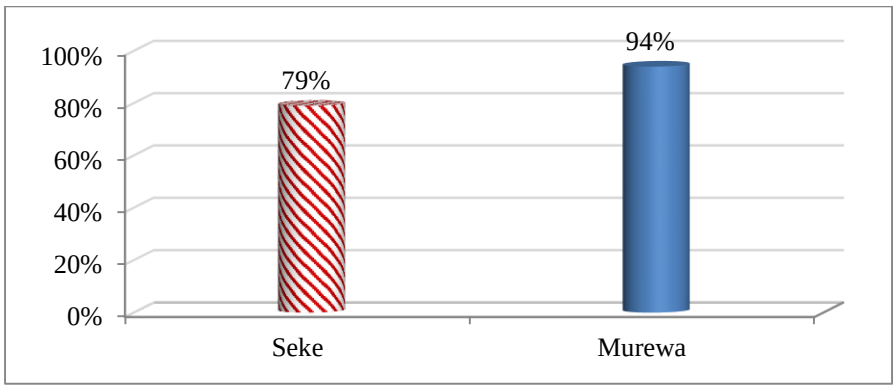
5.1 Introduction

This chapter intended to fullfill the second objective of the study, which was to assess how access to ICTs influenced climate change awareness amongst communal farmers in Seke and Murewa districts. This chapter is organised as follows: firstly, it gives descriptive statistics on climate change awareness and secondly, it then gives the regression analysis of the socio-economic determinants of climate change awareness. The discussion of the results is done concurrently with the presentation of results.

5.2 Assessment of climate change awareness

Climate change awareness was evaluated by first asking the respondents whether they were aware or had some knowledge of climate change. The majority of respondents in both districts indicated that they were aware of climate change, though Murewa had a greater percentage of respondents than Seke, with about 94% and 79% respectively (Figure 5-1). In addition, almost all respondents in both districts (99% in Murewa and 97% in Seke) indicated that it was important to know about climate change.

Figure 5-1: Percentage of respondents indicating that they were aware of climate change



Source: Survey data

Climate change awareness was further evaluated as outlined in sections 3.4.2 and 3.6.2 of Chapter 3. To recap, the procedure is briefly outlined here. Of those respondents that indicated that they were aware of climate change they were asked how they agreed with the

eleven (11) statements that were formulated to assess their knowledge of climate change. These statements relate to the causes, effects, adaptation and mitigation. The statements had a five point Likert scale, "strongly agree, agree, undecided, disagree, strongly disagree".

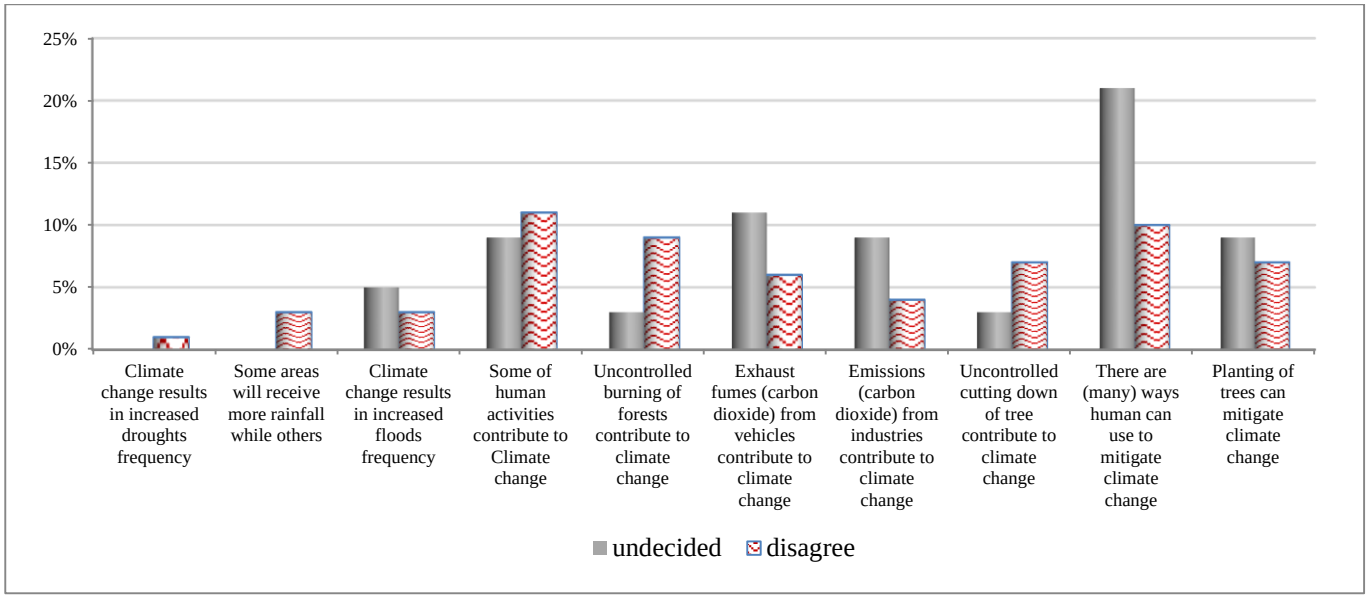
It is important to note that the statements were general and not too technical. Some of the rural people did not have formal education; hence, the survey was conducted in the local language "shona". One of the challenges encountered in evaluating climate change awareness was how to operationalise English language terms such as "carbon dioxide" as they did not have proper equivalent terms in the local language. In order for some of the respondents to comprehend the statements, reference to issues such as "carbon dioxide emission" ended up being referred to as gaseous emissions or pollution[9]. In addition, the terms "climate variability" and "climate change" were also difficult to differentiate due to the fact that in the local language these tend to assume the same meaning[10]. Nonetheless, proper measures (outlined in section 3.5.4) were taken in training enumerators to properly administer the survey and avoid making ambiguous statements. The responses to the various statements on climate change awareness were checked for their internal consistency using the Cronbach's Alpha (see Section 3.7). In this current study, the Cronbach's alpha coefficient for the 11 statements was 0.82. This coefficient value of 0.82 indicates a good internal consistency in terms of the reliability of the scale.

Respondents were generally expected to agree to the ten of the eleven statements. However, there is one statement "Zimbabwe is the only country likely to experience climate change". It aimed to capture how respondents perceived the global nature of climate change. Respondents were generally expected to disagree to this statement because climate change is a global phenomenon, and as such, other countries are also affected. The percentages of those who were undecided or who disagreed to the various statements are presented in Figure 5-2 for Seke and Figure 5-3 for Murewa. The statement "Zimbabwe is the only country likely to experience climate change" is not included in the two graphs (N.B. done for presentation purposes only, its responses are different from the other statements); nevertheless, its responses are presented in the discussion.

[9] This is problematic as highlighted in the discussion on mental models, cultural models, and the understanding of climate change in section 2.7.8

[10] This constraint was also highlighted by Chagutah, 2010:25, see section 2.7.6

Figure 5-2: Percentage of respondents in Seke who either disagreed or were undecided



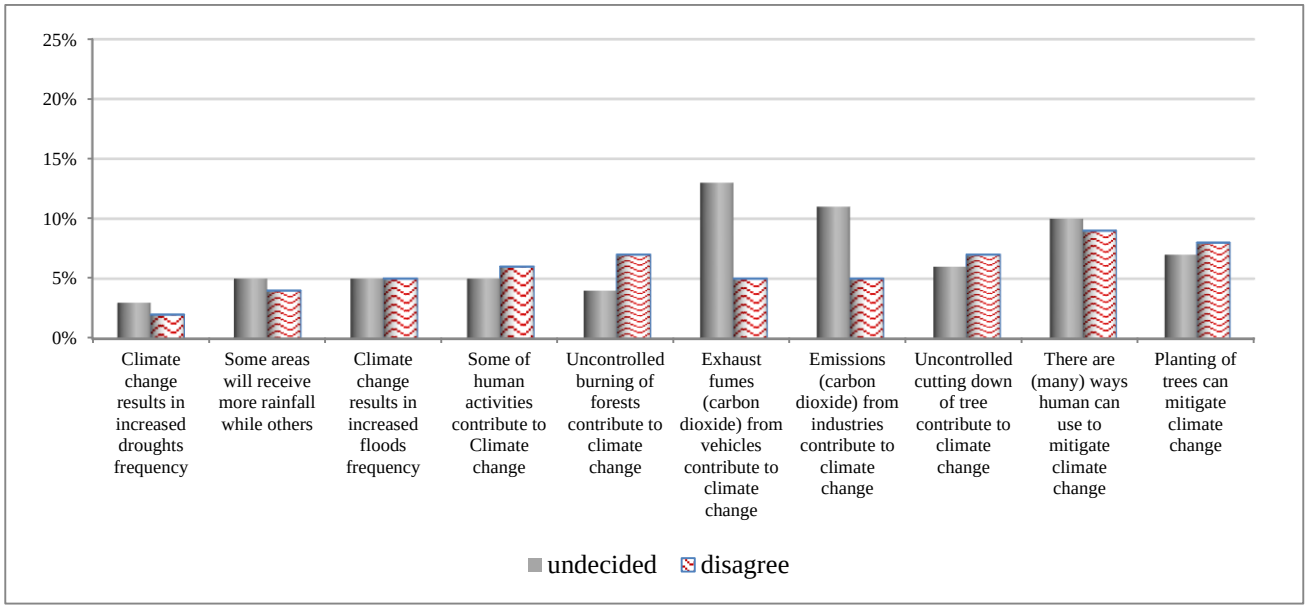
Source: Survey data

Figure 5-2 shows that in Seke, six (plus one not in the graph) of the eleven statements had 5% or more of respondents (two of which had 10% and above) who were undecided though they had indicated that they were aware of climate change. The two statements that had 10% and above of respondents who were undecided are: "Exhaust fumes (carbon dioxide) from vehicles contribute to climate change"; and "There are (many) ways human can use to mitigate climate change". In addition, six of the eleven statements also had 5% or more of respondents (two of which had 10% and above) who disagreed, though in general they were expected to agree. The two statements that had 10% and above of respondents who disagreed were: "Some of the human activities contribute to climate change"; and "There are (many) ways human can use to mitigate climate change". The statement "Zimbabwe is the only country likely to experience climate change" had about 10% of respondents agreeing to that statement, though generally they were expected to disagree to it.

Figure 5-3 shows that in Murewa, eight (plus one not included in the graph) of the eleven statements had 5% or more of respondents (four of which had 10% and above) who were undecided though they had indicated that they were aware of climate change. The four statements that had 10% and above of respondents who were undecided are: "Zimbabwe is the only country likely to experience climate change"; "Exhaust fumes (carbon dioxide) from

vehicles contribute to climate change"; "Emission (carbon dioxide) from industries contribute to climate change"; and "There are (many) ways human can use to mitigate climate change". In addition, eight of the eleven statements had 5% or more of respondents who disagreed though in general they were expected to agree. Whereas respondents were expected to disagree to the statement "Zimbabwe is the only country likely to experience climate change", it actually had about 26% of respondents who agreed to it. The responses to the various statements were then used in further evaluation.

Figure 5-3: Percentage of respondents in Murewa who either disagreed or were undecided



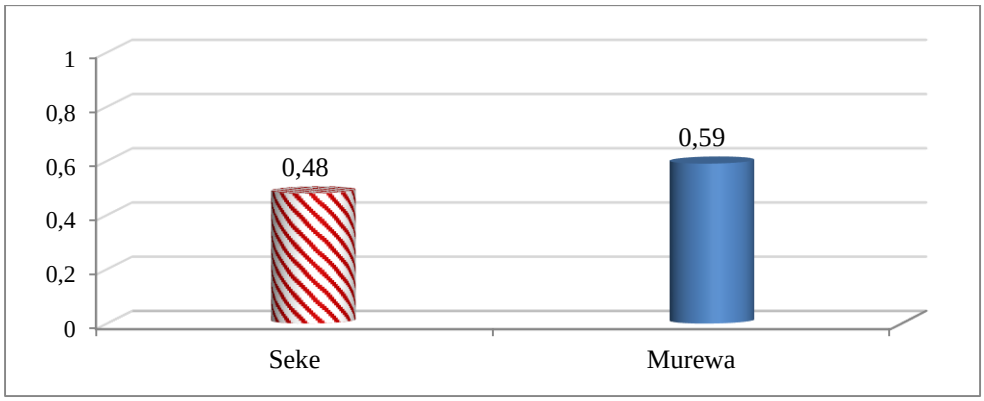
Source: Survey data

5.3 Calculation of the climate change awareness index

To evaluate the level of climate change awareness, a climate change awareness index (CCAI) (as described in detail in section 3.6.2) was formulated. In brief, the scores from the 11 statements[11] were added to get total scores that ranged between -22 and 22; the total score for each respondent was then divided by 22 to get an index between -1 and 1. The climate change awareness indices for the two districts are presented in Figure 5-4.

[11] NB: the responses to the statement "Zimbabwe is the only country likely to experience climate change" were transformed to be in line with the rest of the statements.

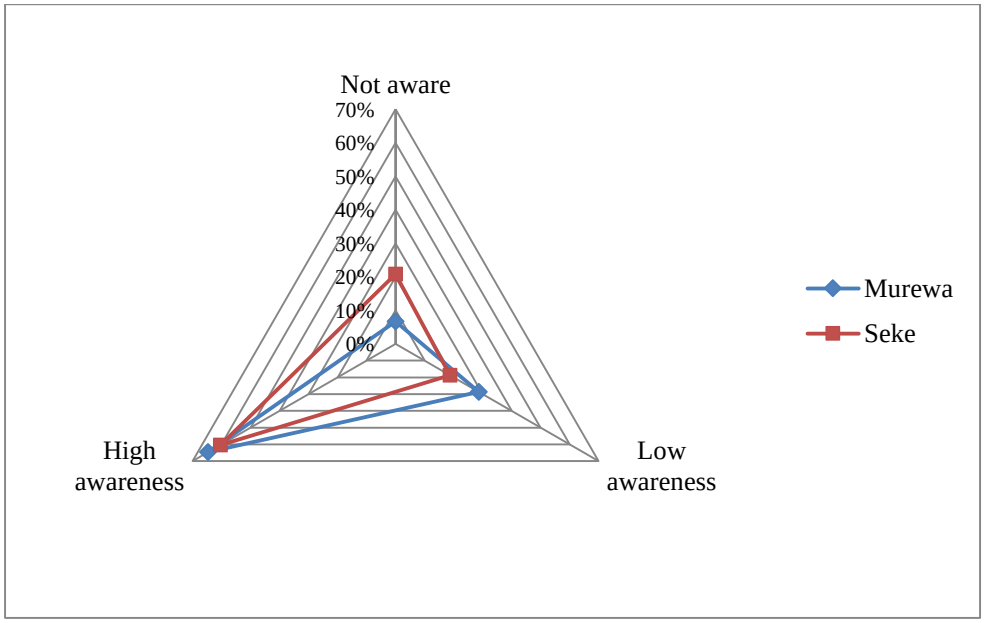
Figure 5-4: Climate change awareness indices for Seke and Murewa



Source: Survey data

Figure 5-4 shows that Seke had an index of 0.48 while Murewa had an index of 0.59. Based on the index, respondents were then categorised into three namely: not aware (index ≤ 0); low awareness (0 < index < 0.5); and high awareness (0.5 < index ≤ 1). The output of categorisation is presented in Figure 5-5.

Figure 5-5: Categorisation of respondents according to level of climate change awareness



Source: Survey data

Figure 5-5 shows that in the 'not aware' category, Seke had a greater proportion of respondents at 21% compared to 7% for Murewa. In the low awareness category, Murewa had a greater proportion of respondents at 29% compared to Seke's 19%. In the high

awareness category, Murewa had a greater proportion of respondents at 65% as opposed to Seke's 60%. This ordered categorisation was used as the dependent variable in the regression analysis in section 5.7. Having presented the findings on climate change awareness from the general survey, the next paragraph highlights the responses from the key informants.

Generally, all the key informants indicated that they were aware of climate change. They attributed the causes of climate change to the uncontrolled cutting down of trees, deforestation, industrial activity, uncontrolled burning of forests and veld fires. Some of the key informants also attributed it to spiritual and cultural beliefs, which was also a prevalent belief among the respondents. The key informants in Murewa indicated that, generally people in the community (more than half) were aware of climate change. In Seke, though the key informants indicated that the people in the community were aware of climate change, their views were mixed. Some indicated that more than half while others indicated that less than half of people in the community were aware of climate change. In addition, the key informants in both districts indicated that the districts were experiencing climate change related effects and regrettably, the majority of the people in the community were not able to cope with the effects. The key informants indicated that some of the commonly used coping strategies to reduce the effects of droughts include the growing of drought tolerant crops (small grains such as rapoko and millet), using irrigation, and practising conservation agriculture. In terms of food shortages, the people in the community used barter trade to get food and also received government and NGO food support. To cater for water shortages they dug and deepened boreholes and wells. The next paragraphs give a general discussion of the findings that have been presented so far.

