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Factors affecting perceptions and responsiveness to climate variability induced hazards.

By

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A Thesis Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Science in Agricultural and Applied Economics

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Submitted by GRACE MUDOMBI **in Partial Fulfilment of the Requirements of the Degree of** MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

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DEDICATIONS

This thesis is dedicated to my son Dalitso Thabo Rusinamhodzi and my husband Leonard Rusinamhodzi. Thank you very much for your support.

ABSTRACT

Smallholder farmers are heterogeneous in terms of resource endowments, production orientation and access to markets. An understanding of these factors and how they influence local perceptions and responsiveness to climate variability has potential to improve the livelihoods of smallholder farmers. The objective of this study was to understand the major factors that contribute to heterogeneity across households and across sites and to understand how different households respond to climate variability induced hazards. Cross-sectional data was collected using a household questionnaire from 300 randomly selected households from Seke and Murewa districts in Zimbabwe but only 299 questionnaires were used for analysis. Principal component analysis was used to identify uncorrelated factors. The multinomial logit model was used to determine the influence of household characteristics on farmers' perceptions and logit model was used to ascertain the influence of socioeconomic factors and perceptions on responsiveness. Findings showed that households that are heterogeneous in religion; direct personal experiences; and access to weather information have different perceptions to climate variability induced hazards. Empirical results from multinomial regression analysis showed that socioeconomic factors such as distance to the market and access to credit information have a significant influence on perceptions but human capital-related and gender-related characteristics have an insignificant influence on farmers' perceptions. Econometric investigation using logistic regression model revealed that socioeconomic factors have an influence on responsiveness but perceptions do not influence responsiveness; this could be so because there are other underlying factors related to adaptive capacity which are limiting farmers in responding to hazards. The overall conclusion is that differences in access to markets and credit result in heterogeneity in farmers' perceptions. In terms of policy implications this means that improvement of access to markets and credit is very crucial to improve farmers' responsiveness to climate variability induced hazards.

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ACRONYMS

ARVs: Anti Retroviral Drugs

CRA: Community Risk Assessment

CV: Climate variability

ENSO: El Nino-Southern Oscillation

FGDs: Focus Group discussions

ICTs: Information and Communication Technology

KMO: Kaiser-Meyer-Olkin

MNL: Multinomial logit

PC: Principal Component

PCA: Principal Component analysis

FGD: Focus Group Discussion

UN: United Nations

CHAPTER 1: THE RESEARCH CONTEXT

1.0 Introduction

Climate variability refers to variations in the mean state and the occurrence of extremes of climate on temporal and spatial scales beyond that of individual weather events (IPCC, 2001). Climate variability includes short-term events e.g. drought, floods, tropical storms and long-term events e.g. changes in temperature and rainfall patterns (WRI, 1996). The short term events are causing abrupt disruptions which have devastating implications for agriculture and livelihoods. These disruptions appear to be worsening problems such as heat stress, lack of water at crucial times, pests and diseases. All these problems interact with ongoing pressures on land, soils, and water resources that exist regardless of climate variability (Legesse and Drake, 2005). However, the impact of extreme events largely depends on the extent of natural hazards mitigation, sustainable human development and adaptation in response to variations in climate (O'Brien *et al.*, 2006). According to the 2002 UN report, an integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, is an essential element of a more secure world.

1.1 Background and motivation

Southern Africa is characterized by a unimodal rainfall pattern where 90% of cereal crops are produced under rain-fed conditions thus crop productivity is highly vulnerable to seasonal shifts and precipitation patterns (Hulme, 2001). Southern Africa is particularly vulnerable to climate variability because of its overdependence on rain-fed agriculture, compounded by factors such as widespread poverty and weak financial and structural capacity. This has led to overall reduction in agricultural productivity and yields, including rangeland livestock production, threatening

food security and increasing the risk[1] of famine (WRI, 1996). Through increased frequency of droughts and flood events, climate variability poses a serious challenge to socio-economic development; particularly the issue of poverty alleviation and enhancing food security. Given the fact that unpredictable weather conditions are simulated to become worse under climate change scenarios, farmers will have to increasingly adapt to changing seasonality in order to manage the risk posed by climate variability and change (Jennings and Magrath, 2009).

Adaptation helps farmers achieve their food security, income and livelihood objectives in the face of climate variability and changing socio-economic conditions such as volatile short-term changes in local and large-scale markets (Boko *et al*., 2007; Gwimbi, 2009). Adaptation to climate variability involves the identification of mechanisms that farmers can implement within their circumstances that can offset the unpredictable nature of climate. Individual perception of the risks associated with climate variability is fundamental in determining their ability to adapt as perception is usually translated into agricultural decision making process (Bryant *et al.*, 2000). However, Maddison (2006) and Fosu-Mensah *et al.* (2010) noted that not all of the farmers who perceive climate variability actually respond by taking adaptation measures. Therefore, there is need to understand the reasons underlying their response or failure to respond for those who do not adapt. Mitigation efforts to reduce the sources or enhance the sinks of greenhouse gases are essential but are usually in competition with other development agendas and pressing needs which makes adaptation critical and of concern for vulnerable societies (Schipper and Pelling, 2006; Nhemachena and Hassan, 2007).

[1] Risk is possible occurrence of an event with negative impacts.

1.2 Problem statement and justification

Zimbabwe is highly dependent on the agricultural sector and of late has been facing a rapid increase in poverty and food insecurity due to recurrent droughts, economic shocks and a complex political environment (Scoones et al., 1995). The majority of farms in Zimbabwe depend on rainfall as a source of water and only 7% of the smallholder areas are under irrigation (Mutisi, 2009). According to Legesse and Drake (2005), smallholder farmers' risk perception and risk responses have bearings on the type of intervention measures that would be considered across households and ecosystems. If risk is excluded from the livelihoods analysis, then findings would be misleading and policy recommendations and ultimate decisions on identification of relevant improvements and intervention measures might be inappropriate (Vedwan and Rhoades, 2001). Despite this fact, smallholder farmers are rarely considered in academic, policy and public discourses as most studies on climate variability confine their inquiries to the biological and physical domains, concentrating mainly on representing the responses of crops to various changes in climate (Berkes and Jolly, 2001).

In many cases, coping and adaptation choices are limited by inadequate financial resources and knowledge. However, reducing vulnerability is a key aspect to improving smallholder farmers' resilience. Studies focusing on the socio-economic aspects of global climatic variability are sparse and have almost exclusively restricted their analyses to the impact of environmental modifications on agricultural production (Legesse and Drake, 2005). A better understanding of farmers' perceptions regarding long-term climate variability, current adaptation measures and their determinants will be important to inform policy for future successful adaptation of the agricultural sector. There is need to have a clear understanding of who is most vulnerable to the

impacts and how the interactions between nature and society shape the underlying factors that contribute to vulnerability (Thomalla *et al.*, 2006). Without the appropriate policies or adaptive strategies in place, the smallholder farmers will find it extremely difficult to practice sustainable agriculture in an environment with unpredictable climatic conditions. Thus, this study will provide insights on factors affecting farmers' perceptions and responsiveness to climate variability in Zimbabwe and thus bridge the gap between scientists and smallholder farmers.

1.3 Research objectives

The major objective of the study is to analyze factors affecting smallholder farmers' perceptions and responsiveness to climate variability induced hazards in Zimbabwe. The specific study objectives are:

i. To identify characteristics of households with similar perceptions to climate variability induced hazards.
ii. To identify socioeconomic factors influencing smallholder farmers' perceptions to climate variability induced hazards.
iii. To determine the influence of socioeconomic factors and perceptions to responsiveness to climate variability induced hazards.

1.4 Research questions

The study will be guided by the following research questions to address the specific objectives:

i. Are there significant similarities in characteristics of households with similar perceptions to climate variability induced hazards?
ii. What are the socioeconomic factors that influence smallholder farmers' perceptions and responsiveness to climate variability induced hazards?

iii. Do socioeconomic factors and perceptions influence responsiveness to climate variability induced hazards?

1.5 Research hypotheses

The study will seek to answer the above research questions using the following hypotheses:

i. Households with different characteristics have different perceptions.

ii. Socioeconomic factors influence smallholder farmers' perceptions to climate variability induced hazards.

iii. Socioeconomic factors and perceptions have an influence on responsiveness to climate variability induced hazards.

1.6 Organization of the study

This study consists of seven chapters and the section below outlines how each of these chapters is linked:

Chapter One: This first part comprises the introductory chapter which outlines the scope of the study. It presents the background and the motivation that inspired this study. The chapter is also the platform to outline the major research questions and hypotheses that will be tested in chapter four, five and six. Topics presented in this chapter are: introduction, background and motivation, problem statement and justification, outline of research questions, objectives and hypotheses and organization of the whole study.

Chapter Two: The second part presents a review of pertinent literature surrounding climate variability. It provides a critical review on the key concepts related to climate variability. Issues covered in this chapter include a review of empirical studies on importance of perceptions with regards to issues of adaptation to climate variability induced hazards. The importance of this

section is that it provides the theoretical framework that guides the research methodology, analyses and recommendations that come in the subsequent chapters.

Chapter Three: The third part presents the research methodology. Research methodology comprises of the background to the study area, data collection methods, the conceptual framework and the analytical methods employed in the study. It sets the motion by presenting the conceptual framework which glues together the research objectives and theoretical setting to analytical methods that are used in this study.

*Chapter Four, Five and Six***:** The fourth part presents the analytical chapters that test the theory behind this study. These four chapters draw on the interview material to present key findings on socio-economic characterization of households under study; socioeconomic factors affecting perceptions to climate variability induced hazards; and the influence of socio-economic factors and perceptions to responsiveness to climate variability induced hazards. The analytical chapters provide the missing links that glues the first three chapters to the concluding findings of this research. The chapters make use of various analytical techniques to infer and make conclusions on the research hypotheses of the study.

Chapter Seven: The last part presents the summary of findings, conclusion, recommendations as well as areas of further study that could not be dealt within the scope of this study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter will first review the background of climate variability in Zimbabwe. This is then followed by a review of literature on importance of perceptions; vulnerability of smallholder farmers to climate variability induced hazards and a section on how farmers' perceptions affect choice of risk reducing strategy. This section is necessary as it makes the objectives of this study more clear. The last section reviews relevant studies which have used econometric modeling. Concluding this section is a section on insights from literature.

2.1 Background to climate variability

El Nino-Southern Oscillation (ENSO) is the most studied occurrence of climate variability. ENSO is an interaction between the ocean and the atmosphere over the tropical Pacific Ocean that has important consequences for weather patterns around the globe (IPCC, 2001). Since the 1991/92 drought in southern Africa, awareness of the potential to better manage climate variability has grown. This has been enabled through seasonal climate forecasting and monitoring of ENSO. However, ENSO is not the only factor affecting southern Africa's weather patterns (Dilley, 1999). Recent evidence has shown that there is now an increase in drought frequency particularly in the semi-arid regions. In some years, the same locations that experience droughts are experiencing flooding. This has negatively affected smallholder farm production. Also the rainfall season in the past decade has unusually started late and farmers are increasingly wary of establishing the effective planting period (Jennings and Magrath, 2009).

2.1.1 Impacts of climate variability induced hazards on agriculture

The impact of climate variability on Australia was highlighted by events during the early 1990s. In 1990-91 the wet season produced abundant rains, but the following year drought set in across Queensland and New South Wales (Commonwealth of Australia, 2010). In some areas of Australia, drought continued through 1992 and 1993. According to Commonwealth of Australia (2010), rural productivity is linked to the behavior of ENSO as proved by variations in wheat yield with variations in ENSO in these two areas.

In the beginning of 2007, weeks of heavy rains in Mozambique triggered floods along the Zambezi River and its tributaries, washing away homes, bridges, livestock and crops in four central provinces Tete, Manica, Sofala and Zambezia. Destruction from these hazards compounded by greater unpredictability in seasonal rainfall patterns has made farming even more difficult and risky (Legesse and Drake, 2005). Thus the unpredictable weather pattern has severe negative impacts on economic activities, particularly in the natural resources sector (Matarira *et al.*, 1995; Rosenzweig and Hillel, 1995).

Climatic conditions in Zimbabwe have been very unpredictable. In 1981/2, 1991/2 and 2001/2 seasons, Zimbabwe experienced severe droughts but the 2000/01 and 2002/03 seasons were characterized by severe flooding due to cyclone Eline and Japhet respectively (Gwimbi, 2009). Low lying areas in the Zambezi and Limpopo basins have been subjected to devastating floods in the last two decades, leading to loss of life and property as well as costly damage to infrastructure (Magadza, 2004).

2.1.2 Risk reducing strategies

The major strategies to reduce climate variability induced hazards are adaptation of food and farming systems to climate variability, enhancing the adaptive capacity and mitigation. Adaptation measures can modify the impacts of climate variability while mitigation measures can tackle the causes of climate variability and change (Matarira *et al.*, 1995; Rosenzweig and Hillel, 1995). In the United States, Australia, Japan and other developed countries, preparedness and mitigation strategies combined with high coping capacity ensure that in most cases natural disasters may cause extensive damage but communities are able to recover quickly (O'Brien *et al.*, 2006).

- *Adaptation*

A study by Downing (1992) showed that adaptation has the potential to reduce food deficits in Africa from 50% to 20%. Magadza (2004) defined adaptations as actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climatic conditions. Adaptations may be done by modifying a traditional approach or by taking a new approach depending upon the challenge being addressed. The adaptation measures are of various types, private and public, autonomous and planned. At farm level and national level, adaptation measures for crop production may include: early planting, dry planting, staggering planting, use of drought tolerant crops, use of wetland to extend growing season length, livelihood diversification into non-agricultural activities, flood forecasting and early warning systems, diversification of the cultivated crops, mulching, water storage, natural barriers, improved irrigation techniques, terracing, management of water resources, crop insurances, conservation farming, and drip irrigation. For livestock production the measures may include: harvesting crop residues (stover) and keeping it for the dry season, collecting water for

livestock drinking, supplementary livestock feeding, diversifying into small ruminants from cattle production (Downing, 1992).

The government can put both reactive and anticipatory adaptive measures into place through policies on infrastructural developments, research and development, product pricing, education and water resources management. Economic policy adjustments include shifts in regional production centers and adjustments of capital, labor, and land allocations. For example, trade adjustments can help to shift commodity production to regions where comparative advantage improves; in areas where comparative advantage declines, labor and capital may move out of agriculture into more productive sectors (Matarira *et al.*, 1995).

- *Enhancing adaptive capacity*

Livelihood adaptation to climate variability is a continuous process built on the socio-economic circumstances and adaptive capacity of the community. Adaptive capacity is not equally distributed worldwide. In developed countries, the vulnerability of sectors such as agriculture, water resources, and human health that are sensitive to variations in climate is substantially lower than the vulnerability of developing countries. The two main reasons for their greater vulnerability are their sensitivity and exposure and their lower adaptive capacity. Institutional changes such as formation of producer organizations and farmer-controlled cooperatives, marketing organization and credit institutions (including rural finance institutions) are needed to support smallholder farmers in order to improve adaptive capacity (Downing, 1992).

- *Mitigation*

Through mitigation of Greenhouse Gas (GHG) emissions over the coming decades, long term effects can be reduced. Mitigation is an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases. Mitigation implies technological change and substitution

that reduce resource inputs and emissions per unit of output. Depending on the responses and choices society will make, these changes will in turn directly and indirectly cause changes in the socio-economic system due to changes in costs and prices, production and consumption patterns, technology, policies and trade. Improved livestock diets as well as feed additives can substantially reduce methane emissions from enteric fermentation and manure storage. Energy-saving practices have also shown to be quite effective in reducing the dependence of intensive systems on fossil-fuel energy (Thornton and Gerber, 2010). While mitigation can be viewed as reducing the likelihood of adverse conditions, adaptation can be viewed as reducing the severity of many impacts if adverse conditions prevail i.e. adaptation reduces the level of damages that might have otherwise occurred (Rosenzweig and Hillel, 1995).

2.1.3 Constraints to risk reducing strategies

Despite having several adaptation options that yield positive results, adoption and assimilation of these has been slow. This can be attributed to a number of factors that affect or hinder adoption and up-scaling. The primary challenge is to address these factors in such a way as to enhance adaptive capacity. Some of the main factors are economic resources, technology development and dissemination, information and skills, infrastructure, land tenure, gender and equity, governance structure, socio-cultural perspectives, environmental and health issues, extension services and incentives, and conflicts among different interest groups among others (Ngigi, 2009).

At household levels some of the constraints have been viewed as a socio-cultural rigidity among farmers themselves, the lack of or restricted access to credit, assets and other resources, as well as any alternative livelihood options in the locality. At institutional levels, a limited

understanding of climate risks and vulnerabilities, together with a lack of policy direction and regulatory guidance still account for constraints faced by local farmers resulting in their failure to adapt to climate change (Ngigi, 2009).

i. Economic capacity

Poverty is directly related to vulnerability, and is therefore a rough indicator of the ability to cope and adapt (IPCC, 2001). Whether farmers' economic conditions are expressed in terms of economic assets, capital resources or financial means, they are clearly a determinant of adaptive capacity. Adaptation and adoption of new technology costs money, and because poor communities have less diverse and more restricted entitlements, they lack the empowerment to adapt, locking them into a vulnerable situation. It is therefore necessary to provide smallholder farmers with the resources for them to be able to adapt to climate variability (Ngigi, 2009).

ii. Technology

IPCC (2001) stated that lack of technology has the potential to seriously impede a community's ability to implement adaptation options by limiting the range of possible responses and interventions. Many of the adaptive strategies for managing variations in climate directly or indirectly involve technology such as crop breeding and irrigation. Hence, a community's level of technology and its ability to adapt and modify technologies are important determinants of adaptive capacity. Awareness of and sensitization to the development and utilization of new technologies are also key to strengthening adaptive capacity. In many cases, technology choices are limited by inadequate financial resources and knowledge (Ngigi, 2009).

iii. Information and skills

Information is a powerful tool for enhancing adaptation. Successful adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess the options, and the ability to choose and implement the most suitable ones. In terms of climate variability, this can be demonstrated through acquiring information and dissemination of

information on weather hazards. Once such information becomes more available and understood, it's possible to analyze, discuss, and develop feasible adaptation measures at all levels (Ngigi, 2009).

iv. Infrastructure

Physical and social infrastructure is an important component in any development program. Physical infrastructure aspects to be considered are transport and marketing systems, storage and processing structures and communication. Social infrastructure aspects include farmers' organizations and cooperative societies. Poor infrastructure affects adaptation at both local and national levels. Inadequate infrastructure and associated lack of financial resources restricts the availability of adaptation options, especially for smallholder farmers, whose investment decisions depend on good prices for their produce and expected economic returns. Equally important are efficient marketing systems that encompass good road networks, ready market and storage facilities to avoid post-harvest losses (Ngigi, 2009).

v. Land tenure

Land tenure is the system of rights and institutions that govern access to and use of land. Access to credit for investment or inputs is also linked to land ownership, collateral or security. Most traditional land tenure systems are male-dominated and rarely give equal rights to women, who spend much time working on the land. Also farmers with lower levels of land ownership are less likely to adopt alternatives than those with higher levels of land ownership. Hence secure land tenure is a prerequisite to investments in climate change adaptations related to land and water management (Ngigi, 2009).

vi. Gender issues

Inadequate integration of gender issues compromises the sustainability of many development projects in Africa. According to Ngigi (2009), there is limited attention to the needs of women in low-income countries, and an even greater lack of women's participation in talks on mitigation

and adaptation to variations in climate. Some of the gender issues that affect adaptation to variations in climate are:

• Unequal access to land and water resources

• Inadequate gender equity, equality and diversity in the decision-making process.

vii. Governance structures

Governance structure refers to the policy, legal and institutional framework that governs socio-economic development in a country. Poor governance has been cited as a major hindrance to socio-economic development and adaptation to climate variability. The most notable component of a governance structure is the institution. The effectiveness of institutions depends on a clear policy framework and supporting legislation. A weak institutional arrangement is not conducive to addressing climate risks and easing the hardship of the people. Inherent institutional deficiencies, and weaknesses in managerial capacities to cope with the anticipated natural events, affect a country's ability to reduce vulnerability to climate variability (Ngigi, 2009).

2.2 Importance of farmers' perceptions

Perception is the way smallholder farmers think and behave in relation to climate variability and change (Wehbe *et al.*, 2006). An assessment of the community perception of climate variability induced hazards can help to uncover the nature of the risk and its underlying factors and associated socio-economic consequences. As cited by Slovic (1992), Renn (1992), and Slovic (2001), Legesse and Drake (2005), the public has a qualitative and complex conception of risk that incorporates considerations such as uncertainty, dread, catastrophic potential, controllability, equity and risk to future generations into the risk question. On the other hand, experts' perceptions of risk are not closely related to these dimensions or the characteristics that underlie them. The experts' point of view is that there are legitimate, value-laden issues underlying the multiple dimensions of public risk perceptions which need to be considered in risk policy

decisions (Legesse and Drake, 2005). Internal risk is determined by individual or community perception of insecurity while external risk is determined through scientific analysis which raises the importance of community-based participatory risk assessment when dealing with natural hazards. When dealing with climate-related risks, it is necessary to first understand current vulnerability to climate variability and extremes in order to get adaptation measures that build and reinforce resilience (O'Brien *et al.*, 2006).

According to Legesse and Drake (2005), the complexity of rural life cannot be properly understood through a single theoretical perspective as perception varies with the socio-economic, cultural, gender, environmental and historical context and to some extent personal experiences of the risks are also important in influencing perception. In a report by Vedwan and Rhoades (2001), to consider why perceptions such as those of Himalayan apple farmers in India are more accurate for certain kinds of weather and variations in climate, it is useful to look at mechanisms by which weather affects agricultural output.

Hence, Legesse and Drake (2005) argue that, new perspectives and approaches are needed to understand public risk perceptions and risk reducing strategies. For example, early studies of risk perceptions demonstrated that the public's concerns could not simply be blamed on ignorance or irrationality. Instead, research has shown that many of the public's reactions to risks can be attributed to sensitivity to technical, social, and psychological qualities of hazards that are not well-modeled in technical risk assessments. Qualities such as uncertainty in risk assessments, perceived inequity in the distribution of risks and benefits, and aversion to being exposed to risks

that are involuntary, beyond one's control or feared are some of the examples (Legesse and Drake, 2005).

2.3 Vulnerability of smallholder farmers to climate variability induced hazards

The Vulnerability Context forms the external environment in which people exist and gain importance through direct impacts upon people's asset status. Vulnerability is characterized as insecurity in the well-being of individuals, households, and communities in the face of changes in their external environment. Vulnerability has two facets: an external side of shocks, seasonalities, and critical trends; and an internal side of defenselessness caused by lack of ability and means to cope with these.