Various studies from different parts of the world have shown mixed results on level of climate change awareness (Section 2.7.6). Some of the studies generally point to low awareness while others indicate higher awareness. This study found that the majority of respondents were relatively aware of various aspects of climate change. Nevertheless, whereas most of the respondents perceived and were aware of climate change, it is important to highlight that they had different levels of climate change awareness. As revealed by the climate change awareness index, some were not aware; others had low awareness, while some had high awareness. It was found that around 60% of the respondents were in the high awareness category, while roughly about 20% belonged to the low awareness category, and

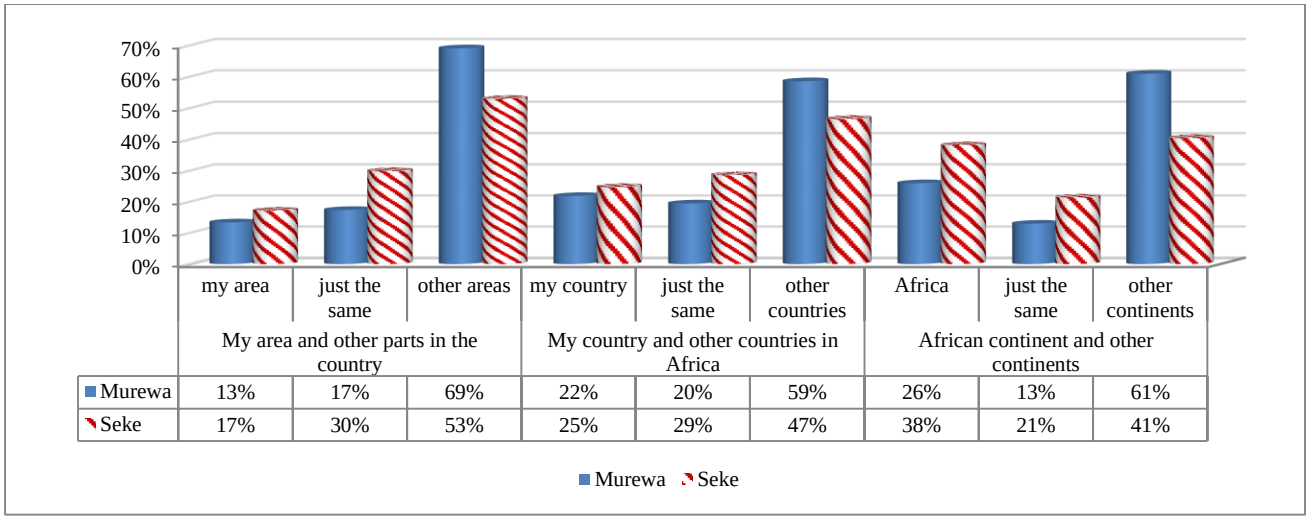
roughly another 20% belonged to the not-aware category. This implies that in some cases people/individuals might think they are aware of climate change when in fact they have wrong information or perceptions about some aspects of it.

Overall, though respondents were largely aware of climate change, they had limited understanding of issues related to the causes, mitigation and to some extent its global nature. This finding is in general agreement with earlier observations in the literature (section 2.7.6). An important observation can be made from this study and also from the literature in terms of climate change awareness. Respondents particularly those dependent on climate sensitive livelihoods such as farming are generally aware of climate change. However, when it comes to causes and mitigation aspects of climate change that knowledge tends to be relatively lower. The next section presents results on how respondents perceived how other areas were being affected by climate change.

5.4 Perceptions on how other areas were experiencing climate change

The majority of respondents (of those who had indicated that they were aware of climate change) agreed that their area and other areas within the country were experiencing climate change. In addition, they indicated that other countries in Africa and other countries outside Africa were experiencing climate change. Respondents were again asked where they thought the effects of climate change were worse. The responses are presented in Figure 5-6.

Figure 5-6: Where do you think the effects of climate change are worse



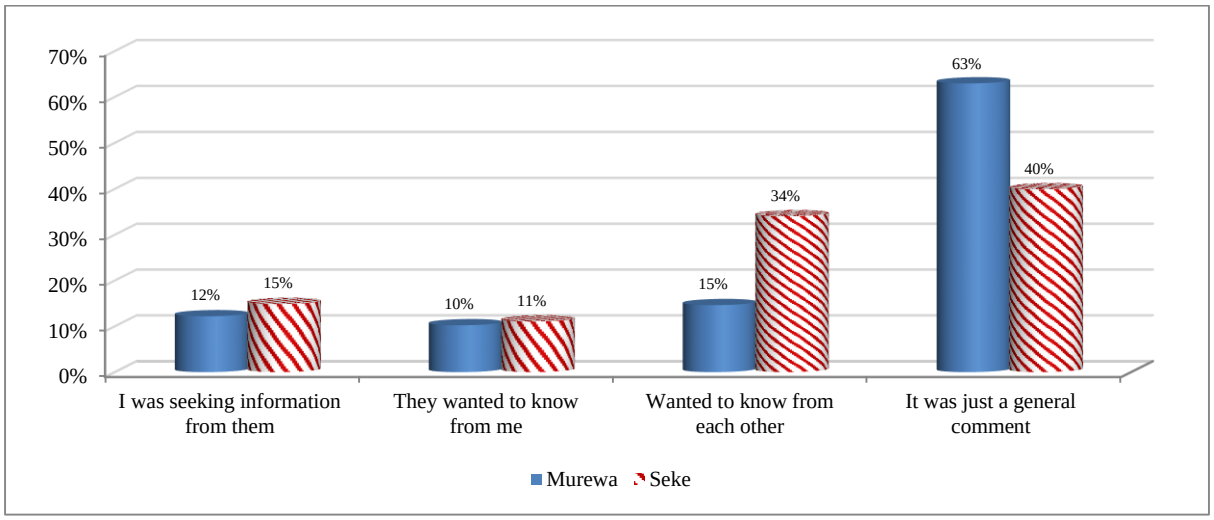
Source: Survey data

It is apparent from Figure 5-6 that the majority of respondents in both districts were of the perception that other areas were more affected by climate change than their area. That is to say when compared to their area the majority perceived that other areas within the country were more affected by climate change. Similarly, when compared to their country, the majority perceived that other countries within the African continent were more affected. Likewise, a greater proportion was of the opinion that other continents were more affected by climate change than the African continent. In all these aspects, Murewa generally had a greater proportion than Seke of respondents who perceived that other areas were more affected than their area, country, and continent. On the contrary, Seke had a greater proportion than Murewa of respondents who perceived that their area, country, and continent were affected the same as or more than other areas, countries, and continents.

5.5 Respondents who had talked/discussed about climate change

About 86% of respondents in Murewa and 79% of respondents in Seke indicated that they had at one time or the other talked or discussed about climate change with other people (family, friends, non-family, and non-friends). The main reasons for such discussions are highlighted in Figure 5-7.

Figure 5-7: Main reason for the talk



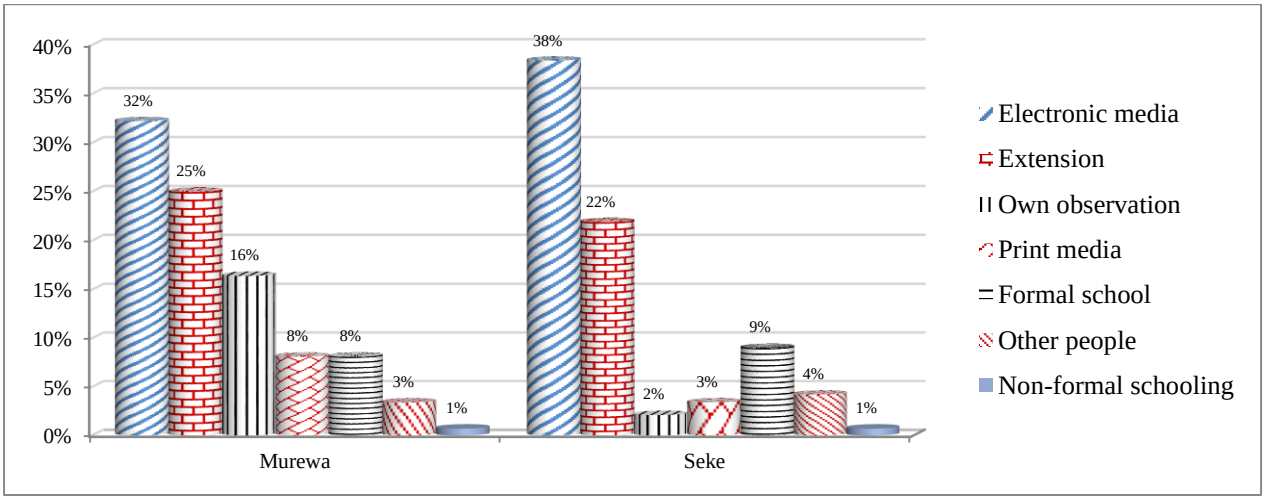
Source: Survey data

Figure 5-7 shows that most of the respondents in both districts (though Murewa had a greater proportion than Seke) indicated the main reason for the discussion was that it was just a general comment about climate change. The second main reason was that they wanted to know/ learn from each other (Seke had a greater proportion of respondents than Murewa). Other reasons that were highlighted by the respondents include just seeking information from other people and vice versa.

5.6 Important sources of climate change information

Sources of climate change information include the electronic media, print media, extension, farmer's own observation, formal school, non-formal school, and other people. From these sources, respondents were asked to rank their most important source of climate change information. The results are presented in Figure 5-8.

Figure 5-8: Ranking of sources of climate change information



Source: Survey data

Figure 5-8 shows clearly that the main sources for climate change information in both districts were electronic media, followed by agricultural extension. In Murewa, these were then followed by the individual's own observation, print media and formal schooling. In Seke, the main sources were followed by formal school, other people and the print media. The least ranked source of climate change information in both districts was non-formal schooling. The next section presents the regression results.

5.7 Regression results on the determinants of climate change awareness

As highlighted in section 3.6.2, an ordered multinomial logit regression model was used to determine the (socio-economic factors and ICT access) variables that had a significant relationship with the level of climate change awareness. The dependent variable was the ordered climate change awareness variable (explained in section 5.3) whereby respondents were categorised into three ordered groups (0= not aware; 1= low awareness; 2= high awareness). This ordered dependent variable was regressed against various independent variables (see Table 3-6 and discussion in Chapter 3). Three regression models[12] were run concurrently in Stata data analytical software. The regression models are as follows, one for each of the two districts (that is Seke and Murewa districts separately), and the other one is for the two districts combined. The output of all the three models have p-values (Prob> chi2) of 0.000 which indicate that all the three models are statistically significant. The significance of the independent variables was determined by the p-value of the regression coefficients (Long and Freese, 2006:193). The selection of the significance levels is arbitrary and can be informally based on general research experience (StatSoft, 1997), Hence, the researcher to make an educated guess (Field, 2009:56). Therefore, in this study the level of significance was evaluated at three levels namely 10%, 5%, and 1%. The summary of the models and coefficient of the independent variables and their significance levels are presented in Table 5-1.

For the Murewa model, six independent variables were found to have significant relationships with the level of climate change awareness. Five of the factors had a positive relationship in line with a priori expectations, three of these factors namely, access to mobile phone, access to newspapers and ever talked about climate change were highly significant (at 1% level), while access to extension and age of the respondent were significant at 10% level. However, one factor namely position of authority had a significant negative relationship (at 10% level) which was contrary to a priori expectations.

For the Seke model, five factors were found to have a significant positive relationship with the level of climate change awareness. The highly significant factors were participation in developmental organisations (at 1% level), and ever talked about climate change (at 5%

[12] The "do file" and output for the models are attached in appendix 6 and appendix 7 respectively.

level). The following variables, education level, participation in farmer organisations, and access to newspapers were significant at 10% level. The positive relationship between these independent variables and the level of climate change awareness is in line with a priori expectations.

Table 5-1: Ordered Logit regression model results

Model summary	**Murewa Model**	**Seke Model**	**Combined Model**
Log Likelihood	-83.887263	-106.63421	-221.40891
LR Chi2	69.54	54.48	76.01
Pseudo R2	0.2930	0.2035	0.1465
Prob> chi2	0.0000	0.0000	0.0000
Independent variables	**Coefficient and Significance level**	**Coefficient and Significance level**	**Coefficient and Significance level**
Gender	0.305	-0.697	-0.366
Age	0.034 *	0.024	0.013
Education level	-0.107	0.206 *	-0.013
land size	-0.011	-0.021	-0.002
Agricultural income	0.024	0.054	0.268
Access to extension	2.211 *	0.245	0.971
Cosmopoliteness	-0.030	0.186	0.018
Position of authority	-0.932 *	0.073	-0.407
Participation in farmer organisations	-0.140	0.547 *	-0.024
Participation in developmental organisations	-0.360	0.717 ***	0.320 **
Access to radio	0.574	0.541	0.635 *
Access to TV	-0.001	-0.344	-0.064
Access to mobile phone	1.829 ***	-0.149	0.779 **
Access to newspapers	1.814 ***	0.914 *	0.914 ***
Access to farming/ environmental magazines	-0.292	0.566	0.324
Ever talked about climate change[13]	4.075 ***	1.299 **	1.710 ***

Source: Survey data *Significance level: * = 10%; ** = 5%; *** = 1%*

When the districts are combined the following factors were found to have a significant positive influence on the level of climate change awareness. The highly significant factors at

[13] The variable "Ever talked about climate change" refers to whether the respondent had at one time or another talked or discussed about climate change with other people (e.g. family, friends, non-family, and non-friends).

1% level were access to newspapers and, ever talked about climate change, followed by participation in developmental organisations and access to a mobile phone at 5% level and, access to radio at 10% level. The positive relationship between these independent variables and the level of climate change awareness is line with a priori expectations.

From the output of these models, it is clear that factors that had a significant relationship with the level of climate change awareness varied across the two districts. In summary, from the three models, factors that were found to have a significant positive relationship with climate change awareness are access to radio, access to a mobile phone, access to newspapers, age of the respondent, education level, participation in developmental organisations, participation in farmer organisations, access to extension, and ever talked about climate change. Position of authority had a significant negative relationship. Each of these factors is discussed in the next paragraphs.

The following ICT and media related factors namely, access to radio, access to a mobile phone and access to newspapers had a significant positive relationship with the level of climate change awareness. The important role played by these channels in promoting awareness or behaviour change has noted in literature, see section 2.7.7 (e.g. Bertrand et al. 2006:568; Reid et al. 2012:51; Ospina and Heeks, 2012:5). In terms of personal attributes, age of the household head was found to have a significant positive influence on the level of climate change awareness. In other words, older farmers were likely to be more aware of climate change than younger farmers. In this study, age was included among the independent variable as a proxy for farming experience; that is the older the farmer was the more the farming experience. The importance of farming experience in terms of positively influencing climate change awareness has been highlighted in the literature, see section 2.7.7 (e.g. Patt and Schröter, 2007:17; Maddison, 2007:24; Hassan and Nhemachena, 2008:98). The likelihood of being more aware of climate change with age could possibly be a result of individuals having observed the changes in the climate which subsequently leads them to seek more information and knowledge on the possible causes of such changes.

The education level of the household head was found to have a significant positive relationship with the level of climate change awareness. Farmers that were more educated were more likely to have more knowledge on various aspects of climate change. Education is important, firstly, in understanding the language in which the climate change content is

transmitted in (which is mainly the English language). Secondly, it is important in understanding the various technical relationships between causes, effects, adaptation, and mitigation. The literature in section 2.7.7 (e.g. Maddison, 2007:3) highlights that education and literacy has a positive effect on awareness and adaptation.

Participation in farmer organisations and developmental organisations were found to have significant positive relationships with the level of climate change awareness. In the two districts, the majority of the household heads interviewed participated in farmer organisations (81%), and developmental organisations (56%). The positive relationship between participation in farmer and developmental organisations is highlighted in the literature; see section 2.7.7 (e.g. UNFCCC, 2005:15; Reid et al. 2012:43). In addition, access to agricultural extension was found to have a significant positive relationship with the level of climate change awareness. The literature presented in section 2.7.7 (e.g. Maddison, 2007:3; UNDP, 2012:33) indicated that agricultural extension and advisory services can help farmers respond to climate change. The variable (ever talked about climate change) was found to have a significant positive relationship with the level of climate change awareness. The respondents indicated that it was important to know and also talk about climate change. The majority of respondents indicated that they had at one time or the other talked (or discussed) about climate change with other people (family, friends, non-family, and non-friends). Some of the reasons for discussing about climate change included: it was just a general comment about climate change and, seeking to know and learn from each other.

The variable (position of authority) was found to have a significant negative relationship in Murewa, and a non-significant positive relationship in Seke, with the level of climate change awareness. Position of authority is closely related to the role played by opinion leaders. As highlighted in literature, position of authority was expected to have a positive relationship with climate change awareness. However, contrariwise, a significant negative relationship was found in Murewa. The possible reason could be that, while positions of authority might generally be viewed as closely related to opinion leadership, this might not necessarily apply when evaluating knowledge related issues such as climate change. Especially when considering the fact that some of these positions of authority are traditional and political leadership positions. Such positions may not actually be associated with the likelihood of being aware or knowledgeable about issues such as climate change.

The implication of this finding is that though opinion leadership is generally important, what might be more important is to evaluate the type of opinion leadership in relation to the subject matter. For example, in the context of this study, the opinion leadership that might be more important can include successful farmers and local knowledge experts such as extension workers and development practitioners. These are the people who are likely to have more knowledge on climate change issues rather than anyone with a position of authority within the community. Having discussed the various factors that were found to have a significant relationship with the level of climate change awareness, the next section gives the conclusion for the chapter.