Vulnerability is the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes (IPCC, 2001). In this respect vulnerability is seen as the function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. Often, the poor are dependent on economic activities that are sensitive to climate. For example, agriculture and forestry activities depend on local weather and climate conditions; a change in weather conditions could directly impact productivity levels and diminish livelihoods (IRG, 2007). Thus reducing vulnerability is a key aspect to reducing risk posed by climate variability and change. Vulnerability is summarized by the function illustrated below where:

Vulnerability=*f* (Exposure, Sensitivity, Adaptive Capacity)

Exposure is represented by patterns of hazard e.g. drought or predicted change in temperature and rainfall by a certain time period such as 2050. Sensitivity is the degree to which a system is affected, either adversely or beneficially by climate change stimuli whereas adaptive capacity is represented by wealth, technology, availability of infrastructure and institutions, potential for irrigation and literacy rate. Agricultural systems particularly dry-land farming are sensitive to variability in temperature and rainfall. In Zimbabwe, cereal crop yields in the present climate average 0.6t/ha with a range of 0.1 to 1.8 t/ha for smallholder farmers. According to earlier crop impact assessments a warming of 2°C to 4°C leads to a cereal crop yield reduction of 10 to 30% in this sub-Saharan region. This would worsen household food insecurity for rural households (IPCC, 2007).

2.4 Conceptualizing how farmers' perception affect choice of risk reducing strategy

The degree to which households are able to and do respond to a specific climatic threat is in part determined by their perception of the threat as well as the relative importance they place on climatic risk compared to other sources of stress and the range of choice and opportunity they have been given by the particular socio-economic conditions in which they live (Wehbe *et al.*, 2006). As cited by Legesse and Drake (2005), Patt (2001) argues that farmers make decisions based on what they think is likely to occur, and sometimes based on what they fear, or hope is possible which explains differences in behavior among farmers in Zimbabwe. According to Wehbe *et al.* (2006) a farmers' perspective is that production, income, and investment decisions are made rarely in response to a single stressor such as drought risk, but rather the outcome of a process of considering simultaneously a wide variety of stressors including, but not limited to climatic factors.

Sociological and anthropological studies have shown that perception and acceptance of risk have their roots in social and cultural factors (Slovic, 1998) as cited in Legesse and Drake (2005). As cited in Legesse and Drake (2005), Kasperson (1992) states that what matters is social, institutional and cultural processes in ways that can intensify or ease perceptions of risk and shape risk behavior. Legesse and Drake (2005) also found out that characteristics of human capital such as years of experience or knowledge in farming and level of education have a positive association with perceptions of risks.

As cited in Legesse and Drake (2005), Cornish and Stringer (2000) state that in the absence of relevant information, individuals form judgements in similar ways based on similar information. According to Slovic (1998) as cited in Legesse and Drake (2005), individuals acting within social groups downplay certain risks and emphasize others as a means of maintaining and controlling the group which leads to persistent biases. In a report by Jennings and Magrath (2009), seasonality scores highly in people's perceptions as a distinctly different phenomenon to other climatic and environmental changes e.g. the occurrence of floods or droughts. Their perceptions include the changing of the timing of seasons, and changing characteristics within seasons e.g. intense rainfall events becoming more common. These perceptions of changing timing and character of seasons often find support in the meteorological record and are also to some degree consistent with climate model simulations (Jennings and Magrath, 2009).

2.5 Livelihood outcomes that justify responsiveness

The UNDP warns that the progress in human development achieved over the last decade may be slowed down or even reversed by climate variability and change as new threats emerge to water and food security, agricultural production and access nutrition and public health (Ludi, 2009).

According to Ngigi (2009), dry spells negatively affects crop yields two out of every three years in sub-Saharan Africa and drought causes complete crop failure in one out of every ten years. This means that access to water will enable farmers to diversify and grow higher value crops such as fruits and vegetables.

Climate variability and change affects the growing environment for sensitive horticultural crops which make it necessary to grow them under greenhouses. Under optimal growing conditions, vegetables and fruits can produce up to ten times more than rain-fed conditions. Another adaptation strategy, conservation agriculture is very efficient with reported crop yield increases ranging from 50-100% (Ngigi, 2009). The adoption of direct seeding pre-germinated seed into flooded paddy fields has also been reported to reduce the crop cycle by 10-45days which increases production under changing rainfall patterns. Some drought tolerant maize varieties produce 20-50% higher yields than other maize varieties under drought tolerant conditions (Ngigi, 2009). All the above mentioned outcomes justify responsiveness and they reduce vulnerability and improve livelihood outcomes.

2.6 Empirical models from climate variability studies

Since this study focuses on how heterogeneity in household socio-economic characteristics affects perceptions and responsiveness to climate variability, it is crucial to present empirical evidence of relevant studies that have been done in the past. Econometric modeling mainly uses multivariate analysis in the form of discrete choice models e.g. binomial or multinomial Logit, Tobit, Heckit and Probit models and multiple regression models. Discrete choice models maximize the likelihood of a household harvesting a particular natural resource whilst the

multiple regression models factors affecting the quantity of resources that will be drawn of a particular resource.

Using Heckman's sample selectivity probit model, Maddison (2006), found out that although experienced farmers are more likely to perceive climate change, it is educated farmers, farmers who have enjoyed free extension advice and who are situated close to the market who are more likely to respond by making at least one adaptation. Hassan and Nhemachena (2008), analyzed determinants of farm-level climate adaptation measures in Africa using a multinomial logit approach to data from a cross-sectional survey of over 8000 farms from 11 African countries. The results indicated that specialized crop cultivation (mono-cropping) is the agricultural practice most vulnerable to climate change in Africa.

Legesse and Drake (2005) used factor analysis (principal component extraction method) to identify factors influencing smallholder farmers' perceptions of sources of risks. Logistic regression analyses were used to study the relationships of identified principal components to perceived frequencies of occurrences and consequences of various sources of risks. Logistic regression analyses revealed that asset endowments, location settings and livelihood diversification strategies pursued determine smallholders' perceived risks. Legesse and Drake (2005) also found out that information from village or religious leaders, informal peers and neighbors, has a stronger effect on perceptions of the farmers than that attained from formal sources like extension workers. Direct personal experience about hazards and indirect knowledge derived from fellow farmers and development workers also influences farmers in decision making.

Ishaya and Abaje (2008) used descriptive analysis to examine the way indigenous people in Jema'a of Kaduna State in Nigeria perceive climate change and their adaptation strategies to climate change. Findings revealed that indigenous people perceived that climate has changed and the threat of climate change is more on health, food supply, biodiversity loss and fuel wood availability than on businesses and instigating of disaster; and it is the poor who are mostly affected by incidence of climate change. Result from their study further revealed that lack of improved seeds, lack of access to water for irrigation, lack of current knowledge of modern adaptation strategies, lack of capital, lack of awareness and knowledge of climate change scenarios are the hindering factors to the adoption of modern techniques of combating climate changes in the area.

2.7 Insights from literature

In their study, Legesse and Drake (2005) used the cultural theory paradigm approach to risk perception as a comprehensive framework for explaining how cultural patterns structure the mind-set of individuals and social organizations to adopt certain values and to reject others. Three culture-related qualitative variables were included in their study to understand how these variables are related to smallholder farmers' perceptions to various sources of risks. In this study the cultural theory paradigm is also going to be adopted as a framework to help explain how cultural patterns are shaping farmers' perceptions to climate variability induced hazards.

As evidenced by literature several factors affect perceptions and responsiveness of smallholder farmers to climate variability. Some of the factors are within the farmer's control while others are beyond the farmer's control. The factors can be subdivided into socio-economic, cultural,

institutional factors and demographic characteristics. In this study, the Sustainable livelihoods approach will be used to explain how the varying access of each household to a bundle of capitals determines the level of vulnerability to hazards. This is then linked to disturbances such as trends in climate and shocks such as natural hazard impacts. Linking access to resources to shocks and trends in climate is important because climate risks are basically determined by the interaction between hazards and vulnerability.

CHAPTER 3: RESEARCH METHOD

3.0 Introduction

This chapter outlines the methods used to collect data and methods used to analyse the data. The first section outlines the background to the study area, the data requirements and data collection. The middle section explains the conceptual framework and further shows it schematically. The last section is the analytical framework which outlines methods which are going to be used in data analysis for chapters four, five, six and seven.

3.1 Background to study area

A field study was conducted in two districts of Zimbabwe namely Seke and Murewa . Zimbabwe is divided into five agro-ecological regions with Natural Region II being subdivided into IIA and IIB. The rainfall characteristics are the same except that Natural Region IIB experiences some mid-season droughts while Natural Region IIA has uniformly distributed rains. Natural Region II covers 15% of total land area in Zimbabwe[2]. Despite receiving rainfall levels of 800 -1000 mm of rainfall per year which are lower than that of Natural Region I, Natural Region II is suitable for intensive farming based on crops or livestock production (USDA, 2004).

Both districts are in the Mashonaland East province in Zimbabwe. Seke district is located 23km South of Harare while Murewa district is located 81.5km Northeast of Harare. Seke district has a population of 77 840 people and 18 854 households while Murewa has a population of 162 660 people and 37 152 households. Seke district has a total of 75 080ha with 36 808ha in Natural Region IIA (CSO, 2004).The map for Mashonaland East province is shown in Figure 3.1.

[2] More detail on agro-ecological regions in Zimbabwe is in the appendix section

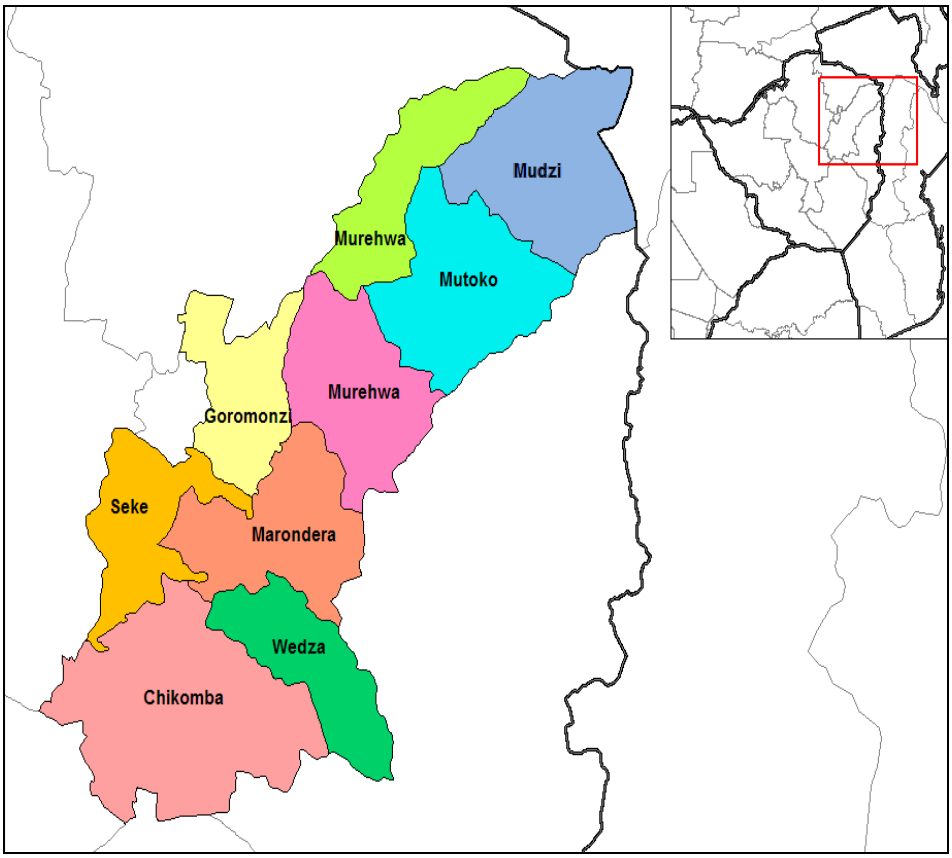

Figure 3.1 Map showing the study site

3.2 Data Requirements and data collection

From each district a sample size of 150 respondents were selected using stratified random sampling method. In each district three wards were randomly selected and from each ward, five villages were randomly selected. Selection of households in each village was done randomly targeting ten households. The data collection process was done in two major phases. The first phase involved collecting data from both Seke and Murewa district using a structured household questionnaire[3]. The second phase involved use of participatory rapid appraisal tools; mainly focus group discussions. A semi-structured focus group discussion questionnaire[4] was used to diagnose vulnerabilities and assess the community's priorities. Each focus group discussion had

[3]Household questionnaire is attached in the appendix section.

[4] Focus group discussion questionnaire is attached in the appendix section.

participants ranging from 8 to 15 people. This also enabled validating information that was collected to improve on the accuracy of the collected information. Accuracy is an important aspect to getting quality results.

3.2.1 Household characteristics

The questionnaire included questions on household characteristics, employment of household members and the quantity of labor used in agricultural production. Household size was used to assess the effect of labor availability. The survey also collected farm-level production activities, information on farmer perceptions on climate change, adaptation strategies being used by farmers and perceived barriers to responding to perceived climate changes. The survey also requested information on the type of livestock, poultry and other animals possessed by the farmers.

3.2.2 Socio-Economic characteristics

The variables included in the estimation were total land under crop, livestock ownership, access to market, extension contact, household size used as a proxy to household labor, household access to irrigation. The livestock variables were included to enable the analysis to assess the importance of livestock in helping farmers adapt to changing climatic conditions. The underlying assumption is that further increases in temperature and reductions in rainfall are less favorable for crop production and thus livestock becomes an important option under very stressful conditions.

3.2.3 Institutional characteristics

Access to extension services was assumed to be an important source of climatic information, whilst access to credit, off-farm employment and land tenure were also included as contributing factors to perceptions (perceptions on changes in frequency of droughts) and responsiveness (number of adaptation strategies adopted). District location was also used to show the effect of proximity to major towns as a factor that could affect responsiveness. Distance from major towns is important as it might determine the flow of information from urban areas to smallholder farmers in surrounding locations.

3.2.4 Cultural factors

Religion and gender were assumed to be important cultural factors that can affect responsiveness to climate variability.

3.3 Empirical specifications of model variables

The dependent variables in the empirical estimation for this study are the farmer's perception (perceptions on changes in frequency of droughts) and responsiveness (number of adaptation strategies adopted). The choice of explanatory variables is dictated by theoretical behavioral hypotheses, empirical literature and data availability. The explanatory variables considered in this study consist of household characteristics, socioeconomic factors, cultural factors and institutional characteristics. Table 3.3 summarizes the explanatory variables used for empirical estimation and develops some hypotheses about their expected influence on farmer's perception and responsiveness.

Table 3.3 Definition of variables used in the empirical analysis

Variable	Definition	Values/measure	Expected sign / Dependent Variable number
perception	*Perceptions on changes in frequency of droughts*	0=No change 1=decreasing 2=increasing 3= I don't know	Dependent variable 1
responsiveness	*Number of adaptation strategies adopted*	1=adaptation 0= no-adaptation	Dependent variable 2
ghhld_head	*Gender of household head*	1=male and 0=female	±
hhld_size	*Household size*	Number of members	+
Agehhld_head	*Age of household head*	Number of years	±
Farmg_exper	*Number of years household has been farming*	Number of years	+
Eduhhld_head	*Education level of household head*	Highest education level reached	+
Infowthr	*Get rainfall information from weather station.*	1=yes and 0=no	+
Accextension	*Access to extension services*	1=yes and 0=no	+
borrow	*Access to credit*	1=yes and 0=no	+
Farm_size	*Farm size*	Hectares	+
Markets	*Distance to markets*	Km	-

3.4 Conceptual framework

This study employs the Sustainable Livelihoods Framework[5] to analyse the vulnerability context in the study areas. The framework depicts stakeholders as operating in a Context of Vulnerability, within which they have access to certain assets. These assets gain their meaning and value through the prevailing social, institutional and organizational environment (Transforming Structures and Processes). This context decisively influences the Livelihood

[5]The sustainable livelihoods framework is illustrated in figure 3.4.

Strategies that are open to people in pursuit of their self-defined beneficial Livelihood Outcomes (Christensen and Pozarny, 2008).

The Vulnerability Context forms the external environment in which people exist and gain importance through direct impacts upon people's asset status. Vulnerability depends upon the assets that a household has, the entitlement to food that it possesses and the extent to which the asset holders can adapt. Vulnerability varies widely across people, whether in the same geographical location or not. It comprises trends, shocks and seasonality. Seasonality includes seasonality of prices, products or employment opportunities. On the other hand trends include demographic, environmental, economic, governance and technological trends. Shocks include natural hazards and economic shocks. Vulnerability context represents the part of the framework that lies furthest outside stakeholder's control. Assets are considered to be stocks of different types of capital that can be used directly or indirectly to generate livelihoods. They can give rise to a flow of output, possibly becoming depleted as a consequence, or may be accumulated as a surplus to be invested in future productive activities.These assets include human, financial, physical, social and natural capitals (Kollmair and Gamper, 2002; Christensen and Pozarny, 2008).

Transforming Structures and Processes represent the institutions, organizations, policies and legislation that shape livelihoods. They are of central importance as they operate at all levels and effectively determine access, terms of exchange between different types of capital, and returns to any given livelihood strategy. Livelihood Strategies comprise the range and combination of activities and choices that people undertake in order to achieve their livelihood goals. The former

can be viewed as responsiveness in the context of climate variability. They have to be understood as a dynamic process in which people combine activities to meet their various needs at different times and on different geographical or economical levels, whereas they may even differ within a household. Livelihood outcomes are the achievements of livelihood strategies, such as increased well-being, reduced vulnerability e.g. better resilience through increase in asset status, improved food security and a more sustainable use of natural resources (Kollmair and Gamper, 2002). The sustainable livelihoods framework is shown in figure 3.4.

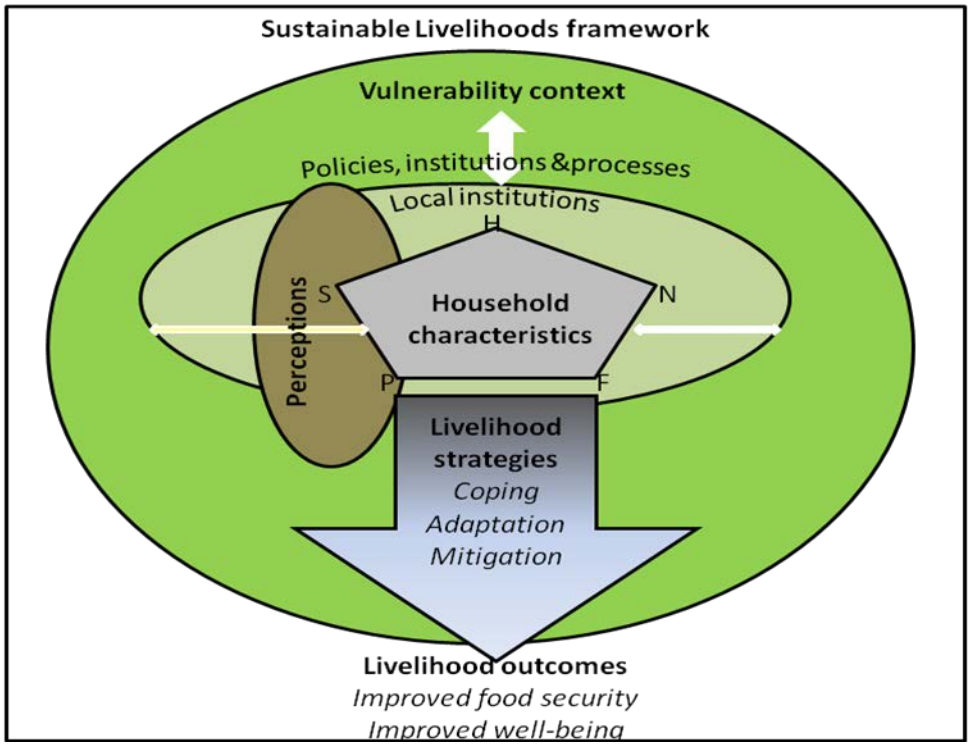

Figure 3.4: Conceptual Framework (Adapted from Christensen and Pozarny, 2008)

3.5 Analytical framework

In analyzing the data, the study used various analytical methods that range from lower-order to higher-order econometric tools. This study will focus on factors affecting smallholder farmers' perceptions and responsiveness to climate variability as it poses unprecedented risk to farming not only in Zimbabwe but worldwide.

3.5.1 Univariate and bivariate analysis

Descriptive statistics such as frequencies and cross-tabulations will be used to analyze relationships between household characteristics, socioeconomic characteristics and perceptions to changes in rainfall and temperature. Cross-tabulation will be used to establish the association between these variables. The significance of the association is determined by the Pearson's chi-square value. T-tests are also used to test whether there are significant differences between those who perceive changes in rainfall and temperature and those who perceive no-change.

3.5.2 Principal component analysis

Principal Component Analysis (PCA) will be used to transform socio-economic factors into an uncorrelated set of factors which will be used in Multinomial logit and Logit models. The PCA method transforms the set of observed correlated ratings into another set of uncorrelated indices called principal components (PCs). PCs can be defined as a linear combination of optimally-weighted observed variables (Maddala, 1992; StataCorp, 2001). PCs are mathematical functions of all the original observed ratings - the first PC explains the largest amount of the variance in these ratings, followed by the second PC, and so on (Smith, 2002).

In this case the Kaiser (eigenvalue-one) criterion was used to select the principal components. This method usually retains the correct number of components, particularly when less than 30 variables are being analyzed, or when the analysis is based on more than 50 observations and the mean communality is greater than or equal to 0.60. The rationale for choosing the eigenvalue-one criterion being that each observed variable contributes one unit of variance to the total variance in the data set, with those variables that display an eigenvalue greater than 1.00

accounting for a greater amount of variance. Such a component is worthy to be retained but a component with an eigenvalue less than 1.00 accounts for less variance and is not retained (StataCorp, 2001).

The PCs were estimated as linear functions of the original ratings as shown by equation (1):

$$PC_i = a_{i1}x_1 + a_{i2}x_2 + ... + a_{in}x_n \qquad (1)$$

where $a_{i1}....a_{in}$ = the regression coefficients (or weights) for observed variable *n*, as used in creating principal components and $x_1....x_n$ are the subject's scores on observed variable *n*.

3.5.3 Multinomial logit model

This study used the multinomial logit (MNL) model to analyze the factors affecting smallholder farmers' perceptions because it is widely used in studies involving multiple choices and is easier to compute than multinomial probit (MNP). The advantage of using a MNL model is its computational simplicity in calculating the choice probabilities that are expressible in analytical form. The main limitation of the model is the independence of irrelevant alternatives (IIA) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set.