5.8 Conclusion

Although the majority of respondents in both districts were largely found to be aware of climate change, some of those who perceived themselves as being aware, were actually not aware or had low awareness as revealed by the climate change awareness index. By and large, the respondents had limited understanding of the issues relating to the causes and mitigation of climate change, and its global nature. Over the years, there has been a general increase in climate change awareness, particularly, amongst the farming community due to increased coverage of climate change issues and their own observation (experience). Some of the factors that were found to have a significant positive relationship with climate change awareness are access to radio, access to a mobile phone, access to newspapers, access to extension, age of the respondent, education level, participation in developmental organisations, participation in farmer organisations and ever talked about climate change. However, position of authority was found to have a significant negative relationship. In sum, access to some ICTs and certain socio-economic factors had siginificant relationships with the level of climate change awareness. The chapter concentrated on variables that had a significant relationship with climate change awareness. Nonetheless, it is important to bear in mind that having information and being aware of climate change does not easily translate in action (adaptation and mitigation).

CHAPTER 6: ACCESS TO EARLY WARNING AND WEATHER FORECASTING INFORMATION

6.1 Introduction

One of the biggest challenges is how to strengthen the social, economic and environmental resilience of the poorest and the most vulnerable against climate variability and change (Fischer, Shahs and van Velthuizen, 2002:9). In that context, the third objective of the study was to investigate the contribution of ICTs in climate change adaptation amongst communal farmers in Seke and Murewa districts of Zimbabwe. As discussed in the literature review (section 2.9), there are many ways in which ICTs can contribute to climate change adaptation in the agricultural sector. In brief, these include observation, analysis and planning, implementation and management, monitoring and evaluation, networking, capacity building, timely decision-making, early warning systems and forecasting processes. The study was not able to cover all these ways. Nonetheless, it concentrated on assessing how farmers accessed forecasting and early warning information, and how this helped them in decision-making and adapting to climate variability and change.

The chapter is organised into four main parts. Firstly, it presents results on perceptions on climate variables and extremes (rainfall, temperature, droughts, violent storms, and floods). This is followed by results on access to and use of climate and weather forecasting information. This included assessing the various sources of forecasting information, and evaluating the role played by the forecasting information in farm decision-making. In addition to the sources of forecasting information, the main sources of agricultural information are presented as well. Then a general discussion of the results is provided and, the conclusion marks the end of the chapter.

6.2 Perceptions on climate variables and extremes

It is important to understand how the public understands and perceives changes in climate variables over time. Accordingly, respondents were asked their perceptions on rainfall, temperature, droughts, violent storms and floods. Each of these aspects is presented in the following subsections.

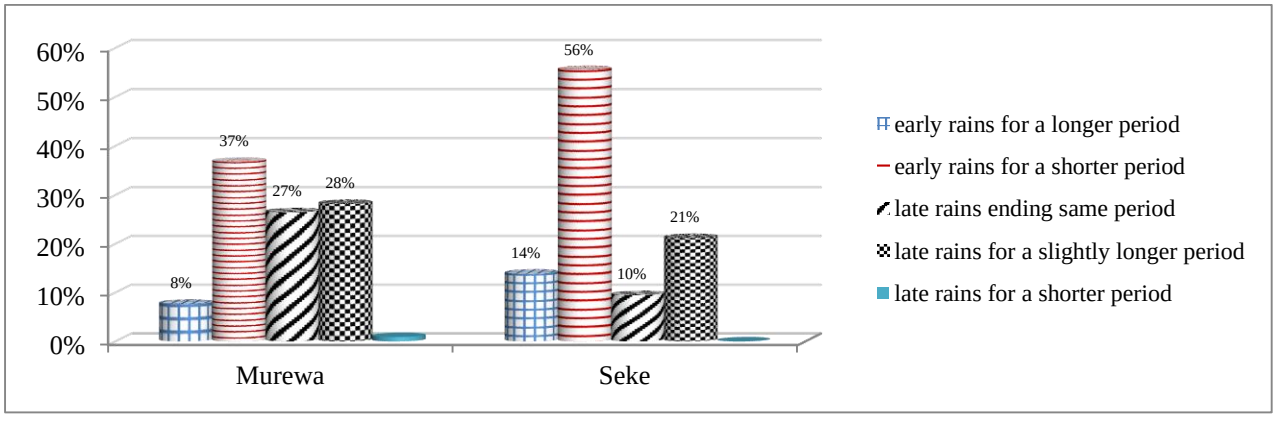
6.2.1 Perceptions on rainfall

Respondents were first asked whether they receive adequate rainfall. An estimated 60% of respondents in Murewa, and 17% of respondents in Seke indicated that they received adequate rainfall. The general perceptions of the respondents were confirmed by the responses of the key informants. In Murewa, the key informants indicated that the area largely receives adequate rainfall, while those in Seke indicated that the area largely receives inadequate rainfall. While no proper historical rainfall data could be sourced from weather stations[14], this could likely mean that Murewa generally received more rainfall than Seke as shown by these general perceptions.

The respondents were then asked if they had observed any change in the rainfall amount and distribution. The majority of respondents in the two districts (81% in Murewa and 90% in Seke) indicated that they had observed changes. In terms of rainfall amount; in Murewa, 76% of those that had observed changes in rainfall indicated that the rainfall was decreasing while the remainder indicated that rainfall was increasing. In Seke, 82% of those who observed changes in rainfall indicated that the rainfall amount was decreasing while the remainder indicated that the rainfall was increasing.

Respondents were further asked how they perceived the changes in the distribution of rainfall. The responses are presented in Figure 6-1.

Figure 6-1: Perceptions on the change in the distribution of rainfall



Source: Survey data

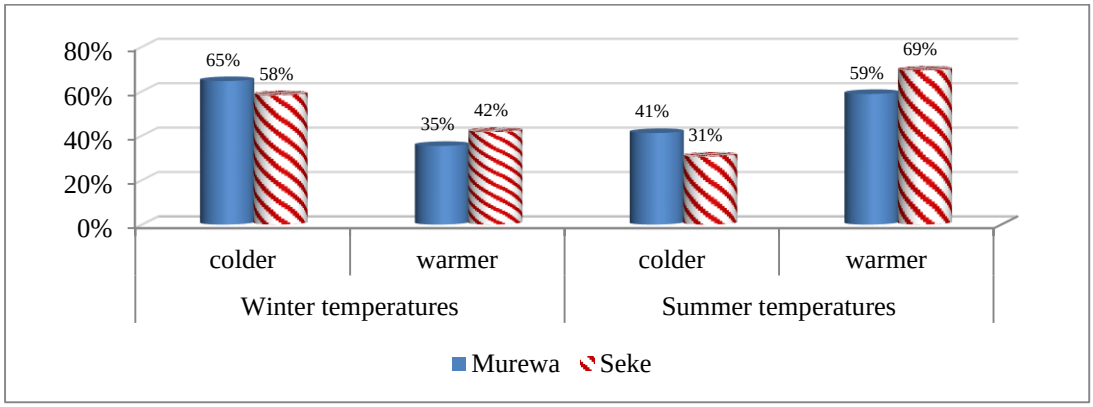
[14] During the data collection period, it was relatively difficult and expensive to access historical rainfall and temperature data for the two districts from the Meteorological Service Department (Met Office).

A significant number of respondents in both districts (37% in Murewa and 56% in Seke) perceived that they were receiving early rains that lasted for a shorter period. This was followed by those who perceived that they were receiving late rains that lasted for a slightly longer period. In Murewa, the key informants had mixed perceptions on the distribution of rainfall. In Seke, the key informants substantiated the general perception of the majority of respondents that they were receiving early rains that lasted for a shorter period.

6.2.2 Perceptions on temperature

The respondents were asked if they had observed any changes in winter and summer temperatures. The majority of respondents (71% in Murewa and 77% in Seke) indicated that the temperatures were changing. Their perceptions on how the temperatures were changing are shown in Figure 6-2.

Figure 6-2: Perceptions on changes in winter and summer temperatures



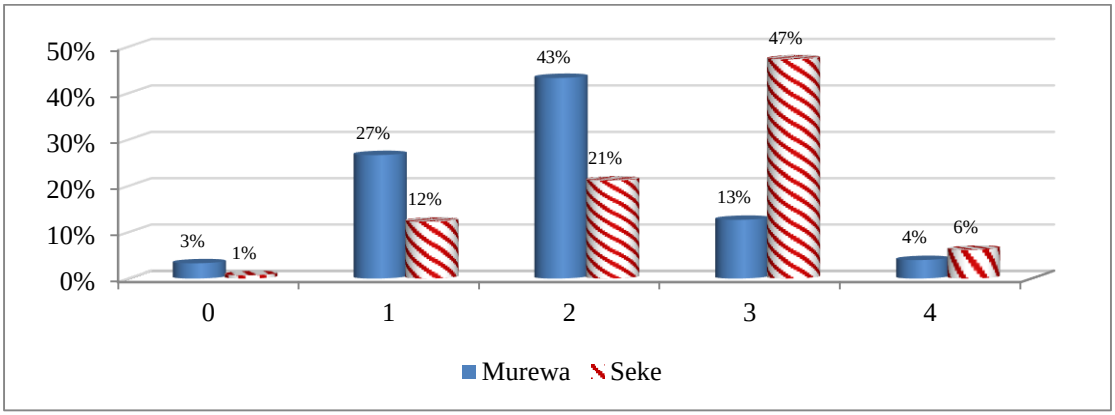
Source: Survey data

The majority of respondents in both districts indicated that winter temperatures were largely getting colder, with about 65% in Murewa and 58% in Seke. In contrast, the majority of respondents perceived that summer temperatures were getting warmer, with about 59% in Murewa and 69% in Seke. The general perception of the respondents in both districts was concurred by the key informants, who generally perceived that the temperatures were changing with winter temperatures getting colder while summer temperatures were getting warmer.

6.2.3 Perceptions on droughts

Respondents were asked if they had experienced a drought/s. Almost all respondents in both districts (98% in Murewa and 95% in Seke) indicated that they had experienced a drought. For those who indicated that they had experienced a drought they were further asked how many droughts had they experienced in the last ten years. The results are presented in Figure 6-3.

Figure 6-3: How many droughts in the last ten years



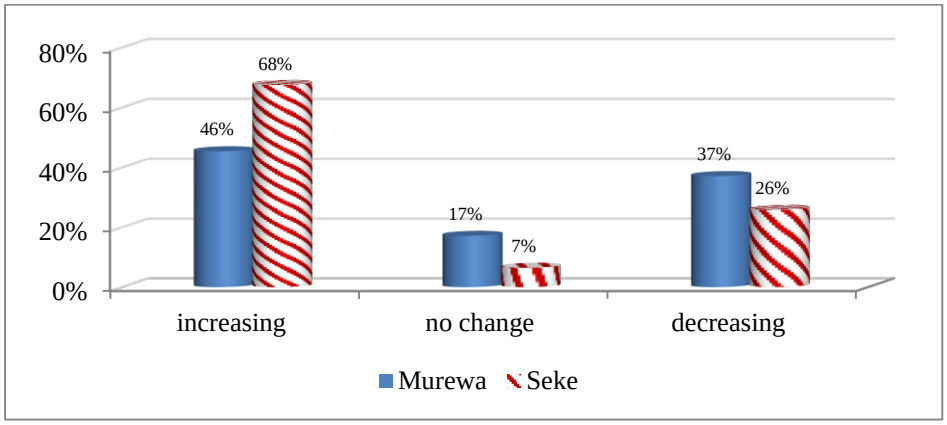
Source: Survey data

Figure 6-3 shows that in Murewa, a greater percentage of respondents (43%) had experienced two droughts in the last ten years, while, 27% indicated that they had experienced one drought in the last ten years. This was also supported by the key informants who indicated that on average Murewa had experienced about two droughts in the last ten years. In Seke, a greater percentage of respondents (47%) indicated that they had experienced three droughts in the last ten years, while, 21% indicated that they had experienced two droughts. By and large, the key informants in Seke were in agreement with the overall perception of the majority that the area had experienced about three droughts in the last ten years.

Furthermore, respondents were asked how they perceived the frequency of droughts and the results are presented in Figure 6-4. The figure shows that a greater proportion of respondents in both districts perceived that the frequency of droughts was increasing. This is followed by those that perceived that it was decreasing, while some indicated that there was no change in the frequency of the droughts. All in all, Seke had a greater proportion than Murewa of respondents who perceived that the frequency of droughts was increasing. Conversely,

Murewa had a greater proportion than Seke of respondents who perceived that the frequency of droughts was decreasing.

Figure 6-4: Frequency of droughts



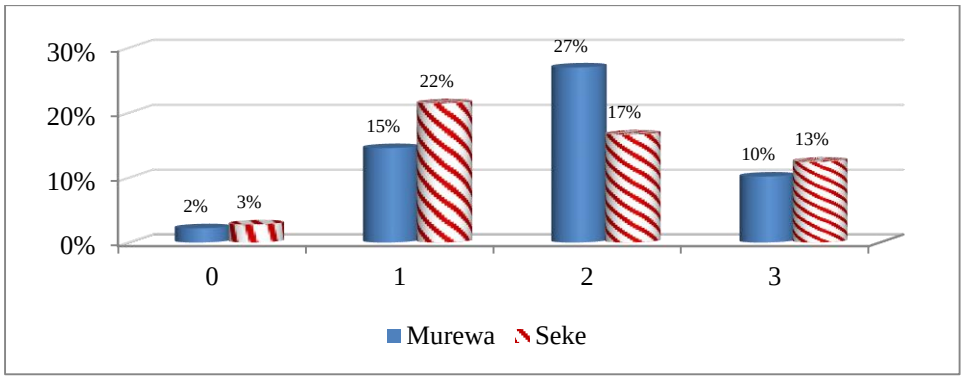
Source: Survey data

In terms of dry spells, the key informants in Murewa indicated that the area experienced at least one dry spell whose duration could last between one to four weeks in a season. Consequently, these dry spells could result in the wilting of some crops, which can affect yields. In addition, the dry spells could have significant effects on both pastures and water availability for livestock. The key informants indicated that the frequency and duration of the dry spells was not changing. In Seke, the key informants indicated that the area experienced one to two dry spells in a season. These dry spells lasted for about three to four weeks and at times could extent to more four weeks. These dry spells could result in the wilting of some crops with significant effect on yields, as well as significantly affecting both pastures and water availability for livestock. Broadly, the key informants in Seke indicated that the frequency and duration of the dry spells was increasing.

6.2.4 Perceptions on violent storms and floods

Just over half of the respondents in both districts (55% in Murewa and 54% in Seke) indicated that they had experienced a violent storm. These respondents were then asked how many violent storms they had experienced in the last ten years (Figure 6-5).

Figure 6-5: The number of violent storms in the last ten years

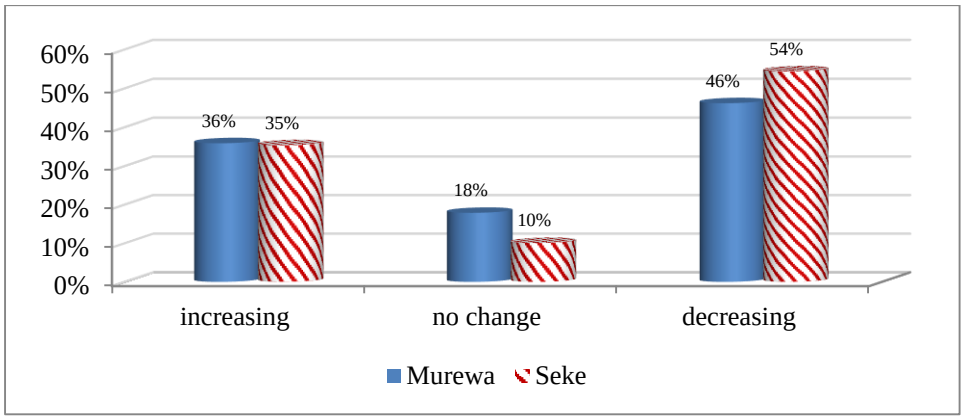


Source: Survey data

A greater percentage (22%) of respondents in Seke indicated that they had experienced one violent storm in the last ten years. This was followed by those (17%) who indicated that they experienced two violent storms, and about 13% who indicated that they had experienced three. Largely, the key informants in Seke indicated that the area had experienced about two violent storms in the last ten years. In Murewa, a greater percentage (27%) of respondents indicated that they had experienced two violent storms in the last 10 years. This was followed those who indicated that they had experienced one violent storm, while 10% indicated that they had experienced three violent storms. Altogether, the key informants in Murewa indicated that the area had experienced about one to two violent storms in the last ten years. Respondents were then asked if they had observed any change in frequency of violent storms, the results are presented in Figure 6-6.

Figure 6-6 shows that the greatest percentage of respondents in both districts perceived the frequency of violent storms as decreasing, with about 46% and 54% in Murewa and Seke respectively. This was followed by respondents who indicated that the frequency of violent storms was increasing, with about 36% and 35% in Murewa and Seke respectively. A relatively small percentage of respondents in both districts indicated that there was no change in the frequency of violent storms. However, in terms of floods, none of the respondents and the key informants in both districts indicated that they had experienced flooding in the area.