The MNL model allows household characteristics to have different effects on the relative probabilities between any two choices. Let *Ai* be a random variable representing the perception of farming household. We assume that each farmer faces a set of discrete, mutually exclusive choices of perception. These perceptions are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X (Greene, 2003). The MNL model

specifies the following relationship between the probability of choosing option *Ai* and the set of explanatory variables X as:

$$\Pr(A_i = j) = \frac{\exp^{\beta_j x_i}}{\sum_{k=0}^{j} \exp^{\beta_k' x_i}}, \; j = 0,1....J \qquad (1)$$

Where β_j is a vector of coefficients on each of the independent variables X. Equation (1) can be normalized to remove indeterminacy in the model by assuming that $\beta_j = 0$ and the probabilities can be estimated as:

$$\Pr(A_i = j / x_i) = \frac{\exp^{\beta_j x_i}}{1 + \sum_{k=1}^{j} \exp^{\beta_k' x_i}}, \; j = 0,1..., J; \beta_0 = 0 \qquad (2)$$

Estimating equation (2) yields the J log-odds ratios

$$\ln\left(\frac{p_{ij}}{p_{ik}}\right) = x_i'\left(\beta_j - \beta_k\right) = x_i'\beta_j, \; If \;\; k = 0 \qquad (3)$$

The dependent variable is therefore the log of one alternative relative to the base alternative.

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j\left[\beta_j - \bar{\beta}\right] \qquad (4)$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Long, 1997; Greene, 2003). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

Table 3.4 Definition of independent variables for multinomial logit analysis

Variable	Description
Demographic characteristics	
Age of household head	Age in numbers *Years*
Farming experience	Number of years household has been farming *Years*
Education level	Education level of household head: *1=No formal education 2=Adult education 3=Primary education 4=Vocational training 5=Secondary education 6=Advanced level 7=College education 8=University education*
Access to information	
Information	Access to weather information *1=Yes 0=No*
Highest education level	Highest education level in the family head: *1=No formal education 2=Adult education 3=Primary education 4=Vocational training 5=Secondary education 6=Advanced level 7=College education 8=University education*
Own radio	Household own a radio *1=Yes 0=No*
Own television	Household own a television *1=Yes 0=No*
Institutional characteristics	
Extension	Access to extension *1=Yes 0=No*
Credit	Access to credit information *1=Yes 0=No*
Cultural factors	
Gender of household head	Sex of household head *0=female 1=male*
Religion	Link religion to variations in climate *1=Yes 0=No*
Head marital status	Marital status of household head *1=Single 2=Monogamously married 3=Polygamously married 4=Widowed 5=Divorced/ Separated 6=Other*
Geographical location and past experiences	
District	District
Experienced storm	Experienced storm*1=Yes 0=No*
Experienced food shortages	Experienced food shortages*1=Yes 0=No*

3.5.4 Binary logistic regression model

The binary logistic regression model will be used to determine the influence of household characteristics and perceptions to responsiveness of smallholder farmers to climate variability. The binary logistic model falls in the group of qualitative response models which have the dependent variable as an indicator of a discrete choice. The logistic regression model has been used in many applications due to its mathematical convenience (Greene, 2003). The binary logit is represented as shown below.

$$\Pr(y=1\,|\,x') = \frac{\exp(x'\beta)}{1+\exp(x'\beta)} = \mathrm{A}(x'\beta) \qquad (1)$$

Where $\Pr(y=1\,|\,x')$ represents the probability of an event happening, the dependent variable takes a value of 1 given an independent variable x'. x' represents vectors of all the independent variables. The explanatory power of the independent variable is explained by the coefficient β. The dependent variable is the probability of a household responding to climate variability by adapting to variations in weather. This dependent variable takes two discrete values which are: 1= at least one adaptation strategy or 0=no adaptation.

The model predicts the maximum likelihood of a household being an adapter versus being a non-adapter. The coefficient β in the model depicts a relationship of how variations in the independent regressors affect the predicted log of odds of a household being an adapter versus being a non-adapter. This relationship between the dependent and the independent variable can be depicted using the antilog of the β ($\exp\beta$) which is the odds ratio. The formula of the odds ratio is presented below.

$$\frac{P_i}{1-P_i} = \frac{1+e^{\Lambda(x'\beta)}}{1+e^{-\Lambda(x'\beta)}} = e^{\Lambda(x'\beta)} \qquad (2)$$

Where P_i is the probability of adapting ($\Pr(y=1\,|\,x')$ in equation (1) and $1-P_i$ is the probability of no adaptation ($\Pr(y=0\,|\,x')$). Equation (2) represents the odds ratio in favor of adapting to variations in weather which is the ratio of the probability that a household adapts to the probability of not adapting. An odds ratio that is greater than 1 implies that a unit increase in

the continuous variable or discrete change in the categorical variable in the regressors leads to a decrease in the odds of a household being an adapter versus being a non-adapter (Long, 1997).

Table 3.5 Definition of independent variables for logistic analysis

Variable	Description
Demographic characteristics	
Age of household head	Age in numbers *Years*
Farming experience	Number of years household has been farming *Years*
Education level	Education level of household head: *1=No formal education 2=Adult education 3=Primary education 4=Vocational training 5=Secondary education 6=Advanced level 7=College education 8=University education*
Human capital characteristics	
Household size	Number of family members
Highest education level	Highest education level of the family head: *1=No formal education 2=Adult education 3=Primary education 4=Vocational training 5=Secondary education 6=Advanced level 7=College education 8=University education*
Access to information and technology	
Information	Access to weather information *1=Yes 0=No*
Own radio	Household own a radio *1=Yes 0=No*
Own television	Household own a television *1=Yes 0=No*
Markets	Distance to markets
Productive assets owned	
Total land	Total land owned *Acres*
Draft ownership	Number of cattle
Livestock water	Distance to water source for livestock
Institutional characteristics	
Extension	Access to extension *1=Yes 0=No*
Credit	Access to credit information *1=Yes 0=No*
Land tenure	Land ownership type
Cultural factors	
Gender of household head	Sex of household head *0=female 1=male*
Religion	Religion of household head: *1=Nonreligious; 2=Islam; 3= Christianity; 4=African Traditional Religion.*
Head marital status	Marital status of household head *1=Single 2=Monogamously married 3=Polygamously married 4=Widowed 5=Divorced/ Separated 6=Other*
Perceptions	
Frequency of droughts	Perception of household head on frequency of droughts: *0=No change 1=decreasing 2=increasing 3= I don't know*

3.6 Summary analytical framework for the study

Table 3.6 Summary of analytical framework for the study

Research questions	Research objectives	Research hypothesis	Analytical tools
Are there significant similarities in characteristics of households with similar perceptions to climate variability?	To identify characteristics of households with similar perceptions to climate variability.	Households with different characteristics have different perceptions.	• Descriptive statistics
What are the socioeconomic factors that influence smallholder farmers' perceptions to climate variability?	To identify socioeconomic factors influencing smallholder farmers' perceptions to climate variability.	Socioeconomic factors influence smallholder farmers' perceptions to climate variability.	• Principal component analysis • Multinomial logit regression model
Do socioeconomic factors and perceptions influence responsiveness to climate variability?	To determine the influence of socioeconomic factors and perceptions to responsiveness to climate variability.	Socioeconomic factors and perceptions have an influence on responsiveness to climate variability.	• Principal component analysis • Logit regression model

3.7 Limitations of the study

This study was carried out in Seke and Murewa districts in Mashonaland East in agro-ecological region II. These two districts share the same climate thus generalizations cannot be made based on evidence from this study for smallholder farmers in other provinces where climatic conditions might be different. There is need to carry out more studies in other districts which are prone to flooding and/or those that are in other agro-ecological regions.

The other limitation of this study was assuming a linear relationship on variables for community priorities during computing their respective weighted indices. Using aggregated weighted indices on analyzing community priorities can lead to aggregation errors especially when there are non-linear relationships such as the relationship which may exist between the individual priorities and responsiveness to climate variability induced hazards.

CHAPTER 4: HOUSEHOLD AND VILLAGE CHARACTERIZATION

4.0 Introduction

This chapter gives the preliminary analysis for the study. The objective of this chapter is to explore the differences in household characteristics for households with different perceptions to climate variability induced hazards and their respective village characteristics. Households are characterized according to socioeconomic characteristics; institutional characteristics; cultural factors and also according to their perceptions of climate variability induced hazards. Data for this analysis came from a questionnaire survey covering 299 households from Seke and Murewa districts. The first section gives a general description of characteristics of the sampled households in terms of demography, resource endowments and indicators of access. The second section gives a general description of the villages. The third section links different socioeconomic factors to the observed variability in perceptions. In order to ascertain the overall significance of each variable on perceptions, t-test was used.

4.1 General description of the sample

Table 4.1 gives a general description of the sample.

Table 4.1 General sample description

Variable	N	Percentage proportion within sample (%)
Households interviewed	299	100
Female headed households	96	32.1
Male headed households	203	67.9
Communal farmers	252	84.3
Small-scale commercial farmers	47	15.7
Proportion with primary education (yes/no)	272	91.0

Source: Survey data

A total of 300 households were interviewed but 1 questionnaire was discarded due to inconsistencies in the way questions were answered. Of the 299 households, 149 households are from Seke district and the other 150 households from Murewa district. From the 299 households, there are more male-headed households than female-headed households where 96 (32.1%) are female-headed and 203 (67.9%) are male headed. Total number of household heads with at least primary education was 272 which constituted 91.0% of the total sample.

4.1.1 Household Characteristics

Table 4.2 General demographic characteristics

Variable	Minimum	Maximum	Mean	Variance
Age household head	23	98	52.23	228.697
Household size	1	18	5.78	7.624
Land size (acres)	1	82	7.71	140.507
Cultivated area in acres (2009/10)	0	47	3.64	22.447
Cultivated area in acres (2010/11)	0	56	4.36	42.937

Source: Survey data

The youngest household head that was interviewed was aged 23years whilst the oldest was aged 98years with a mean age of 52.23 years. The minimum household size was 1 and maximum household size was 18 with a mean of 5.83. The smallest land size for the interviewed households was one acre while the largest land size owned was 82acres. In 2009/10 and 2010/11 seasons there were households who did not grow any crops thus the cultivated areas in acres was zero. The maximum cultivated area in acres for 2009/10 and 2010/11 was 47acres and 56 acres respectively.

i. Age of household head

Age of household heads is normally distributed variable and hence can be categorized into three quartiles as shown in the table below. Household heads that will be considered as young-aged are those that are between the ages of 23 and 40 years and these will form group1, the middle-aged 41 to 70years will form group2 whilst the old-aged household heads will be from 71 to 98years and these will form group3.

Table 4.3 Age of household head by gender of household head cross-tabulation

		Gender of household head		Total (%)
		Female (%)	Male (%)	
Age of household head	**1**	15.8	33.2	27.6
	2	68.4	54.5	58.9
	3	15.8	12.4	13.5
Total		100.0	100.0	100.0

Notes: *Of the interviewed households, total number of female-headed households is 96 and male-headed households are 203.* Source: Survey data

The results show that 58.9% of household heads are middle aged and young constitute 27.6% of the total. Old-aged households constitute only 13.5% of the total. For both sexes the majority of household heads fall below 70 years. This shows that most household heads are still in the working age group especially when the young are combined with the middle-aged household heads.

ii. Education level of household head

Education level does not only shape the way farmers might perceive climate variability induced hazards but can also influence responsiveness. A more educated farmer is able to use internet which is a vital source of current information on climate variability and change. In this study the education level of household is important and it affects ability of farmers to use Information and Communication Technologies (ICTs) to get more knowledge on climate-related issues which

affect perceptions. It also affects farmer's ability to adopt new and/or complex agricultural technology. Thus more educated farmers are assumed to be in a better position to make informed decisions.

Table 4.4 Summary of education level of household head

Education type	Frequency	Percent
No formal education	13	4.3%
Adult education	14	4.7%
Primary education	115	38.5%
Vocational education	4	1.3%
Completed secondary education	142	47.5%
Advanced level	4	1.3%
College education	4	1.3%
University education	3	1.0%
Total	299	100.0%

Source: Survey data

From the above table it can be noted that most of the household heads had received education most of them up to secondary education. Only 4.3% had no formal education. Those who attained college and university education constituted 1.3% and 1% respectively. This shows that most of the interviewed households can use ICTs as a source of information to make informed decisions on responding to climate variability induced hazards.

iii. Marital status

Households in most rural areas have husbands who work elsewhere and come home occasionally or *de jure* female headed households where no husband exists because they are divorced/separated or widowed. According to Oka (2001), female de-facto households tend to have the greatest available cash income which mainly comes from remittances and off-farm activities. The male-headed households have greater income than the female *de jure* households

which are the most cash constrained households. Marital status can influence decision making by household head (Oka, 2001).

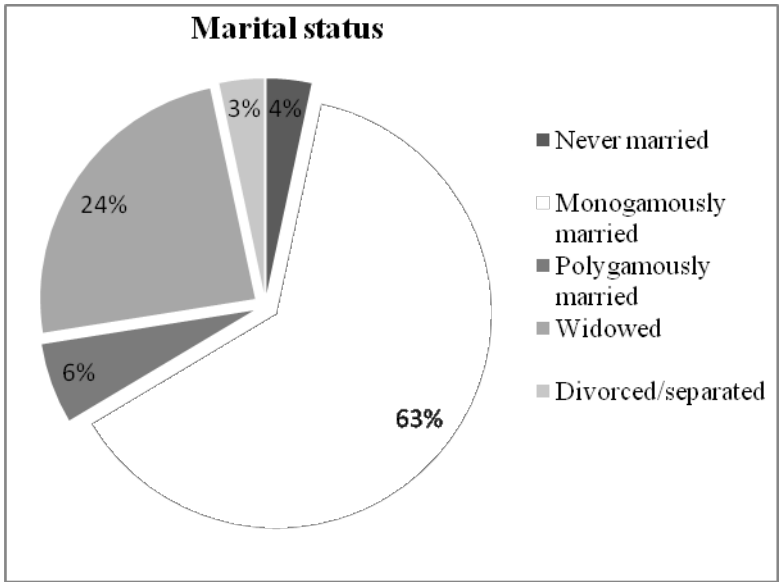

Figure 4.1 Marital status

From the pie-chart above 63% households are monogamously married followed by 24% households which are widowed. Only 4% of household heads have never been married. Monogamously and polygamously married household heads constitute 69% of household heads. This can be translated to mean that most households are resource and subsequently have more adaptive capacity than widowed/ separated and those who never married.

4.1.2 Socio-economic characteristics of sampled households

i. Income from agriculture

For this study, income from agricultural activities can be through sale of field crops, horticultural activities, sale of livestock and hiring out agricultural labor. It is assumed that those who get income from agricultural activities are likely to be more responsive so that their source of livelihood is not jeopardized.

Table 4.5 Agricultural income by district Cross-tabulation

			District		Total
			Murewa	Seke	
Agricultural income	**No**	Count	18	45	63
		% of Total	6.0	15.1	21.1
	Yes	Count	132	104	236
		% of Total	44.1	34.8	78.9
Total		Count	150	149	299
		% of Total	50.2	49.8	100.0

Source: Survey data

Results in the Table 4.5 show that more households are dependent on agriculture as a source of income in both districts. In Seke district, 15.1% of households get no income from agriculture while in Murewa only 6.0% of the interviewed households also does not get income from agriculture. However, 78.9% of the sampled households in both districts get income from agricultural activities. This shows that agriculture is a significant source of livelihood for farmers in both districts.

ii. Income from non-agricultural income sources

Income from technical activities is one of the non-agricultural income sources/off-farm employment for people in both Seke and Murewa districts. It can be in form of carpentry, brick molding, thatching and building among others. Other off-farm employment activities are hiring out non-agricultural labor within and outside the community e.g. nearest business centre/ town.

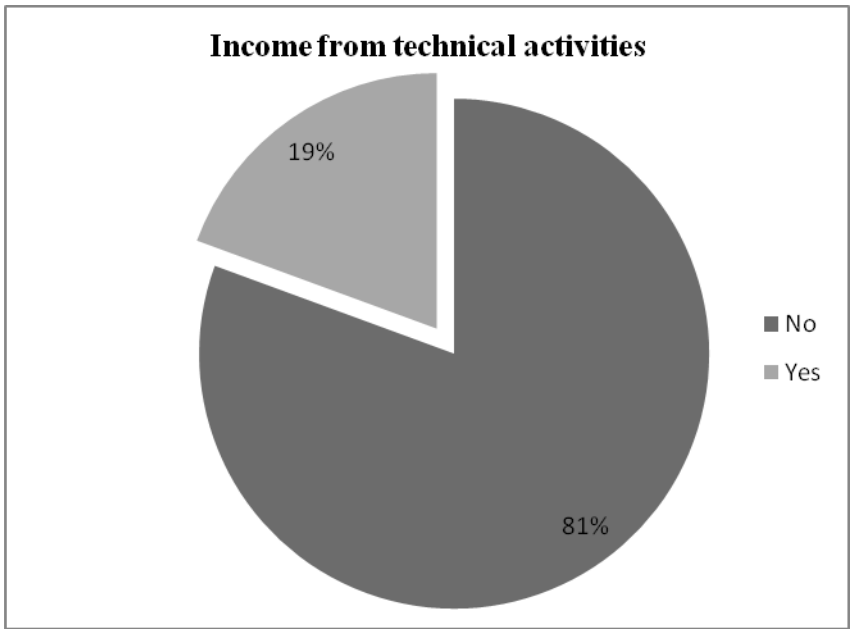

Figure 4.2 Income from technical activities

From figure 4.2, only 19.4% of households in both districts get income from technical activities but 80.6% of the households don't get income from technical activities. This shows that in both districts the percentage of households who depend on income from technical activities is low. Results in figure 4.2 above however further support results in Table 4.2 which showed that more households are dependent on agriculture as a source of livelihood.

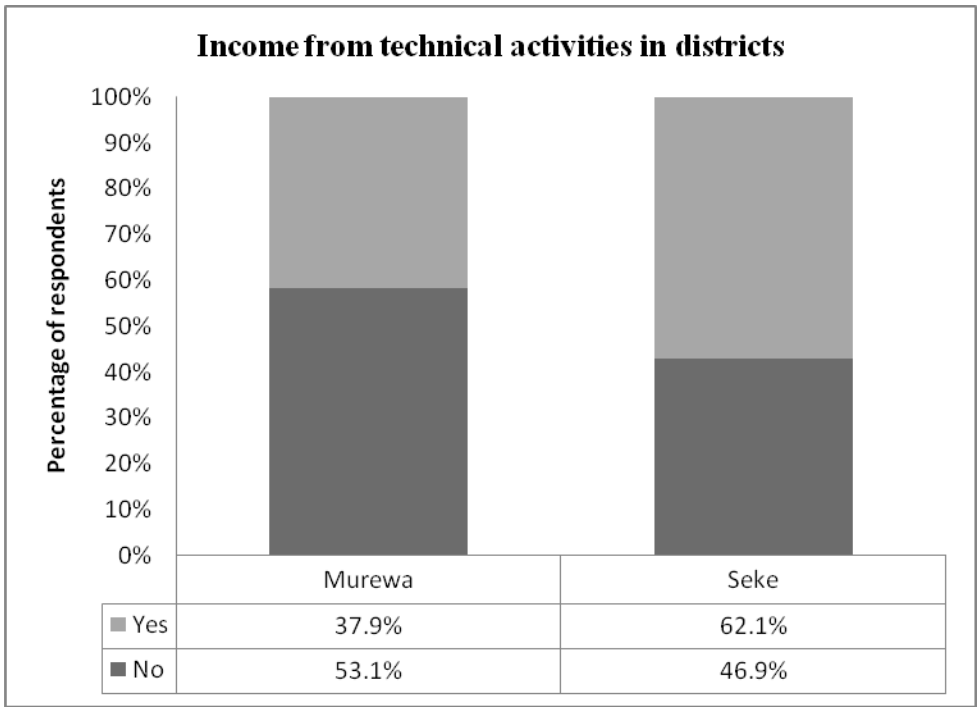

Figure 4.3 Income from technical activities

The percentage of households who get income from technical activities in Seke and Murewa district is 62.1% and 37.9% respectively. This shows that more households in Seke district get their income from technical activities compared to Murewa district. This could be because Seke district is much closer to Harare than Murewa district so household heads in Seke district can get off-farm employment in the city.

4.1.3 Institutional characteristics

i. Access to extension services

Farmers' access to extension services is a very important source of climate information, new technology, marketing strategies and adaptation strategies among others. In this study access to extension is proxy to awareness of and sensitization to the development and utilization of new technologies, and is also a key source of up to date weather information.

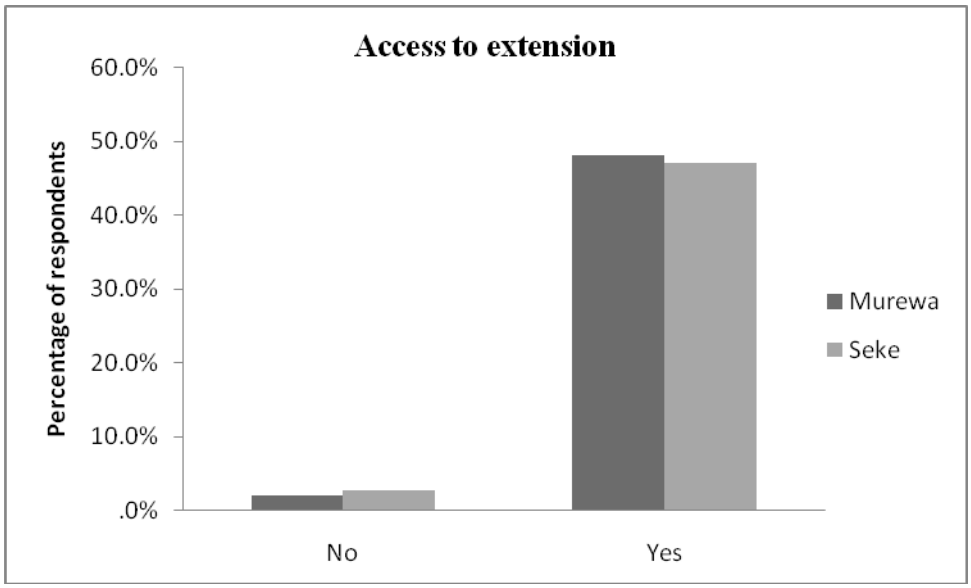

Figure 4.4 Access to extension

There is no big difference in access to extension services between Seke and Murewa districts. When districts are combined, 95.3% of the sampled households have access to extension and only 4.7% households said they don't have access to extension. Thus we conclude that farmers in both Seke and Murewa districts have access to climate information from extension officers.

ii. Effect of gender on access to extension services

Bringing out the gender aspect was necessitated by the fact that gender roles demarcate responsibilities between men and women in social and economic activities, access to resources and decision-making authority. Several researchers have found that inadequate integration of gender issues compromises the sustainability of many development projects in Africa (Ngigi, 2009). In this study differential access to extension across gender divide is paramount in adaptation to variations in climate.