Figure 6-6: Frequency of violent storms



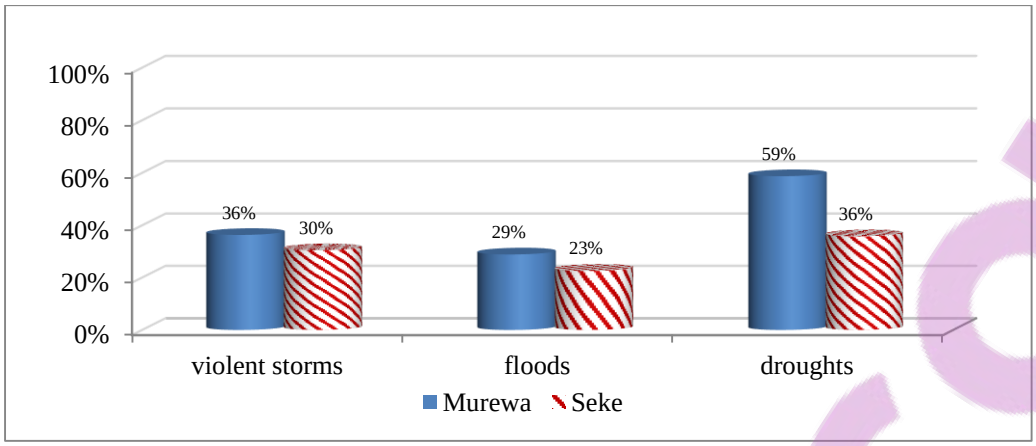
Source: Survey data

By and large, from the assessment of farmers' perceptions on trends and changes in climate variables and extremes it is evident that they are experiencing change. The challenge, however, is whether to refer to such perceived change as general climate variability or if it points to climate change. The general change in the climate is associated with the occurrence and increased frequency of climate extremes. Usually, these climate extremes result in devastating effects on the livelihoods of rural people. From the respondents' perceptions, it is clear that the two districts are and will be more vulnerable to dry spells, droughts and to some extent to violent storms. This necessitates the need for individuals and communities to be better prepared for such events. The next section presents results on early warning information.

6.3 Early warning on violent storms, floods and droughts

The importance of early warning systems in enhancing timely and effective responses to climate extremes is emphasised in the literature (see section 2.7.10). Early warning information can help people prepare for and respond to extreme weather events, thereby minimising the likely negative impacts. In that regard, respondents were asked if they got timely warnings on violent storms, floods and droughts. The results are presented in Figure 6-7.

Figure 6-7: Got timely warnings on violent storms, floods and droughts



Source: Survey data

Figure 6-7 shows that more than half of the respondents (59%) in Murewa and more than one-third (36%) in Seke indicated that they got timely warnings on droughts. In terms of violent storms, about one-third of respondents in both districts (36% and 30% in Murewa and Seke respectively) indicated that they got timely warning. Though the two districts are not flood prone, the respondents indicated that they also got warning on floods probably concerning other areas that are flood prone. Almost always, Murewa had a greater percentage than Seke of respondents who indicated that they got timely warning on all the three events (violent storms, floods, and droughts).

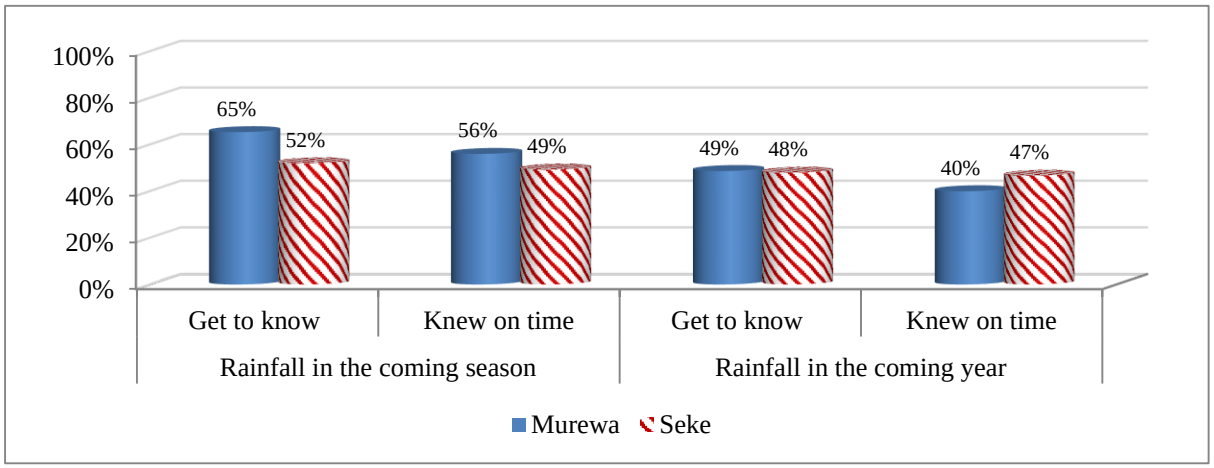
6.4 Access to and use of forecasting information

For any meaningful adaptation, farmers should be prepared in advance for both short and long-term changes in climate variables. Rainfall is an important climate variable whose amount and variation has a bearing on the frequency and intensity of events such as droughts, floods and violent storms. Due to the importance and direct bearing of rainfall on the livelihoods of rural people, this study concentrated on access to rainfall forecasting information by the communal farmers in the two districts. In that regard, the next subsection reports results on the sources of weather forecasting and early warning information in Seke and Murewa districts.

6.4.1 Sources of weather forecasting and early warning information

Respondents were first asked whether it was important to know about the likely amount and distribution of rainfall in the coming season and in the coming year. Almost all respondents in both districts (about 98% in both districts) indicated that it was important. Respondents were then asked if they got to know or accessed information on the likely amount and pattern of rainfall in the coming season and in the coming year. The results are presented in Figure 6-8

Figure 6-8: Accessing rainfall forecasting information for the coming season and the coming year

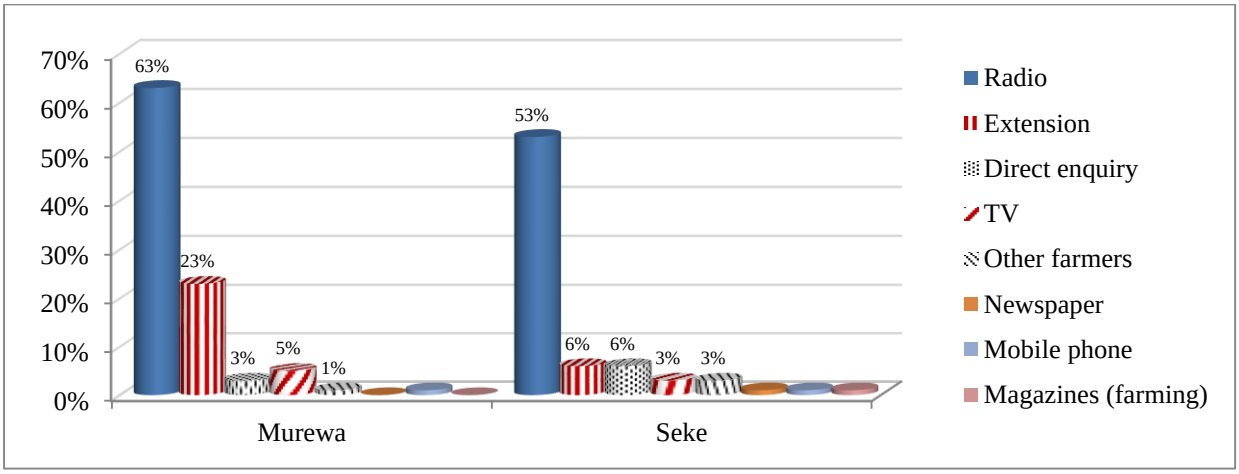


Source: Survey data

More than half of the respondents in both districts indicated that they got to know about rainfall in the coming season, with Murewa having a greater percentage of 65% compared to Seke which had 52%. In addition, 56% and 49% of the respondents in Murewa and Seke respectively indicated that they got the information on time. In terms of getting information on the likely rainfall pattern and amount in the coming year, slightly below half of the respondents in both districts (49% in Murewa and 48% in Seke) indicated that they got the information. Furthermore, 40% and 47% in Murewa and Seke respectively indicated that they got that information on time. By and large, the key informants in both districts indicated that they got to know about the likely rainfall amount and distribution in the coming season and in the coming year. In addition, they indicated that they got the information on time. However, the key informants indicated that broadly the majority of the people were not getting such information on time.

Some of the sources of weather forecasting and early warning information include modern methods, traditional experts, and farmer's own assessment/observation. This study focused mainly on access to forecasting information from modern methods. In that regard, more than half of the respondents in the two districts indicated that they accessed weather forecasting information from weather stations, with about 72% in Murewa and 54% in Seke. The channels through which farmers accessed the information are radio, extension, direct enquiry, TV, other farmers, newspapers, mobile phone, and farming magazines. From all these channels, respondents were asked to rank the most important channel through will they accessed the information. The results are presented in Figure 6-9.

Figure 6-9: Important sources of weather information

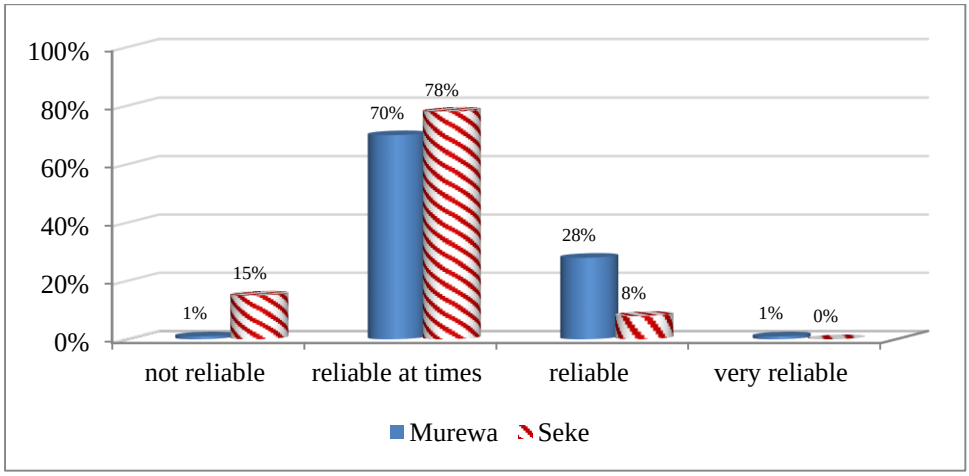


Source: Survey data

It is apparent from Figure 6-9 that most respondents in the two districts ranked the radio as the most important source of the forecasting information. In Murewa, the radio was followed by extension, then the TV. In Seke, the radio was followed by extension and direct enquiry, which were ranked equally. It is important to note that up to the period of and during the data collection process for this study in 2011, the public in Zimbabwe could not directly access weather information and updates on their mobile phones. Such a facility was not yet available on mobile networks. Nonetheless, the NewsDay (2012) reported that the Meteorological Service Department indicated that people in Zimbabwe were soon going to access weather reports on their mobile phones. The report highlights that the negotiations between the department and the country's three mobile network service providers were at an advanced stage.

In addition to sources of forecasting information, respondents were asked about their perceptions on the reliability of the modern forecasting information (that is information from Meteorological Service Department). The results are presented in Figure 6-10.

Figure 6-10: Reliability of weather forecasting and early warning information from Meteorological Service Department



Source: Survey data

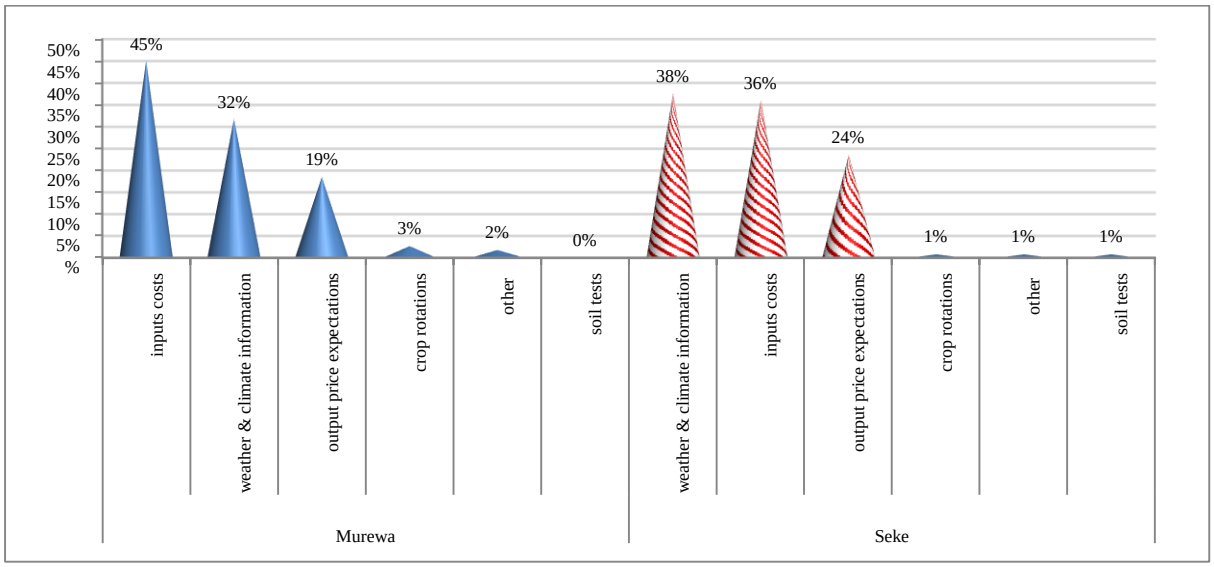
Figure 6-10 shows that none of the respondents in Seke and only 1% in Murewa indicated that the weather forecasting information was very reliable. Furthermore, few respondents indicated that the information was reliable, with only 28% in Murewa and 8% in Seke. Notwithstanding, the majority of respondents perceived that the forecasting information was only reliable at times, with about 78% in Seke, while Murewa had 70%. Besides the majority of respondents indicating that the information was only reliable at times, over 90% of them in both districts indicated that it was important to have access to such information. The next section focuses on the role that weather and climate forecasting information played in farming decision-making process.

6.4.2 The important role of weather and climate forecasting information in farm decision-making

There are many decisions that the farmer has to make in his/her farming activities. The key informants indicated that knowing about the rainfall amount, patterns and distribution helped farmers to plan their agricultural activities in the coming season. This include choosing crop

varieties (short versus long season), procurement of inputs, land preparation and it enhanced their general preparedness to extreme events. In relation to this, the respondents were asked the factors that influenced their farming decisions most. The results are presented in Figure 6-11.

Figure 6-11: Ranking of factors that influenced farming decisions



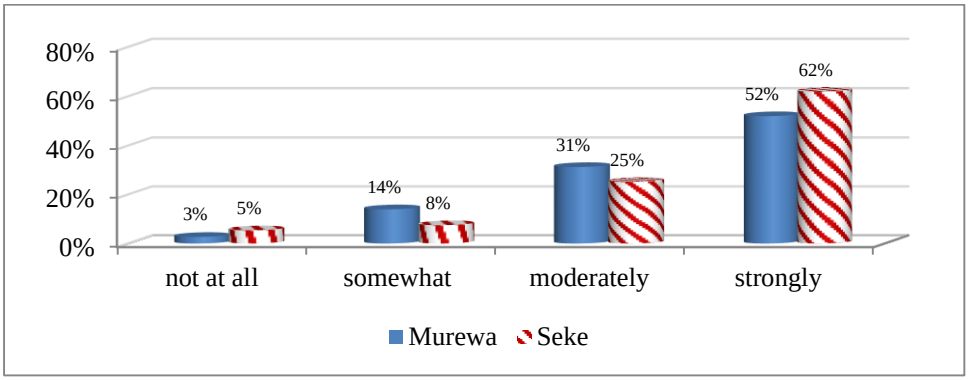
Source: Survey data

As shown clearly in Figure 6-11, the three highly ranked factors that influenced their farming decisions in Murewa were: inputs costs, weather and climate information, and output price expectations. In Seke, the three highly ranked factors were: weather and climate information, input costs, and output price expectations. From these results, it is evident that weather and climate information is very important in influencing farming decisions of farmers in communal areas such as Seke and Murewa districts. In addition, respondents were asked to rate how strongly the weather forecasting and climate information influenced their farming decisions in particular. The results are presented in Figure 6-12.

Figure 6-12 shows that more than half of the respondents indicated that the weather and climate forecasting information strongly influenced their decisions, with 62% in Seke and 52% in Murewa. While about 25% in Seke and 31% in Murewa, indicated that the information influenced their decisions moderately. Very few respondents indicated that their decisions were not influenced by the information, with only 3% in Murewa and 5% in Seke. In general, it is evident that besides the weather and climate forecasting information being

perceived as not very reliable, it played an important role in the farm decision-making process of farmers.

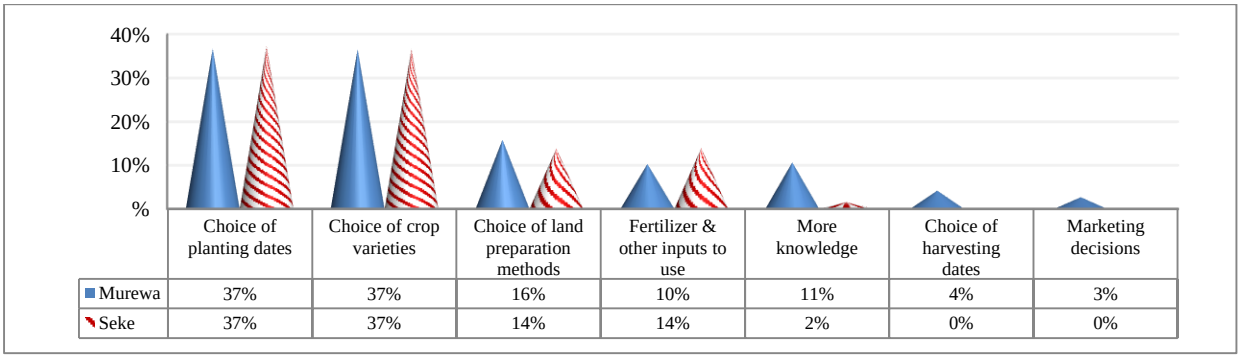
Figure 6-12: How strongly does weather forecasting and climate information influence farming decisions



Source: Survey data

Applying forecasts at the level of the individual farmer offers both the greatest challenges and the greatest rewards, as farmers face a diverse set of decisions in their farming operations (Patt and Gwata, 2002:185). In this context, respondents were asked to rank the farming decisions that were mostly influenced by the weather and climate forecasting information (Figure 6-13). It is apparent from the Figure that the most important uses of weather and climate forecasting information in both districts were in deciding planting dates and choosing crop varieties. In Murewa, this was followed by choice of land preparation methods, then more knowledge, and deciding on the application of fertilizer and other inputs. In Seke, the main uses were followed by deciding on application of fertilizer and other inputs, then choice of land preparation methods, and more knowledge.

Figure 6-13: Main uses of the weather and climate information



	Choice of planting dates	Choice of crop varieties	Choice of land preparation methods	Fertilizer & other inputs to use	More knowledge	Choice of harvesting dates	Marketing decisions
Murewa	37%	37%	16%	10%	11%	4%	3%
Seke	37%	37%	14%	14%	2%	0%	0%

Source: Survey data

As highlighted in the literature (section 2.7.10), farmers should have the capacity to access and utilise the weather and climate forecasting information. In other words, in addition to the forecasting information, farmers should have information and knowledge on how to adjust their farming practices according to the forecasts. This implies that having access to weather forecasting and early warning information is not enough on its own. Thus, farmers also require information and knowledge on appropriate response strategies.

Regrettably, about 41% of respondents in Murewa and 56% of respondents in Seke indicated that they did not have knowledge on how to adjust their farming practices according to the forecasts they received. In addition, 47% of respondents in Murewa and 60% in Seke indicated that they did not have information or knowledge on the seed varieties and technologies that were suitable according to the forecasts. This is to say, they did not have information, for example, on drought-resistant seeds if a drought was predicted or were not aware where such seeds or technologies could be sourced from. For those that indicated that they had such information and knew where the suitable seeds or technologies could be sourced, only 54% of them in Murewa and 37% of them in Seke indicated that they could afford them.

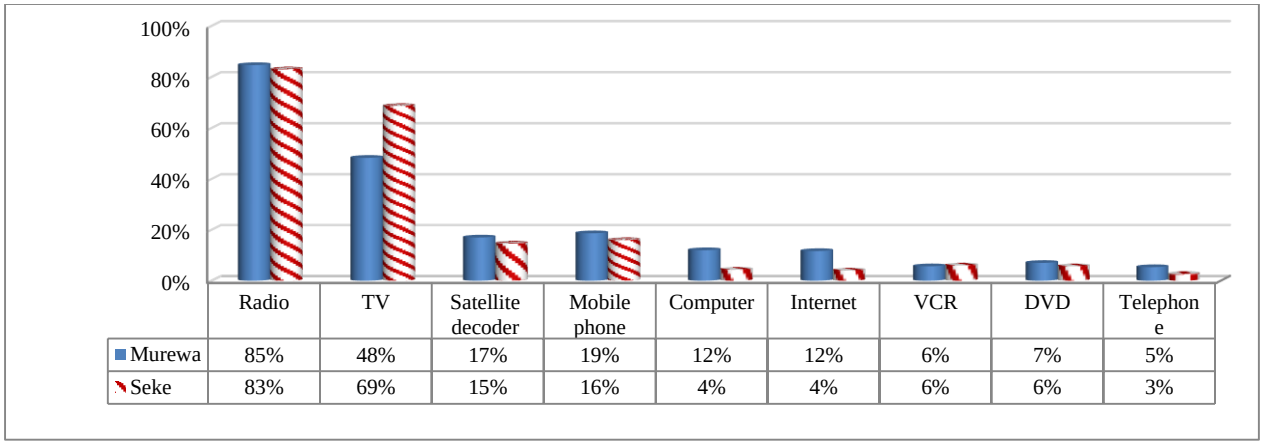
The key informants indicated that though the suitable seed varieties and technologies (as predicted by the forecasts) were generally available on the market, the majority of the people could not access them. This is mainly due to the inputs not being available on time, as well as, the unaffordability of the inputs. In addition, the key informants highlighted the following additional challenges faced by farmers. These include the inaccessibility to print and electronic media, wrong prediction of weather forecasts, and difficulties in interpreting weather forecasts. Largely, extension workers (an important source of forecasting information besides the radio) face a number of challenges in conveying forecasting information to farmers. During one of the key informant interview sessions, an extension worker remarked that at times they did not know what to tell the farmers concerning rainfall forecasts. This is due to lack of timely weather information and at times having information that is too general, which was not relevant at the local level. Having wrong predictions and wrong interpretation of forecasting information can have negative impacts on the livelihoods of people. Indeed, this might end up increasing their exposure to hazards. The findings in this

study tend to support observations in the literature (see section 2.7.10, e.g. Ziervogel et al. 2004:1). Having discussed access to forecasting and early warning information, the next section briefly presents findings on access to agricultural information.

6.5 Main sources of agricultural information

Respondents were asked whether they got agricultural information (such as farming practices, input and output prices) from the various ICTs. The results are presented in Figure 6-14.

Figure 6-14: Main ICT sources of agricultural information



	Radio	TV	Satellite decoder	Mobile phone	Computer	Internet	VCR	DVD	Telephone
Murewa	85%	48%	17%	19%	12%	12%	6%	7%	5%
Seke	83%	69%	15%	16%	4%	4%	6%	6%	3%

Source: Survey data

Figure 6-14 shows that the radio was the main source of agricultural information, with over 80% of respondents from both districts, followed by the television, which had close to 70% in Seke and close to 50% in Murewa. The satellite decoder and mobile phone were highlighted as sources of information by about 10-20% of the respondents in both districts. Very few respondents (generally less than 10%) indicated that they got agricultural information from or via the following: the computer, the internet, VCR, DVD, and the telephone.

In terms of print media, the main sources for agricultural information were the newspapers, and farming/environmental magazines. About 60% in Murewa and close to 70% in Seke indicated that they accessed the information from newspapers. This was followed by farming/environmental magazines, which had 45% in Murewa and 54% in Seke. Altogether, there was greater proportion of respondents from Seke than Murewa who indicated that they accessed the information from the various print media. Respondents indicated that the

information they got was relevant to them as it contributed to more knowledge especially on better farming methods.

6.6 Conclusion

The majority of respondents perceived that the rainfall they received was decreasing. In addition they perceived that they were receiving early rains that lasted for a shorter period. In terms of temperatures, the majority perceived that winter temperatures were largely getting colder while summer temperatures were getting warmer. They indicated that the districts had experienced about two to three droughts in the last ten years; the occurrence frequency of droughts was actually increasing. Moreover, they had experienced about one to three violent storms in the last ten years. The districts are and will likely be more vulnerable to dry spells, droughts and to some extent to violent storms. This necessitates the need for individuals and the community at large to be better prepared for such events. The findings in this study show that, up to two-thirds of the respondents did not have timely access to early warning information on violent storms and droughts. In addition, around half of the respondents indicated that they do not get information on the likely rainfall amount and distribution in the coming season and in the coming year.

Almost all respondents indicated that it was important to have access to forecasting information as this enabled them to plan their farming activities. Besides the information being perceived as not very reliable, it played an important role in the decision-making process of farmers. Respondents ranked, deciding the planting dates and the choice of crop varieties as the most important farm decision-making activities that were influenced by the forecasting information. Nevertheless, a serious constraint in the utilisation of forecasting information manifested in two ways. Firstly, there was lack of access to the necessary and complementary information and knowledge on what to do, and how to do it. Secondly, when that information and knowledge was available there was lack of resources/inputs to do what was supposed to be done.

Some of the channels through which farmers accessed early warning and weather forecasting information are radio, extension, direct enquiry, TV, other farmers, newspapers, mobile phone and farming magazines. From all these channels, the most important channel was the

radio. Overall, it is evident from the findings and the literature review that both ICT and non-ICT channels played an important role in the dissemination of forecasting information that helped farmers to better respond to weather and climate extremes.

CHAPTER 7: SUMMARY OF FINDINGS, CONCLUSIONS AND SUGGESTIONS

7.1 Introduction

This chapter presents the summary of findings, conclusions and suggestions. It links the objectives of the study stated at the beginning of the thesis (in chapter 1), with the main findings of the study. It then highlights the contributions of the study to the body of knowledge, policy and practice. This is followed by suggestions/recommendations for the various stakeholders. It then closes the chapter by suggesting areas of further research.

7.2 The objectives of the study

The first objective was to determine the level of access to and usage of ICTs by communal farmers in Seke and Murewa districts of Zimbabwe. The second objective was to evaluate how access to ICTs influenced climate change awareness of those communal farmers. The third objective was to investigate the contribution of ICTs in climate change adaptation amongst the communal farmers.

7.3 Summary of key findings

7.3.1 Level of access to ICTs by communal farmers

From the findings, it is evident that communal farmers in Seke and Murewa districts had relatively better access to old ICTs in particular, the radio and the TV, and for the new ICTs, they had better access to the mobile phone. Seke, generally had better access to most of the ICTs and print media that Murewa. The main power sources for the ICTs were solar power, electricity, and rechargeable batteries. In terms of print media, they had better access to the newspaper, church magazines, posters and farming/ environmental magazines. For almost all the print media, the main sources of the media was through friends and relatives, and the readers buying themselves. An important source for the posters was mainly in libraries and public places. The majority of respondents understood the language used in conveying information via the ICTs, though some had difficulties.

7.3.2 Evaluation of how access to ICTs influenced climate change awareness of the communal farmers

The majority of respondents in both districts were largely found to be aware of climate change. Notwithstanding, some of those who perceived themselves as being aware were actually not aware or had low awareness as revealed by the climate change awareness index. Chiefly, the respondents had limited understanding of issues relating to causes and mitigation of climate change, as well as its global nature. From the regression analysis, Murewa district had six independent variables that were found to have a significant relationship with the level of climate change awareness. Five had a positive relationship namely, access to mobile phone, access to newspapers, ever talked about climate change, access to extension and age of the household head. One variable (position of authority) had a negative relationship. For the Seke model, five independent variables were found to have a significant positive relationship with the level of climate change awareness namely participation in developmental organisations, participation in farmer organisations, ever talked about climate change, education level, and access to newspapers. Overall, when two the districts are combined five factors were found to have a significant positive relationship on the level of climate change awareness namely access to newspapers, ever talked about climate change, participation in developmental organisations, access to a mobile phone, and access to radio.

7.3.3 Contribution of ICTs in climate change adaptation

The third objective was fulfilled by exploring how communal farmers in the two districts accessed early warning and weather forecasting information and how such information helped them in their decision-making. Over half of the respondents in Murewa and just less than one fifth of respondents in Seke indicated that they received adequate rainfall. In general, they perceived that they were receiving early rains that lasted for a shorter period. In terms of temperatures, the majority perceived that winter temperatures were getting colder while summer temperatures were getting warmer. Almost all respondents in both districts indicated that they had experienced a drought. By and large, they perceived that the frequency of droughts was increasing. In addition, they also experienced dry spells, which negatively impacted on crop yields, and had effects on both pastures and water availability for livestock. Just over half of the respondents in both districts indicated that they had experienced a violent storm. A greater proportion of respondents in both districts perceived

that the frequency of violent storms was decreasing. Almost all respondents in both districts indicated that it was important to have access to forecasting information. The information is very important in influencing farming decisions particularly in deciding the planting dates and the choosing crop varieties. Around half of the respondents in the two districts indicated that they accessed weather forecasting information from weather stations. The radio was ranked as the most important channel through which they accessed the forecasting information.

7.4 Conclusion

The findings show that the two districts are and will likely be more vulnerable to dry spells, droughts and to some extent violent storms. This necessitates the need for individuals and the community at large to be better prepared for such events. Unfortunately, up to two-thirds of the respondents did not access timely early warning information on violent storms and droughts. In addition, around half of the respondents indicated that they did not get information on the likely rainfall amount and distribution in the coming season. This shows that there is a huge information deficit amongst these communal farmers, which in turn limits their adaptive capacity to respond to weather and climate extremes.

It is concluded that all information and communication channels are important - that is both old and new, personal and non-personal, ICT and non-ICT. In addition, it was observed that the various channels can have different impacts or influence in different settings. Hence, in order to realise their great potential, it is not about promoting one channel or ICT at the expense of the other, but about using a combination of the most appropriate and complementary channels suitable in those particular settings.

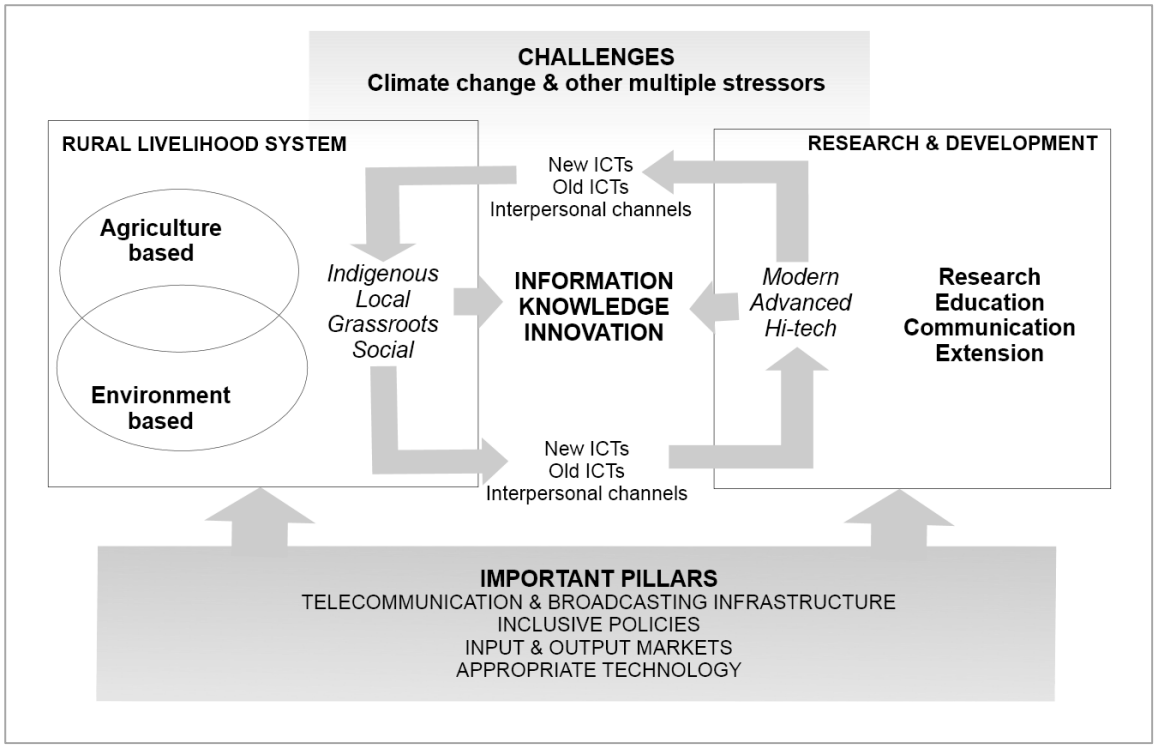
7.5 Contributions of this study

7.5.1 Contribution to paradigmatic and theoretical framework

In terms of theory, an Agricultural and Environmental Knowledge, Information, and Innovation System (AEKIIS) framework is proposed. This framework builds on two important frameworks namely Agricultural Knowledge Information System (AKIS) and Agricultural Innovation System (AIS) frameworks that were discussed in section 2.3. Based

on the findings the proposed AEKIIS framework does not seek to discredit the AKIS and the AIS. Rather, the aim is to have a broad framework, which can integrate crosscutting challenges such as climate change in rural agricultural settings such as Seke and Murewa districts. Climate change has diverse impacts on various aspects of rural people's livelihoods, with notable impacts on their agriculture and the environment. In this context, the AEKIIS framework is useful as it combines both agricultural and environmental knowledge and information to cater for the needs of rural people. The proposed AEKIIS framework is presented diagrammatically in Figure 7-1.