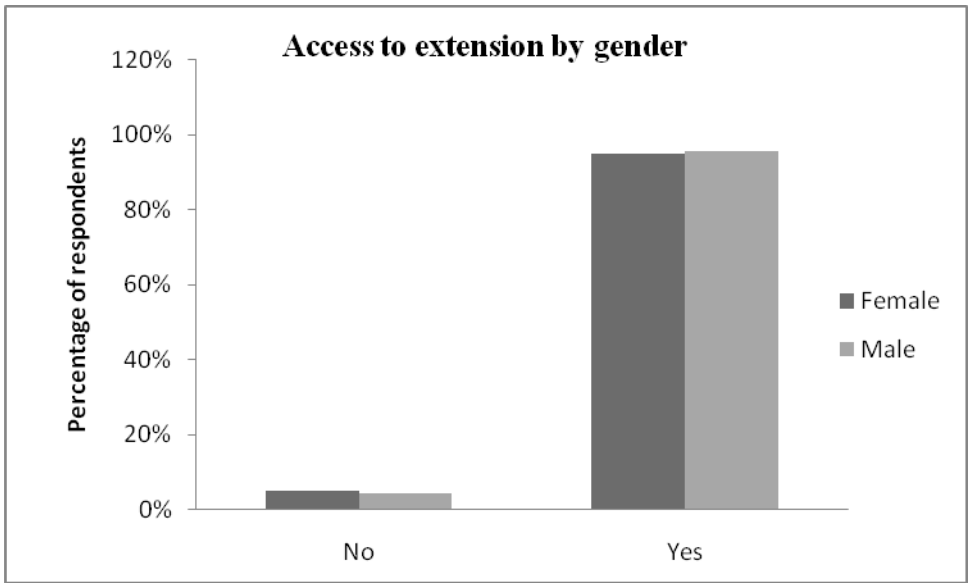

Figure 4.5 Access to extension by gender

Drawing from results in the cross-tabulation in figure 4.5 above, it can be concluded that both female and male headed household heads have equal access to extension services. This is very important as access to extension by women can improve sustainability of risk reducing strategies that might be adopted by either households or communities.

iii. Access to credit

Poverty is directly related to vulnerability as some farmers may perceive an increase in climate variability reduced hazards but fail to cope and adapt. Thus farmers' capital resources or financial means are a determinant of adaptive capacity. Access to credit by smallholder farmers is one way of improving economic capacity and ultimately adaptive capacity. In this study access to credit information is equated to access to credit lines.

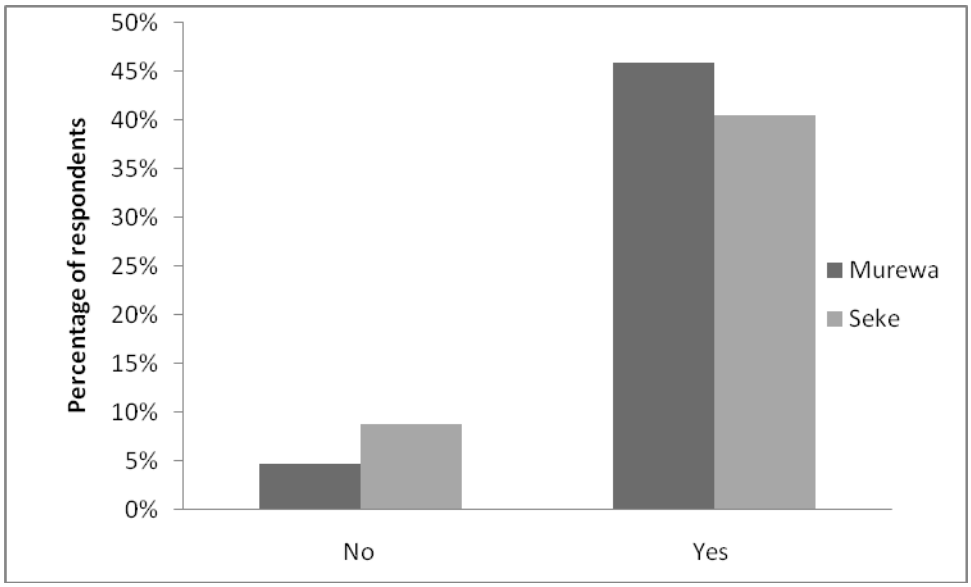

Figure 4.6 Access to credit by district

Figure 4.6 above shows that 45.9% of farmers in Murewa district have access to credit compared to 40.5% farmers in Seke district. This can be attributed the fact that part of farmers in Murewa district are small-scale commercial farmers and thus need more capital for their farming activities. After the Land Reform program in Zimbabwe, the government has been promoting the newly resettled farmers in several ways including extension services; this could explain why access to credit information is higher in Murewa district than Seke district.

iv. Effect of access to credit information on level of borrowing

This cross-tabulation was done to ascertain whether access to credit information in the smallholder farming sector translates to borrowing.

Table 4.6 Information credit and borrowing cross-tabulation

		Credit information		Total (%)
		No (%)	Yes (%)	
Source of credit	Did not borrow	90.0	75.0	77.0
	Relatives/Friends	7.5	15.2	14.2
	Farmer associations/ co-operatives	0.0	5.1	4.4
	Thrift and loan Society	2.5	4.7	4.4
	Total percentages	100	100	100

Source: Survey data

From table 4.6 above, the results show that of the farmers who had access to credit information only 25% borrowed. Of the 25% who borrowed, 15.2% borrowed from relatives and friends. This shows that borrowing from the loan society/ banks is still low. Thus access to credit information does not translate to borrowing. This can be as a result of several factors among them lack of collateral/security for most smallholder farmers as only 4.7% of the farmers who can access credit information borrowed from thrift and loan society. The other reason could be because credit may have been offered as packages that provide a set of inputs to farmers, of which farmers may feel that the package is inappropriate to their situation or needs. Rather than facilitating access to new technologies, credit programs may be responsible for obligating farmers to use a particular technology which makes farmers comfortable borrowing from friends and relatives.

4.1.4 Cultural factors

i. Religion

In this study, religion can stand in for social capital. Religion is subdivided into Christianity; Islamic religion, African Traditional religion and others. Religion is the social resources that the households draw in seeking livelihood outcomes such as networks and connectedness (Kollmair and Gamper, 2002). Cultural factors usually structure the mind-set of individuals and social organizations to adopt certain values and reject others[6]. In this study, individuals exposed to similarcultural factors form judgements in similar ways. This will then influence perceptions both in a positive and negative way.

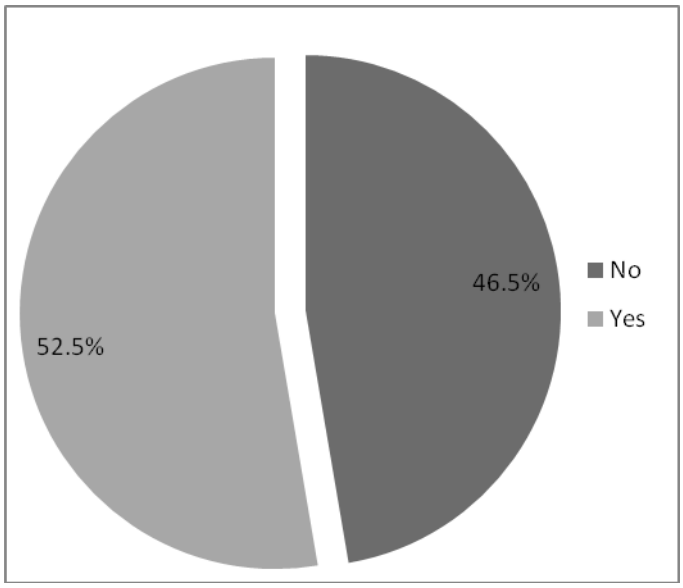

Figure 4.7 Link climate variability to any religious beliefs

From Figure 4.7, 52.5% of the interviewed households link climate variability to some religious belief. This shows that, in this study area religion has the ability to shape farmers' perceptions on climate variability. Religion may have effects that are restrictive to development because it entails excluding other stakeholders but it can also improve efficiency of economic relations by

[6]This statement is drawn from the cultural theory paradigm in Legesse and Drake (2005).

reducing the free rider problem through mutual trust and obligations that it poses on the community. If these different religions are understood, they can be used as a tool to spread information on adopting coping and adaptation strategies to reduce vulnerability to climate variability induced hazards during religious gatherings.

ii. Effect of gender on religious beliefs

Socio-cultural rigidity among farmers is among the constraints to adaptation (Ngigi, 2009). Individuals acting within social groups downplay certain risks and emphasize others as a means of maintaining and controlling the group which leads to persistent biases (Legesse and Drake, 2005). Thus it is important to understand the influence gender might have on linking climate variability to religious beliefs as this can have an effect on responsiveness to climate variability induced hazards.

Table 4.7 Religious beliefs by gender cross-tabulation

		Gender of household head		Total (%)
		Female (%)	Male (%)	
Link climate variability to any religious beliefs	**No**	46.9	47.5	47.3
	Yes	53.1	52.5	52.7
Total		100.0	100.0	100.0

Source: Survey data

The percentage of male-headed households who link climate variability to some religious beliefs is 52.5% while that of female-headed households is 53.1%. These results show that there is not much difference in male-headed households and female-headed households in linking climate variability to any religious belief.

iii. Link climate variability to any religious belief in districts

The percentage of households who link climate variability to some religious beliefs are assumed to be part of an informal network which has active reciprocal links. For households to maintain their religious beliefs, they have to reinforce the informal network either through exchange of information or goods and services. In this study the assumption is that sharing a similar belief means that households belong to the same informal network where they can share information.

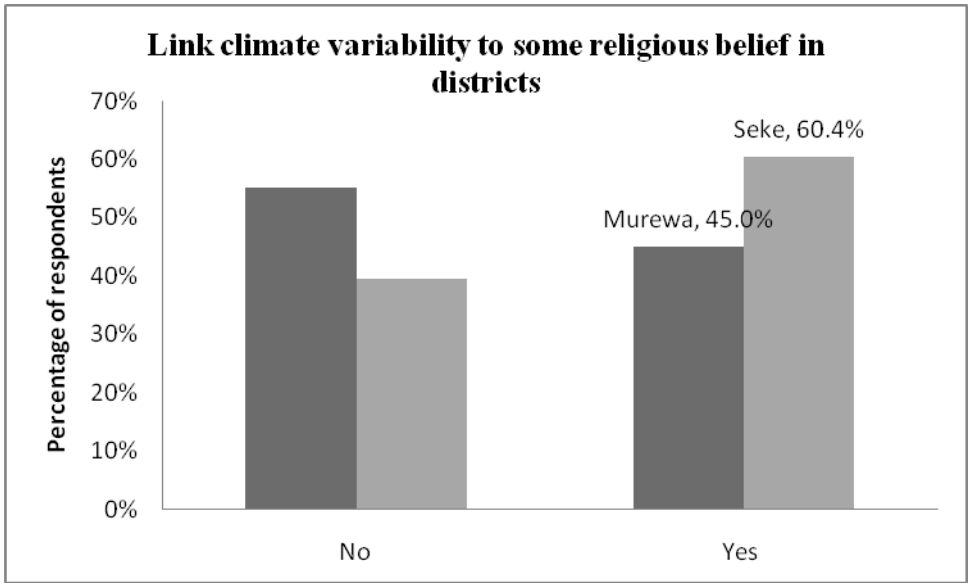

Figure 4.8 Link of climate variability to religious beliefs in districts

Results in figure4.8 above show that 60.4% of households in Seke district link climate variability to religious beliefs compared to 45.0% of household heads who link climate variability to religious beliefs in Murewa district. In Murewa district the percentage of households who link climate variability to some religious belief is lower than the percentage that does not link climate variability to some religious belief. This can be translated to mean that there are more informal networks in Seke district than Murewa district.