Figure 7-1: Agricultural and Environmental Knowledge, Information, and Innovation System framework



Source: Researcher's own illustration

Rural livelihoods are usually dependent on both agriculture and the environment. Hence, the terms 'agricultural' and 'environmental' are explicitly stated. These livelihood sources are highly sensitive to climate change, which has distinct and converging effects on both of them. The key challenge that emerges in adapting to climate change in rural areas in particular, has been the fact that adaptation efforts have tended to be either agricultural or environmental focused. In other words, responses have tended to observe the separation between agriculture and the environment when in fact there is more convergence between the agricultural-based

and environmental-based livelihoods. The argument here is that, what happens in the agricultural sector can have both positive and negative feedback on the environment and vice versa. For example, if there are poor agricultural yields because of droughts, there is likely to be increased pressure on the environment. Similarly, if environmental services diminish because of climate change, the pressure is also likely to increase on the agricultural land. Thus, the need to have a unifying framework.

As shown in Figure 7-1, the proposed framework has two important components namely the rural livelihood system, and the research and development component/system. The rural livelihood system is dependent on agriculture and the environment. However, it faces a number of challenges such as climate change, and other multiple stressors such as poverty, diseases (HIV/ AIDS) and environmental degradation, amongst others. The research and development component is involved in helping to find solutions to the challenges that rural people face such as climate change. Important flows within the AEKIIS framework are three key aspects namely 'knowledge', 'information' and 'innovation'. In terms of responses to challenges such as climate change, all these aspects are important for successful adaptation.

Innovation is an important enabler in climate change adaptation, as there is need to formulate and adopt new ways, new techniques, new technologies, and new strategies in response to climate change. In that regard, innovation relates to the availability and use of appropriate technologies and inputs such as drought tolerant and short maturing seed varieties, irrigation, access to weather and climate information, amongst others. The rural livelihood system and the formal research and development system have two types of 'knowledge, information, and innovation'. The information and knowledge generated and available in the rural livelihood system is mainly indigenous or traditional, and is local specific; and the innovation thereof tends to be grassroots, social, and bottom-up. On the other hand, the formal research and development system tends to generate 'knowledge, information, and innovation', which is modern, scientific, advanced, or hi-tech based. Both types are important and complementary in terms of responding to climate change.

The modern, advanced, hi-tech based innovations might be more important in terms of generating appropriate seeds, early warning and forecasting information, and other complimentary inputs and technologies. On the other hand, social innovation is required in

rural areas particularly in terms of having social safety nets and response strategies that can cushion individuals, households and communities from the negative effects of climate change. At the same time, social innovation can enhance their capacity to take advantage of positive effects that might occur as a result. Additionally, grassroots innovation plays an important role, as it is likely to provide locally relevant and tailor-made solutions to multiple challenges that these rural communities face.

The findings in this study actually showed that various types of information and communication channels are important, that is both old and new ICTs, and interpersonal channels (such as agricultural extension, and farmer-to-farmer exchanges). In the AEKIIS framework, both old and new ICTs and interpersonal channels play an important role in transmitting information and knowledge within the system and between sub-systems. That is within and between the rural livelihood system and the research and development component/system.

Important supporting pillars in the framework are telecommunication and broadcasting infrastructure; inclusive agricultural, environmental, ICT policies; input and output markets; and appropriate technology. It is important to note that in Seke and Murewa, these important supporting pillars were inadequate and in some cases, they were absent. One notably case is that unavailability of internet due to the absence of the necessary internet infrastructure. In addition, agricultural input and output markets were weak and in some cases absent. For instance, it was highlighted that at times the appropriate drought resistant and short maturing seed varieties and other complimentary inputs were not available on the market or were available at exorbitant prices. Overall, the proposed AEKIIS framework can help in understanding and formulating appropriate response strategies to crosscutting challenges such as climate change in rural agricultural settings such as Seke and Murewa districts.

7.5.2 Contribution to the existing body of knowledge

Predominantly, the role of ICTs in climate change adaptation has been highlighted in the literature. Be that as it may, this has been theoretical in most cases. The important contribution is that, this study is one of the few studies that are actually based on empirical data. In addition, this study formulated a climate change awareness index (CCAI) which was outlined in section 3.6.2 and section 5.3. The index was used to classify respondents into

three categories namely not aware; low awareness; and high awareness. Furthermore, an ordered multinomial regression model used, took cognisance of the fact that there was need to use a regression model that takes into account the different levels of climate change awareness rather than a model that just assumes a binary (yes/ no) dependant variable.

The regression analysis that was conducted highlighted an important aspect that needs attention. The two regression models (one for Seke and another one for Murewa) revealed that different independent variables had varied relationships with the level of climate change awareness. In other words, factors that were found to significantly influence the level of climate change awareness were different for the two districts. Whereas the general norm is to generalise findings, these results actually suggest that generalisations might not be appropriate in some cases. There can be loss of important information, due to the fact that issues such as climate change tend to have area-specific impacts and interactions, which in turn affects how it's perceived and understood. This implies that in the context of climate change, there is no need to always generalise findings, what might be more important is to just draw lessons from such findings.

7.5.3 Contribution to policy

This study showed that both old and new ICTs are important in information dissemination and capacity building. Some of the recent efforts have tended to focus only on new and emergent ICTs, however, the findings in this study confirms that even those ICTs and channels that are generally considered 'old' are still relevant and play an important role in rural settings. As a deduction, efforts (e.g. through the ICT policy) should not promote one channel at the expense of the other but rather to ensure that these technologies are embraced as complimentary. In fact, their promotion and usage should be based on their appropriateness to the socio-economic settings and the preferences of the users.

7.5.4 Contribution to practice

While this study focused on climate change adaptation in general, it also took a particular focus on climate change awareness. Very few studies have taken such a focus, particularly in the African context. The important contribution of this study is highlighting that information and knowledge are prerequisites in the adaptation process. One important aspect was to bring

out key issues that need attention when promoting climate change awareness and adaptation in rural settings. An important contribution to practice is that there is need to embrace all the communication channels, and depending on the socio-economic settings, use and promote the most appropriate channel.

7.6 Suggestions

7.6.1 Suggestions to farmers and extension

There is need to promote farmer-to-farmer interaction and learning processes as this has great impacts on the transfer of tacit knowledge and skills which general require the 'show how'. In addition, participation in various farmer and developmental organisations is important as this enables exchange of information and knowledge. At the same time, they strengthen the bonding and bridging social ties, which are essential in the climate change adaptation process. Farmers should be encouraged to take a proactive approach in climate change adaptation rather than being reactive. In addition to seeking information on climate change issues in general, farmers should also seek and acquire the necessary skills on various adaptation strategies.

7.6.2 Suggestions to research and development

Climate change is relatively a new issue and currently locally relevant climate change adaptation information is lacking. Hence, the need to promote the production of such information by strengthening linkages and exchanges between researchers, extension, farmers and practitioners. There is need to provide stakeholders with all information that is essential in the adaptation process. In addition, agricultural extension workers who are the trusted sources of information in rural areas, currently have less knowledge on climate change issues hence the need to incorporate climate change issues into their training. Moreover, there is need to improve the reliability of weather forecasting information. Most importantly, farmers need training in particular on how to interpret the information. Those involved in the development of ICTs and their applications should ensure that they are appropriate and user-friendly for rural dwellers.

7.6.3 Suggestions to communicators and educators

Initiatives to promote climate change awareness and adaptation should provide various platforms for the stakeholders to share and exchange information and knowledge on climate change. Agricultural and climate change information should be transmitted in local languages to ensure that even the illiterate individuals can understand the message. Marginal groups should also have access to such information. Furthermore, there is need to mainstream climate change issues into the school curricula so that young people can embrace such issues from an early age.

7.6.4 Suggestions to government

There is need to ensure that policies in various sectors (such as ICT, agriculture, environment) are integrated. There is need to promote all information and communication channels as these channels are complimentary. Furthermore, there is need to ensure that policies and measures are put in place to promote universal access to ICTs in order to bridge the information deficiencies currently prevalent in most parts of the country. In addition, a serious challenge for farmers was limited access to appropriate farming inputs necessary to adjust their farming systems to suit a changing climate. In this regard, the government and other developmental agencies should intervene (e.g. through provision of subsidies) to ensure that farmers have access to such inputs.

7.7 Areas of further research

This study focused on the contribution of ICTs in addressing climate change amongst communal farmers in Seke and Murewa districts of Zimbabwe. It looked at access to the various ICTs, perception on climate variables, climate change awareness, and access to early warning and forecasting information. However, there are other important areas that need further research, these include:

- While many factors were found to have a significant or a non-significant relationship with climate change awareness, further in-depth analysis is required to explore and understand these relationships.

- The mobile phone was found to play an important role in climate change awareness and agricultural information dissemination in general. There is need to further

investigate in what ways the mobile phone actually contribute to this, especially in the context of the rapid technological development being witnessed in this sector.

- This study mainly focused on climate change awareness and access to early warning and weather forecasting information, thus it is important to assess how ICTs contribute to other aspects of climate change adaptation.

- This study assessed how ICTs contribute to climate change awareness in general, however it did not assess the actually content that is transmitted via these ICTs. In other words this study only assessed this aspect from the receiver's perspective i.e. farmers. On that account, it is important to assess the type of information and the messages being conveyed.

- One important issue that came up is the importance of how traditional and religious beliefs influenced people's perception on climate change. This issue requires further investigation as this seems to have a strong bearing on how people adapt to climate change.

- This study did not look at how access to climate change information actually translates into adaptation; hence, further research is required to clearly establish the relationship between these issues.

- This study was conducted in rural areas; further research might be required in assessing how ICTs contribute to climate change awareness and adaptation amongst urban dwellers.

- This study focused on climate change awareness amongst household heads only; however, future research should focus on inclusion of other population groups, for example, youth.

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APPENDICES

APPENDIX 1: GENERAL HOUSEHOLD SURVEY QUESTIONNAIRE

This is a questionnaire for a research project titled "Analysing the contribution of ICTs in addressing climate change amongst communal farmers from two districts of Zimbabwe". The research data will be used solely for academic purposes. The questionnaire should be administered by a trained enumerator.

HOUSEHOLD ID ☐

A. IDENTIFYING INFORMATION

1. Date of Interview	
2. Country	
3. Province	
4. District	
5. Ward	
6. Village	
7. Is respondent HH? *1=Yes 0=No*	
8. If not, relationship to Household Head *1=Wife 2=Husband 3=Adult son 4=Adult daughter 5=Other (please specify)* **NB:** Interview should be carried out with adult member of household	

B. GENERAL HOUSEHOLD INFORMATION

Variable	Response	Code
Demographic Data		
1. Gender of Household head		*1=Male 0=female*
2. Age of Household head		*Years*
3. Marriage status		*1=Single 2=Monogamously married 3=Polygamously married 4=Widowed 5=Divorced/ Separated 6=Other (Specify)_____*
4. If married, Age of spouse		*Years*
5. If married to more than one spouse, Age of spouse 2		*Years*
6. Household size		
	Males	*Females*
a. Number of Household members aged below 16 years(<16)		
b. Number of members 16 to 30 years		
c. Number of members 31 to 45 years		
d. Number of members 46 to 60 years		
e. Numbers of members above 60 years		
Education		
7. Education level of Household head		*1=No formal education 2=Adult education 3=Some primary education 4=Completed primary education 5=Some vocational training 6=Completed vocational training 7=Some secondary education 8=Completed secondary education 9=Advanced level 10=College education 11=University education*
8. Education level of Spouse		
9. If married to more than one spouse, Education level of Spouse 2		
10. Highest level attained by any family member		

Housing Characteristics			
	Number	*Rooms*	*Description of walls (1=wood 2=mud 3=brick and mud 4=brick and cement 5=Other _____*
11. Number of Houses (Thatched roof)			
12. Number of Houses (Modern roofing e.g. Iron; zinc; asbestos sheets)			
13. Other (Specify)_____			

C. LAND OWNERSHIP

Holdings *(Please specify in Acres)*	**Homeland**	**Mainland**	**Other _____**
1. Owned			
2. Rented			
3. Borrowed			
4. Lent out			
5. Other (Specify)_____			
Cropped Area			
6. Area under/was under cultivation 2010-2011 season			
7. Area under cultivation previous season			
8. Number of years household has been farming			
9. Type of farming?			*1=communal subsistence 2=commercial 3=other (specify)_____*

D. ASSETS: LIVESTOCK

Does the household own the following **livestock?**	a. Indicate **number**	b. Type of **Breeds** *1=local 2=mixed 3=exotic*	c. Main **source** *1=bought 2=exchanged (barter) 3=given by relative 4=Other (specify)*
1. Chicken			
2. Goats			
3. Sheep			
4. Cattle			
5. Donkey			
6. Other (specify)…….....			

E. ASSETS: GENERAL

Do you own the following **assets?**	a. Indicate **number**	b. **Source**	*1=bought 2=government support 3=NGO support 4=Given by friend or relative 5=other _____*
1. Cart			
2. Wheelbarrow			
3. Plough			
4. Planter			
5. Cultivator			
6. Harrow			
7. Water pump			
8. Bicycle			
9. Tractor			
10.Car			

F. LIVELIHOOD ACTIVITIES

1. Do you get income from agricultural activities? *if no go to 4*		*1=Yes 0=No*	
2. If yes in (1), do you do the following?	a. *1=Yes 0=No*	b. If yes please indicate level of market participation *1=Partial market participation (Sell small excess produce)* *2=Strong market participation (sell a large amount)* *3=Other_____*	c. Annual Income (US$) *(Approximate)*
i. Sale of crops			
1. Horticultural crops e.g. vegetables			
2. Field crops e.g. maize, cotton, etc			
ii. Sale of livestock			
iii. Hiring out agricultural labour			
iv. Other……			
3. If yes in 2(i) and 2(ii) How do you access market information e.g. prices on? (*can indicate more than one)*			
i. Sale of crops		*1= print media (newspapers, magazines, newsletters),* *2= electronic media (radio, TV),* *3= electronic media (mobile telephone),* *4= extension system,* *5= other farmers* *6= own decisions,* *7= Other _____*	
1. Horticultural crops e.g. vegetables			
2. Field crops e.g. maize, cotton, etc			
ii. Sale of livestock			
4. Do you get income from the following non-agricultural activities	d. *1=Yes 0=No*	e. Please rank *(1=most important)*	f. Annual Income (US$) *(Approximate)*
i. Business			
ii. Technical activities e.g. brick moulding; building; carpentry			
iii. Hiring out non-agricultural labour within the community			
iv. Hiring out non-agricultural labour outside the community e.g. nearest business centre/ town			
v. Other (Specify)_____			

G. SOCIAL PARTICIPATION AND NETWORKS

1. Do you hold any position of authority in your area?		*1=Yes 0=No*
2. If yes in 1, state your position		
3. State your level of participation in the following organisations?		Level of participation *0=Non member* *1=Inactive* *2= Active* *3=Very active*
a. Farmer		
b. Developmental		
c. Professional		
d. Religious		
e. Other _____		
4. How do you relate with other farmers in terms of the following?		Strength of the relationship *1= Weak.* *2= Average* *3= Strong*
a. Input exchange		
b. Labour exchange		
c. Information exchange		

d. Technical exchange e.g. farm equipment		
5. How many times do you visit the nearest	**Frequency** *0=Never 1=Once a year, 2=once in six months, 3=once in three months, 4=Once a months, 5= Once a fortnight*	**Main Purpose** *1= to buy groceries,* *2= other developmental affairs,* *3= agricultural matters.* *4=Other* _____
a. Business centre?		
b. Nearest town?		

H. EXTENSION AND TRAINING

	Response	**Code**
1. Do you have access to extension?		*1=Yes 0=No*
2. What type of extension?		*1=Agricultural* *2=Non-agricultural (e.g. health, business etc)* *3=Both agricultural and non-agricultural*
3. If the answer in (1) is Yes, How frequently do you access extension services within a year?		*1=5 times and below* *2=6 to 10 times* *3=11 times and above*
4. If the answer in (1) is Yes, How do you access the extension services?		*1= only the extension agents visit us* *2= only us visit the extension agents* *3= both us and the extension agents visit us each other*
5. If the answer in (1) is Yes, do you get information on the following?		
a. Fertilizer use		*1=Yes 0=No*
b. Use of improved crop varieties		*1=Yes 0=No*
c. Pest and disease management		*1=Yes 0=No*
d. Soil management		*1=Yes 0=No*
e. Marketing advice		*1=Yes 0=No*
f. Credit		*1=Yes 0=No*
g. Livestock management		*1=Yes 0=No*
h. Natural resources management		*1=Yes 0=No*
i. Weather information		*1=Yes 0=No*
6. Are the extension services adequate		*1=Yes 0=No*
7. Do you get information relating to climate change from extension services?		*1=Yes 0=No*
8. Have you or any member of the household attended/have some agricultural training		*1=Yes 0=No*
9. If yes in 8, indicate the level of training?		*1=ordinary farmer training (e.g. master farmer) 2=Advanced training (certificate level) 3=Advanced training (diploma level) 4=Advanced training (degree level) 5=Other (specify)*_____

I. OWNERSHIP OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS)

Information and Communication Technologies	a. Do you **know** the following or have heard about it? *1=Yes 0=No*	b. If yes in (a) Does anyone who stays at this household **own** the following? *1=Yes 0=No*	c. If yes, **how many**?	d. **Indicate who** own these? *1=Household head 2=Spouse 3=Son 4=Daughter 5=Joint 6=Other_____*	e. Source of **Power** *1=Electricity 2=Generator (Petrol/Diesel) 3=Solar power 4=Non-rechargeable battery 5=Rechargeable battery 6=Generator (Wind) 7=Other _____*
1. Radio					
2. Television					
3. Satellite Decoder					
4. Video Cassette Recorder					
5. Digital Video Player					
6. _____					
7. Telephone (landline)					
8. Mobile phone					
9. _____					
10. Computer					
11. Internet					
12. _____					

f. Are you able to **write**?		*1=Yes 0=No*
g. Are you able to **read**?		

	h. Do you read the following? *1=Yes 0=No*	h. Does any member of the household read the following? *1=Yes 0=No*	i. If yes in (g and h), how frequently? *1=(>= once a wk) 2=(>= once a month) 3=(>= once in 6 months) 4=(>=once a year) 5=Other_____*	j. If yes in (g and h), where/how do you get/access it? *1=buy 2=get from friends/relatives 3=school library 4=public/community library 4=Other_____*
13. Newspapers				
14. Farming/Environmental Magazines				
15. Business Magazines				
16. Entertainment Magazines				
17. Church Magazines				
18. Posters				
19. _____				
20. _____				

J. COMMUNITY TELECENTRES

1.	Do you have any telecentres/information centers		
	a. Within the community?		*1=Yes 0=No*
	b. At the nearest businesses centre?		
2.	If yes in 1, have you ever been in these centers?		*1=Yes 0=No*
3.	If yes in 1, How far is it from homestead?		*Km*
4.	If yes in 1, What was your purpose of visiting the telecentre/ information centre? *(can write more than one response)*		*1=Just to know what is it all about* *2=to search for information* *3=for communication* *4=Other _____*
5.	If answered in 3, did you manage to get or was your intended purpose fulfilled?		*1=Yes 0=No*
6.	Are there **individuals/households** in the community where you go and access services such as	*1=Yes 0=No*	7. If yes in 6, do you access the **service/s** for free? *1=Yes 0=No*
	1=telephone services		
	2=internet services		
	3=typing and faxing		
	4=audio and video services		
	5_____		

K. ACCESS TO AND USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

1. Information and Communication Technologies	a. Have you ever **used** any of the following? *1=Yes 0=No* ***(If No, go to (d))***	b. If yes in (a), do you use it daily? *1=Yes 0=No*	c. If No in (b), how many **days/weeks/months/years** since you last used it? *(Please indicate the unit)*	d. Even if you do not own it, can you **operate** it (gadgets) *1=Yes 0=No*	e. What **language** is mostly used through this media? *1=Local 2=Other local 3=English*	f. Do you **understand** the language? *1=very well 2=with difficulty 3=no*
Radio						
Television						
Satellite Decoder						
Video Cassette Recorder						
Digital Video Player						
_____						
Telephone (landline)						
Mobile phone						
_____						
Computer						
Internet						
_____						

PRINT MEDIA	g. What **language** is mostly used through this media? *1=Local 2=Other local 3=English*	h. Do you **understand** the language? *1=very well 2=with difficulty 3=no*	i. Are there any other **challenges** that you face in understanding the message?
Newspapers			
Magazines			
Posters			
_____			
_____			

L. ICTS AND CLIMATE AND CLIMATE CHANGE INFORMATION

Information and Communication Technologies	a. Do you get any information from the following on? *1=Yes 0=No*			b. If you get the information, is the information relevant to you? *1=Yes 0=No*	c. And Why? (comments)
	i. Agricultural production in general?	ii. Weather Information?	iii. Climate change information?		
Radio					
Television					
Satellite Decoder					
Video Cassette Recorder					
Digital Video Player					
_____					
Telephone (landline)					
Mobile phone					
_____					
Computer					
Internet					
_____					
Newspapers					
Farming/Environmental Magazines					
Business Magazines					
Entertainment Magazines					
Church Magazines					
Posters					

M. PERCEPTION OF IMPORTANCE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) TO DEVELOPMENT

What are your **perceptions** of the following	a. Is it important in relation to your livelihoods in general?	b. Is it important in relation to climate information and climate change awareness?	c. What is your perception of the ICT in terms of easy to use?	d. What is your perception of these devices in terms of maintenance and accessibility costs?
	1= Not important 2=Important 3=Very important		*1= Not easy; 2= Easy; 3= Very easy; 4=Do not know*	*1=Cheap 2=Average 3=Expensive 4=Do not know*
Radio				
Television				
Satellite Decoder				
Video Cassette Recorder				
Digital Video Player				
_____				
Telephone (landline)				
Mobile phone				
_____				
Computer				

Internet				
_____				
_____				
Newspapers				
Farming/Environmental Magazines				
Business Magazines				
Entertainment Magazines				
Church Magazines				
Posters				
_____				
_____				

e. If you get any information (agricultural and climate related), **what do you use it for?**	*Please **Tick** (and can also add other factors)*	*Please **rank** (1=the most important)*
1. Choices of planting dates		
2. Choice of crop varieties		
3. Choice of land preparation methods		
4. How much fertilizer and other inputs to add		
5. Choices of harvesting dates		
6. More knowledge		
7. Marketing decisions e.g. when to sell		
8.		
9.		
10.		
f. What mostly influence your farming decisions?		*1= output price expectations 2= crop rotations 3= climate information 4= input costs 5= soil tests 6= other*

N. CLIMATE CHANGE INFORMATION AND AWARENESS

	Response	**Code**
1. Are you aware of climate change? *NB: If No, Please go to next section on PERCEPTIONS OF CLIMATE CHANGE.*		*1=Yes 0=No*
2. *If Yes in* 1, do you agree with the following statements		
a. Climate change results in increased frequency of droughts in some areas?		*1= Strongly agree 2= Agree 3= Undecided 4= Disagree 5= Strongly disagree*
b. Climate change results in increased frequency of floods in some areas?		
c. Some of the activities being done by human beings contribute to climate change		
d. Uncontrolled burning of forests contribute to climate change		
e. Exhaust fumes (carbon dioxide) from vehicles contribute to climate change		
f. Emission (carbon dioxide) from industries contribute to climate change		
g. Uncontrolled cutting down of trees contribute to climate change		
h. There are (many) ways the humans can implement to mitigate climate change		
i. Zimbabwe is the only country likely to experience climate change		
j. Planting of trees will help to mitigate climate change		
k. Some areas will receive more rainfall while others will receive less rainfall than they used to receive		

3. If yes in (1)	a. Did you get to know about climate change from the	b. If responded Yes in (a), Please rank the responses starting with the most important in contributing to your knowledge about climate change *1=Most important; 2=Second most important;*

	following? *1=Yes 0=No*	*3=Third most; 4=Fourth most important*
i. Learnt from formal schooling		
ii. Learnt from non-formal schooling (adult education)		
iii. Read about it in print media (newspapers, magazines, newsletters)		
iv. Heard it from electronic media (radio and television)		
v. Extension system		
vi. From other people		
vii. Own observation		
viii. Other _____		

O. PERCEPTIONS OF CLIMATE CHANGE

1. Is your area experiencing climate change?		*1=Yes 0=No*
2. Are there any other areas in the country that are experiencing climate change?		*1=Yes 0=No*
3. Are other countries in Africa experiencing climate change?		*1=Yes 0=No*
4. Are other countries outside Africa experiencing climate change?		*1=Yes 0=No*
5. If the answer in 2 or 3 or 4 is Yes, how did you get know about it? *(Please start with the most important)*		*1= Learnt from formal schooling* *2= Learnt from non-formal schooling (adult education)* *3= Read about it in print media (newspapers, magazines, newsletters)* *4= Heard it from electronic media (radio and television)* *5= Extension system* *6= From other people* *7= Own observation* *8= Other (Specify)_____*
6. If the answers in 1 and 2 are Yes, where do you think the effects of climate change are worse, your area compared to other parts of the country?		*1=my area 2=just the same 3=other areas*
7. If the answers in 1 or 2 and 3 are Yes, where do you think the effects of climate change are worse, your country compared to other African countries?		*1=my country 2=just the same 3=other countries*
8. If the answers in 1 or 2 or 3 and 4 are Yes, where do you think the effects of climate change are worse, African continent compared to other continents?		*1=Africa 2=just the same 3=other continents*
9. Is it important to inform/educate people about Climate change?		*1=Yes 0=No*
10. Have you ever talked about climate change?		*1=Yes 0=No*
11. If yes in (10)	a. Have you ever talked to the following about climate change? *1=Yes 0=No*	b. Purpose of the climate talk *1= I was seeking information from them* *2= They wanted to know from me* *3= both 1 and 2* *4= Was just a general comment* *5=Other (Specify)_____*

i. Family members		
ii. Friends		
iii. Non-family and not friends		
12. Which channel/means would you consider most important in disseminating the following information		*1=formal schooling,* *2= non-formal schooling (adult education),* *3= print media (newspapers, magazines, newsletters),* *4= electronic media (radio, TV, etc),* *5= Extension system,* *6= Own observation,* *7=Other farmers* *8=Other _____*
a. Agricultural information in general		
b. Climate and climate change information		
c. Other developmental information		

P. DROUGHTS AND FLOODING INFORMATION

	Response	Code
1. Does your area receive adequate rainfall?		*1=Yes 0=No*
2. From your own experience, is the amount and patterns of rainfall changing? (If No go to 6)		*1=Yes 0=No*
3. If yes in 2, how is the rainfall changing?		
a. The amount of rainfall		*1=decreasing 2=increasing*
b. The distribution of rainfall within seasons		*1=Early rains for a longer period* *2=Early rains for a shorter period* *3=Late rains ending same period* *3=Late rains for a slightly longer period* *4=late rains for a shorter period* *5=Other_____*
4. From your own experience, are the temperatures changing? (Are the winters as cold or summers as hot as they used to be) (If No go to 6)		*1=Yes 0=No*
5. If yes in 4, how are temperatures changing?		
a. Winter temperatures		*1=colder 2=warmer*
b. Summer temperatures		*1=colder 2=warmer*
6. Have you ever experienced a drought?		*1=Yes 0=No*
7. If yes in 6, when did you first experience a drought?		*1=1 to10 years ago* *2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
8. If yes in 6, how many times in the last ten years have you experienced a drought?		
9. If yes in 6, Is the frequency of droughts increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
10. Have you ever experienced any flooding?		*1=Yes 0=No*
11. If yes in 10, when did you first experience flooding?		*1=1 to10 years ago* *2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
12. If yes in 10, how many times in the last ten years have you experienced some flooding?		
13. If yes in 10, Is the frequency of flooding increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
14. Have you experienced any violent storms?		*1=Yes 0=No*
15. If Yes in 14, when did you first experience		*1=1 to10 years ago*

violent storms?		*2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
16. If yes in14, how many times in the last ten years have you experienced some violent storms?		
17. If yes in14, is the frequency of violent storms increasing or decreasing?		*1=increasing 2=not changing 3=decreasing*

Q. ACCESS TO RAINFALL FORECASTING INFROMATION

	a. The rainfall amount and distribution in the coming season?	b. Rainfall patterns and variability in the coming year?	
1. Do you get to know about			*1=Yes 0=No*
2. If the answer in (1) is yes, Do you get know these on time?			
3. Is it important to know about the rainfall amount, patterns and distribution?			*1=Yes 0=No*
4. If the answer in (1) is Yes, Do you get know about these through the following?	***a.** Please **tick***	***b.** Please **rank,** (1=most important)*	
i. Own assessment/ knowledge			
ii. Through electronic media (radio, TV, internet)			
iii. Through print media (newspapers, magazines)			
iv. Extension services			
v. Other farmers			
vi. Local traditional experts			
vii. _____			
5. Do these methods/ channels provide accurate/ reliable information?		*1=not reliable* *2=reliable at times* *3=reliable* *4=very reliable*	
6. If you get to know about the rainfall amount and distribution in the coming season, do you have the knowledge/get other information on how to adjust your farming in line with the forecasting?		*1=Yes 0=No*	
7. If the answer in 6 is Yes, Are the seed varieties and technologies suitable with the forecasts (e.g. drought resistant seeds if a drought is predicted) available in the market or community?		*1=Yes 0=No*	
8. If the answer in 7 is Yes, Can you access/afford these seed varieties and technologies?		*1=Yes 0=No*	
9. How important is information about weather forecasts in your farm planning?		*1= important 2=undecided 3=not important*	
10. How much does climate information influence your decisions?		*0= not at all 1= somewhat 2=moderately 3=strongly*	
11. Does access to weather forecasting information influence your decisions with regards to the following?	*1=Yes 0=No*	*Please rank starting with the most important*	
i. Choice of crops and varieties			
ii. Area to plant			
iii. Type of land preparation			
iv. Time of planting			
v. Amount of inputs/effort to allocate to different crops			

vi. Harvesting time		
vii. What portion of output to sell and what to store (food crops)		
viii. _____		
ix. _____		

R. MODERN RAINFALL FORECASTING

1. Do you get rainfall forecasting information from weather stations (i.e. weather reports from the meteorological department)?		*1=Yes 0=No*
2. If you		
a. Experience violent storms; do you get warning about these violent storms on time?		*1=Yes 0=No*
b. Experience flooding, do you get the warning about these impending floods on time?		*1=Yes 0=No*
c. Experience droughts, do you get the warning about these impending droughts on time?		*1=Yes 0=No*
3. If Yes in 1 and2, What channels do you get this information from? *Please list starting with the most important*		*1=direct enquiry* *2=radio* *3=TV* *3=Newspapers* *4=Magazines (farmer)* *5=mobile phone* *6=extension* *7=other farmers* *8=_____* *9=_____*
4. What are your perceptions about reliability of this weather forecasting from meteorological department?		*1=not reliable* *2=reliable at times* *2=reliable* *3=very reliable*
5. Which forecasting method do you trust more (traditional or modern)		*1=traditional* *2=trust them the same* *3=modern* *4=do not trust any of them*

S. PERCEPTION OF IMPORTANCE OF CLIMATE CHANGE AWARENESS

1. Is it important for people to know about climate change?		*1=Yes 0=No*
2. If your answer in 1 is Yes, What can be done to increase people's awareness of climate change?	_____ _____ _____	

T. ANY FURTHER COMMENTS

_____

_____

_____

_____

THANK YOU FOR YOUR TIME

APPENDIX 2: KEY INFORMANT INTERVIEW QUESTIONNAIRE

This is a questionnaire for a research project titled "Analysing the contribution of ICTs in addressing climate change amongst communal farmers from two districts of Zimbabwe". The research data will be used solely for academic purposes. The questionnaire should be administered by a trained enumerator.

SECTION A: GENERAL INFORMATION

Name of District	
Name of Ward	
Name of Province	

SECTION B: FARMING SYSTEM INFORMATION (AGRICULTURAL ACTIVITIES)

1. What is the main agricultural activity in this community?	a. crop production only b. livestock production only c. both crop and livestock production d. Other (*Please specify)*_____	
2. Main Crops *(Please list in order of importance, starting with the most important)*	**a. Food Crops**	**b. Cash Crops**
	1.	1.
	2.	2.
	3.	3.
	4.	4.
	5.	5.
3. What is the tenure system in the area	1. state 2. communal 3. private/ freehold 4. leasehold 5. other *(Specify)*_____	
4. Is the tenure system secure for different groups of people?		*1. Yes 2. No*
	a. men	
	b. women	
	c. widows	
	d. orphans	
	e. Other *(Specify)* _____	

SECTION C: FARMING SYSTEM INFORMATION (RAINFALL, TEMPERATURE, CLIMATE CHANGE PERCEPTIONS)

1. Does this area receive adequate rainfall?		*1=Yes 0=No*
2. From your own experience, is the amount and patterns of rainfall changing? (If No go to 4)		*1=Yes 0=No*
3. If yes in 2, how is the rainfall changing?		
c. The amount of rainfall		*1=decreasing 2=increasing*
d. The distribution of rainfall within seasons		*1=Early rains for a longer period* *2=Early rains for a shorter period* *3=Late rains for a slightly longer period* *4=late rains for a shorter period* *5=Other*
4. Do you experience any dry spells during the rain season?		*1=Yes 0=No*
5. If yes in 4, state the		
a. frequency of these dry spells within a rain season		
b. average length of the dry spells		*1= < 1 week, 2= 1 to 2 weeks, 3= 2 to 3 weeks, 4= 3 to*

		4 weeks, 5= > 4 weeks
6. If yes in 4, How has these dry spells been changing in the last 10 years, in terms of		
a. frequency?		*1=increasing, 2=no change, 3=decreasing*
b. duration?		
7. If yes in 4, how severe are these dry spells		
a. on crops?		*1= no significant effect on crops, 2= leads to wilting of some crops but little effect on crop yields, 3= leads to wilting of crops with significant effect on crop yields, 4= leads to complete failure of some crops*
b. on livestock?		*1= no significant effect on pastures and water for livestock, 2= significant effect on pastures only, 3= significant effect on water availability (livestock) only, 4= significant effect on both pastures and water availability*
8. From your own experience, are the temperatures changing? (Are the winters as cold or summers as hot as they used to be) *(If No go to* 6*)*		*1=Yes 0=No*
9. If yes in 4, how are temperatures changing?		
c. Winter temperatures		*1=colder 2=warmer*
d. Summer temperatures		*1=colder 2=warmer*
10. Have you ever experienced a drought in this area? *(if No go to 14)*		*1=Yes 0=No*
11. If yes in 10, when did you first experience a drought in this area?		*1=1 to10 years ago* *2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
12. If yes in 10, how many times in the last ten years have you experienced a drought in this area?		
13. If yes in 10, Is the frequency of droughts increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
14. Has this area ever experienced some flooding? *If no go to 18*		*1=Yes 0=No*
15. If yes in 14, when did you first experience some flooding?		*1=1 to10 years ago* *2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
16. If yes in 14, how many times in the last ten years have the area experienced some flooding?		
17. If yes in 14, Is the frequency of flooding increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
18. Has this area experienced any violent storms? *If no go to the next section*		*1=Yes 0=No*
19. If Yes in 18, when did you first experience these violent storms?		*1=1 to10 years ago* *2=11 to 20 years ago* *3=21 to 30 years ago* *4=31 to 40 years ago* *5=> 40 years*
20. If Yes in 18, how many times in the last ten years have you experienced the violent storms?		
21. If Yes in 18, is the frequency of violent storms increasing or decreasing?		*1=increasing 2=not changing 3=decreasing*

SECTION D: CLIMATE AND ENVIRONMENTAL AWARENESS

1. Are you aware of climate change		*1. Yes 2. No*
2. If yes (1), what are the causes of climate change?	_____ _____ _____	
3. If yes (1), what are the effects of climate change?	_____ _____ _____	
4. Are the people in the community aware of climate change?		*1. Yes 2. No*
5. If yes in 4, approximately what proportion of people in the community are aware of climate change?		*1. more than half* *2. less than half*
6. Does this area experience climate change		*1. Yes 2. No*
7. If yes in 6, are the majority of households able to cope with the effects		*1. Yes 2. No*
8. If yes in 6, what has been some of the coping strategies used by households		
Climate Change Effect (Negative)	**Coping Strategy/ies**	

SECTION E: RAINFALL FORECASTING

1. Do you get to know about		
c. The rainfall amount and distribution in the coming season?		*1=Yes 2=No*
d. Rainfall patterns and variability in the coming years?		
2. If the answer in 1 is yes, Do you get know these on time?		
3. Does the majority of people in the community get this information?		
4. Is it important to know about the rainfall amount, patterns and distribution?		
5. Give the reason/s for your answer in 3? *(if any)*	_____ _____ _____ _____	
6. If the answer in 1 is Yes, Do you get know about these through the following? *(Please rank, 1 being the most important)*	*Please* ***Tick***	*Please* ***Rank***
i. Own assessment/ knowledge		
ii. Through electronic media (radio, TV, internet)		
iii. Through print media (newspapers, magazines)		
iv. Extension services		
v. Other farmers		
vi. Local traditional experts		
vii. _____		

viii. _____ ix.		
7. Do these methods/ channels provide accurate/ reliable information?		*1=Yes 2=No*
8. If you get to know about the rainfall amount and distribution in the coming season, do you have the knowledge/get other information on how to adjust your farming in line with the forecasting?		*1=Yes 2=No*
9. If the answer in (6) is Yes, Are seed varieties and technologies suitable with the forecasts (e.g. drought resistant seeds if a drought is predicted) available on the market or in the community?		*1=Yes 2=No*
10. If the answer in (7) is Yes, Can the majority of people access these seed varieties and technologies?		*1=Yes 2=No*
11. Are there any challenges in relation to rainfall forecasting and the availability of the information to the people?		*1=Yes 2=No*
12. If yes in (11), what are these challenges?	_____ _____ _____ _____ _____ _____ _____ _____	

THANK YOU FOR YOUR TIME

APPENDIX 3: ETHICAL CLEARANCE LETTER FROM THE UNIVERSITY

UNISA university of south africa

2013-09-30

Ref. Nr.: 2013/CAES/131

To:
Student: S Mudombi **Student nr: 51851369**
Supervisor: Prof G Nhamo
Department of Environmental Science
College of Agriculture and Environmental Sciences

Dear Prof Nhamo and Mr Mudombi

Request for Ethical approval for the following research project:

Analysing the contribution of ICTs in addressing climate change amongst communal farmers from two districts of Zimbabwe

The application for ethical clearance in respect of the above mentioned research has been reviewed by the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. Ethics clearance for the above mentioned project (Ref. Nr.: 2013/CAES/131) **is approved** after careful consideration of all documentation submitted to the CAES Ethics committee.

Please be advised that the committee needs to be informed should any part of the research methodology as outlined in the Ethics application (Ref. Nr.: 2013/CAES/131), change in any way. In this instance a memo should be submitted to the Ethics Committee in which the changes are identified and fully explained.

Kind regards,

Prof E Kempen,
CAES Ethics Review Committee Chair

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

APPENDIX 4: CLEARANCE LETTER TO UNDERTAKE DATA COLLECTION- GOVERNMENT

Ministry of Local Government, Rural and Urban Development

Telephone 263 4 793700

Fax 263 4 700859

The Office of The Secretary
P. Bag 7755
Causeway,
HARARE
ZIMBABWE

Ref: ADM/23/8

16 May 2011

MIN. OF LOCAL GOVT. RURAL AND URBAN DEVELOPMENT
REGISTRY 1
18 MAY 2011
P. BAG CY 7706, CAUSEWAY
ZIMBABWE

Shakespear Mudombi
3374 Unit D
Seke
Chitungwiza

AUTHORITY TO UNDERTAKE FIELDWORK (DATA COLLECTION): IN SEKE AND MUREWA DISTRICTS SHAKESPEAR MUDOMBI

Reference is made to your application dated 14 April 2011.

I am pleased to inform you that the Head of Ministry has approved your application to carry out a research on the role of Information and Communication technologies in climate change awareness in rural Zimbabwe

Please note that permission has been granted on the following conditions:

1. Information gathered will be treated as confidential and solely for academic purposes.
2. The use of material for unauthorised purposes is strictly prohibited.
3. Please note that on receipt of this letter you are advised to seek entrance from the District Administrators of the above named districts.

The Ministry wishes you the best in your endeavours.

Ikavlanga
For: Secretary for Local Government, Rural and Urban Development

Cc. Mashonaland East-DA – Murewa
Cc. Mashonaland East - DA - Seke

DISTRICT ADMINISTRAT R
(3)
6 JUN 2011
P. BAG 38, SEKE
TELEPHONE 793

APPENDIX 5: CLEARANCE LETTER TO UNDERTAKE DATA COLLECTION- MUREWA

MINISTRY OF LOCAL GOVERNMENT, RURAL AND URBAN DEVELOPMENT

Correspondence should be addressed to The District Administrator Tel. +263 78 22283-4 Facsimile +263 78 22579 Email damurewa@yahoo.com		The District Administrator Private Bag 652 Murehwa 09 June 2011
Ref ADM/23/8		

TO WHOM IT MAY CONCERN

AUTHORITY TO UNDERTAKE FEIDWORK (DATA COLLECTION):IN MUREHWA DISTRICT:MUDOMBI SHAKESPEAR

The above mentioned has been cleared and allowed to carry out a research on the role of Information Communication Technologies in climate change awareness in rural Zimbabwe

Permission has been granted on the following conditions:

1. **Information gathered will be treated as confidential and solely for academic purposes**
2. **The use of material for unauthorized purposes is strictly prohibited.**
3. **Please note that on receipt of this letter you are advised to liase with the village heads of the areas which you will be visiting.**

I wish you the best in your research

Mabhuro M
District Administrator-Murehwa.

DEPARTMENT OF AREX (MASHONALAND EAST) (D.A.E.O.) MUREWA
22 JUN 2011
P.O. BOX 66, MUREWA ZIMBABWE

APPENDIX 6: STATA DO FILE FOR THE ORDERED LOGIT MODEL

Thesis write up_ Ordered Logit model_ Final model_ Shakespear.do - Printed on 2013/12/04 06:35:56 PM

```
1   use "C:\Users\Shakespear\Desktop\THESIS WRITE UP\DATASETS _ FINAL\ICT_CLIMATE
    CHANGE_STATA dataset_SEKE_MUREWA_ATPS with additional transform_8_05_2012_old
    STATA_ thesis_ 9_ 10_ 2013.dta"
2
3   * Ordinal Regression Model* Ordered Logit Regression Model
4
5   *Models used
6   *By district
7   by district, sort : ologit aware_sum_recode gndrhhd agehhd edhhd lnd_mnld  y_agrc
    accextn vsttown potnaut partcpfr partcpdv ownrad owntv ownmobl rdnwpp rdenvr talkdcc
8
9
10  *Combined districts
11  ologit aware_sum_recode gndrhhd agehhd edhhd lnd_mnld  y_agrc accextn vsttown
    potnaut partcpfr partcpdv ownrad owntv ownmobl rdnwpp rdenvr talkdcc
12
13
14  *Hypothesis using Wald test
15  test gndrhhd agehhd edhhd lnd_mnld  y_agrc accextn vsttown potnaut partcpfr partcpdv
     ownrad owntv ownmobl rdnwpp rdenvr talkdcc
```

APPENDIX 7: ORDERED LOGIT REGRESSION MODEL STATA OUTPUT

```
  Notes:
        1.  (/v# option or -set maxvar-) 5000 maximum variables

1 . doedit "C:\Users\Shakespear\Desktop\THESIS WRITE UP\DATASETS _ FINAL\Thesis write up_ Ordered L
  >  model_ Final model_ Shakespear.do"

2 . do "C:\Users\Shakespear\Desktop\THESIS WRITE UP\DATASETS _ FINAL\Thesis write up_ Ordered Logit
  > el_ Final model_ Shakespear.do"

3 . use "C:\Users\Shakespear\Desktop\THESIS WRITE UP\DATASETS _ FINAL\ICT_CLIMATE CHANGE_STATA data
  > SEKE_MUREWA_ATPS_with additional transform_8_05_2012_old STATA_ thesis_ 9_ 10_ 2013.dta"

4 .
5 . * Ordinal Regression Model* Ordered Logit Regression Model
6 .
7 . *Models used
8 . *By district
9 . by district, sort : ologit aware_sum_recode gndrhhd agehhd edhhd lnd_mnld  y_agrc accextn vsttow
  > otnaut partcpfr partcpdv ownrad owntv ownmobl rdnwpp rdenvr talkdcc

-------------------------------------------------------------------------------
-> district = Murewa

Iteration 0:   log likelihood = -118.65902
Iteration 1:   log likelihood =  -90.66743
Iteration 2:   log likelihood = -90.562898
Iteration 3:   log likelihood = -84.263718
Iteration 4:   log likelihood = -83.888879
Iteration 5:   log likelihood = -83.887263
Iteration 6:   log likelihood = -83.887263

Ordered logistic regression                     Number of obs   =        147
                                                LR chi2(16)     =      69.54
                                                Prob > chi2     =     0.0000
Log likelihood = -83.887263                     Pseudo R2       =     0.2930

------------------------------------------------------------------------------
aware_sum_recode |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
        gndrhhd |    .3052525   .5426408     0.56   0.574    -.758304    1.368809
         agehhd |    .0341856   .0189641     1.80   0.071    -.0029834    .0713546
          edhhd |   -.1070401   .1172415    -0.91   0.361    -.3368292     .122749
        lnd_mnld |   -.0114327   .0095161    -1.20   0.230     -.030084    .0072185
          y_agrc |    .0239117   .7423426     0.03   0.974    -1.431053    1.478876
         accextn |    2.211405   1.150875     1.92   0.055    -.0442688    4.467078
         vsttown |   -.0300758   .1468209    -0.20   0.838    -.3178395     .257688
         potnaut |   -.9323686   .5250088    -1.78   0.076    -1.961367    .0966298
        partcpfr |   -.1399636   .3354055    -0.42   0.676    -.7973464    .5174192
        partcpdv |   -.3601868   .2859416    -1.26   0.208     -.920622    .2002483
          ownrad |    .5742887   .5753252     1.00   0.318    -.5533279    1.701905
           owntv |   -.0007736   .5148835    -0.00   0.999    -1.009927     1.00838
         ownmobl |    1.829485   .5168138     3.54   0.000     .8165484    2.842421
          rdnwpp |     1.81431   .6049909     3.00   0.003     .6285501    3.000071
          rdenvr |   -.2917228    .568474    -0.51   0.608    -1.405911    .8224658
         talkdcc |    4.074799   1.072542     3.80   0.000     1.972656    6.176942
-----------------+------------------------------------------------------------
           /cut1 |    4.912522   1.771706                      1.440041    8.385003
           /cut2 |    8.265923    1.90764                      4.527017    12.00483
------------------------------------------------------------------------------
```

```
-> district = Seke

Iteration 0:   log likelihood = -133.87516
Iteration 1:   log likelihood = -107.97401
Iteration 2:   log likelihood = -106.63838
Iteration 3:   log likelihood = -106.63421
Iteration 4:   log likelihood = -106.63421

Ordered logistic regression                     Number of obs   =        144
                                                LR chi2(16)     =      54.48
                                                Prob > chi2     =     0.0000
Log likelihood = -106.63421                     Pseudo R2       =     0.2035
```

aware_sum_recode	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
gndrhhd	-.6970671	.4703224	-1.48	0.138	-1.618882	.2247479
agehhd	.0235863	.0181038	1.30	0.193	-.0118965	.059069
edhhd	.2056425	.1232288	1.67	0.095	-.0358816	.4471666
lnd_mnld	-.021054	.1146564	-0.18	0.854	-.2457765	.2036685
y_agrc	.0541224	.5108855	0.11	0.916	-.9471948	1.05544
accextn	.2454584	.8587846	0.29	0.775	-1.437728	1.928645
vsttown	.1856645	.2044685	0.91	0.364	-.2150863	.5864153
potnaut	.0734873	.4491886	0.16	0.870	-.8069061	.9538807
partcpfr	.5470258	.312461	1.75	0.080	-.0653866	1.159438
partcpdv	.7170959	.2324426	3.09	0.002	.2615168	1.172675
ownrad	.5407296	.5102887	1.06	0.289	-.4594179	1.540877
owntv	-.3438209	.4862482	-0.71	0.480	-1.29685	.609208
ownmobl	-.148602	.5837431	-0.25	0.799	-1.292717	.9955135
rdnwpp	.9143257	.5421192	1.69	0.092	-.1482085	1.97686
rdenvr	.5661389	.4787472	1.18	0.237	-.3721884	1.504466
talkdcc	1.299437	.5634042	2.31	0.021	.1951848	2.403688
/cut1	5.255796	1.873593			1.583622	8.927971
/cut2	6.587012	1.913874			2.835887	10.33814

```
10 .
11 .
12 . *Combined districts
13 . ologit aware_sum_recode gndrhhd agehhd edhhd lnd_mnld  y_agrc accextn vsttown potnau
   > cpdv ownrad owntv ownmobl rdnwpp rdenvr talkdcc

Iteration 0:   log likelihood = -259.41393
Iteration 1:   log likelihood = -223.59982
Iteration 2:   log likelihood = -221.42374
Iteration 3:   log likelihood = -221.40892
Iteration 4:   log likelihood = -221.40891

Ordered logistic regression                     Number of obs   =        291
                                                LR chi2(16)     =      76.01
                                                Prob > chi2     =     0.0000
Log likelihood = -221.40891                     Pseudo R2       =     0.1465
```

aware_sum_recode	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
gndrhhd	-.3660017	.318123	-1.15	0.250	-.9895114	.257508
agehhd	.0130071	.0111176	1.17	0.242	-.008783	.0347971
edhhd	-.0128556	.0757076	-0.17	0.865	-.1612398	.1355286
lnd_mnld	-.0017118	.0077823	-0.22	0.826	-.0169647	.0135412
y_agrc	.268234	.3557074	0.75	0.451	-.4289396	.9654077
accextn	.9708443	.6030807	1.61	0.107	-.2111722	2.152861
vsttown	.018046	.0964642	0.19	0.852	-.1710203	.2071123
potnaut	-.4073799	.3069169	-1.33	0.184	-1.008926	.1941663
partcpfr	-.0236226	.1912592	-0.12	0.902	-.3984838	.3512386
partcpdv	.3204881	.1604741	2.00	0.046	.0059647	.6350115
ownrad	.6352747	.3318223	1.91	0.056	-.015085	1.285634
owntv	-.0644518	.3209789	-0.20	0.841	-.693559	.5646554
ownmobl	.779451	.3202455	2.43	0.015	.1517813	1.407121
rdnwpp	.9140801	.3543452	2.58	0.010	.2195763	1.608584
rdenvr	.3244506	.3385751	0.96	0.338	-.3391445	.9880457
talkdcc	1.709647	.4273479	4.00	0.000	.8720605	2.547233
/cut1	2.837907	1.042612			.7944248	4.881389
/cut2	4.583112	1.069588			2.486759	6.679465