4.2 Village characterization

4.21 Changes in farming system

There has been suggestion for farmers to shift to other farming systems as a means of increasing resilience to climate variability induced hazards but this has been met with mixed feelings among farmers. This study is going to evaluate whether there have been significant changes within or across farming systems in Seke and Murewa districts.

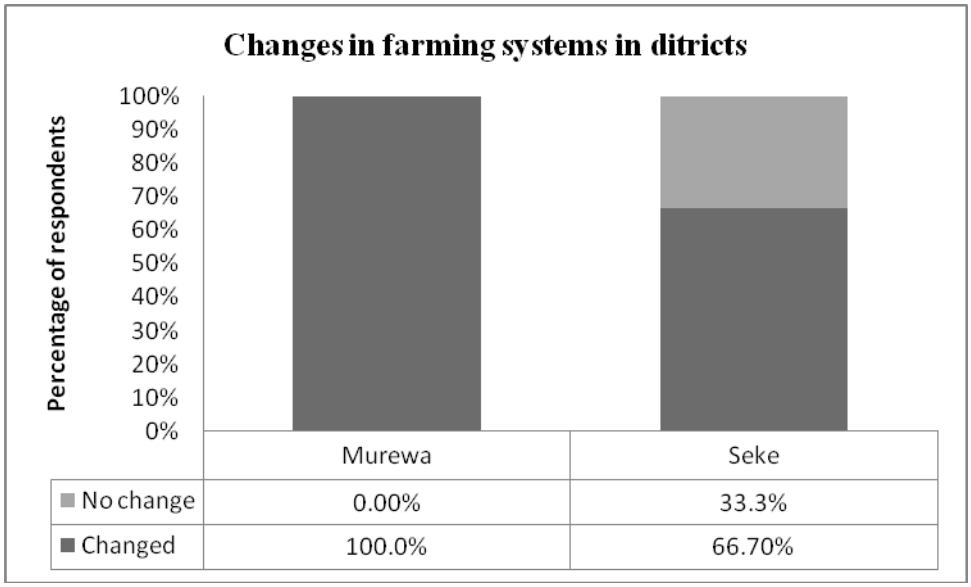

Figure 4.9 Changes in farming systems in districts

The farming system that exists in both districts is mixed livestock and crop production. Drawing from results illustrated in figure 4.9 above, all households in Murewa district had made some changes in the existing farming system. In Seke district, only 66.7% had made some changes in the existing farming system. This can be attributed to several reasons among them being that in Table 4.5 we saw that farmers in Murewa district are dependent on agricultural production as a source of income and thus are more likely to make some adjustments in the existing farming systems to off-set any risk imposed by climate variability induced hazards.

4.2.2 Changes in crop production

When individual farmers are faced with climate variability induced risks, they are likely to prioritize between production and consumption systems that exist. The assumption in this study is that as farmers become more and more exposed to hazards, they are likely to change their crop production habits.

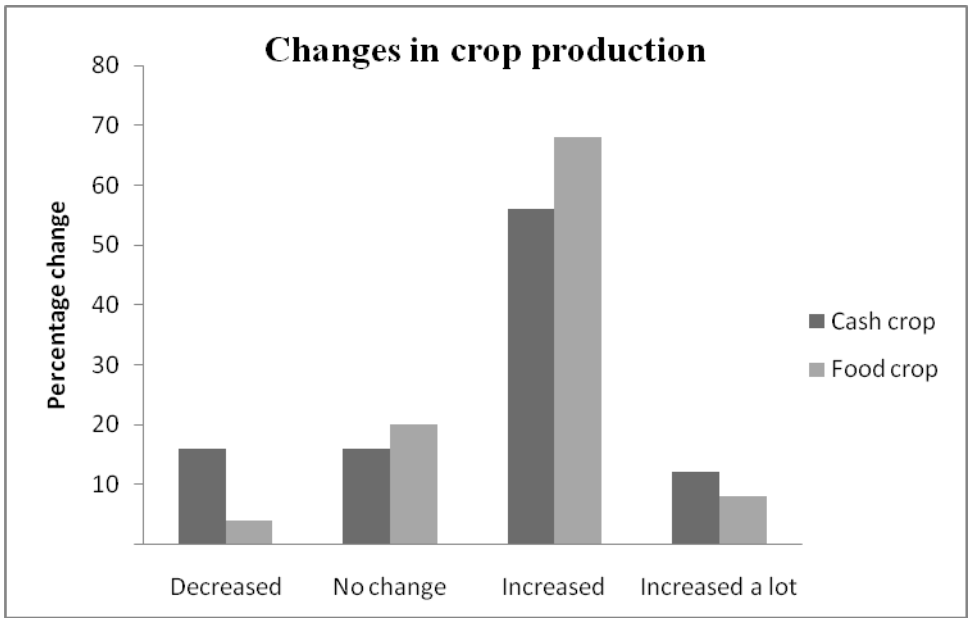

Figure 4.10 Changes in crop production

From figure 4.10, the general trend is that farmers in both districts have increased both cash crop and food crop production. Contrary to expected belief that farmers should diversify into livestock production, more farmers have actually increased crop production and those who have reduced cash crop and food crop production are below 20% for both crops. This can be attributed to the fact that livestock production requires pastures i.e. bigger portions of land but since land is limited farmers are increasing crop production so that they can maintain their income and food source.

4.2.3 Changes in livestock production

Most of the farmers in Seke and Murewa district keep cattle, chickens, goats and sheep. Very few among them keep pigs, guinea fowl, etc. These animals are usually few in numbers and are rarely sold or slaughtered for meat. Cattle are mainly kept for draft power purposes though people go on to use them for other purposes like paying bride-price and for milk.

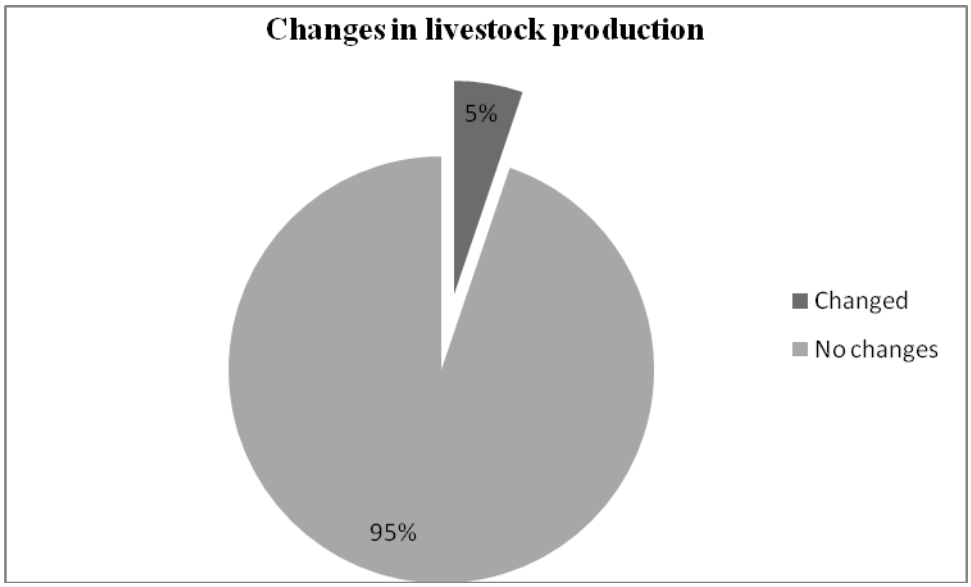

Figure 4.11 Changes in livestock production

The pie chart above shows that very few farmers have made any changes in livestock production. 94.8% of the farmers made no changes in livestock production. These results show that though farmers may perceive increase in drought frequency, they are not likely to make any adjustments in livestock production but are most likely to make adjustment to crop production. These findings can be attributed to farmers' priorities whereby farmers prioritize crop production to animal production because markets for crops are more accessible than markets for livestock.

4.3 Community priorities as distinguished by gender

Variables for opportunities and constraints had to be normalized for easy of comparison. They were normalized ranging between 0 and 1 with zero indicating an unranked risk and one being the total of the weighted indices. Normalization was conducted using the formula:

$$Weighted\ index = \frac{r}{R} \qquad (1)$$

where r is the rank assigned to a variables and R is the sum of all ranks within a group. The results are then presented as averages across specified variables. These averages were computed simply to allow comparison of response of similar ranking exercises across various entities and get a sense of ordinal differences in preferences.

4.3.1 Community vision

Table 4.8 Community vision

Community vision for men	Community vision for women
Irrigation	Food security
Owning farming implements like tractors	Improved boreholes
More income generating projects	More markets
Improved access to markets	Irrigation
Better houses made of brick and cement and have electricity	Own livestock
Food security	Own better farm implements
Have both primary and secondary schools within the village	Modern houses
Improve the existing borehole or drill another borehole	Income generating projects
	Having savings in banks

Source: Survey data

From the summary of community vision in Figure 4.8, the visions for both men and women in either district are mostly agricultural production related. This shows that households in both districts are dependent on agriculture and diversifying into other ventures is limited. However, it is important to note that one of the focus group discussions in Seke district had a vision of better access to ARVs and from the Table 4.8. Men mentioned having a primary school and secondary school in the village as part of their vision. There was also a FGD of women who had a vision of reducing donor syndrome in their village. This shows that besides agricultural production-related visions other issues like health improvement and education are among farmers' priorities.

4.3.2 Opportunities and constraints for the community

The opportunities and constraints listed in Table 4.9 are in order of their importance starting with the most important. The opportunities do not necessarily tally with the constraints, because they are just listed in the order of importance to the communities for both sexes.

Table 4.9 Opportunities and constraints across gender

Men		Women	
Opportunities	**Constraints**	**Opportunities**	**Constraints**
Market gardening	Low output prices	Market gardening	Lack of capital
Cash crop production like Tobacco	No transport to markets	Poultry production	Lack of markets
Land for farming	Lack of loans/ capital	Selling wild fruits	Low output prices
Irrigation pipes	Lack or irrigation	Piggery	Unreliable rainfall
Electricity	Unreliable rainfall	Selling poles	Untimely payments for produce
Fishery	Inputs are very expensive		Labour shortages
	Lack of markets		Poor road network
	Labour shortage		
	Lack of knowledge		
	Draft power shortages		

Source: Survey data

From Table 4.9 above, opportunities that the communities have were few. Farmers are mainly into market gardening and cash crop production but they have no reliable transport to the markets and the road network is poor. This means that far-off markets where their produce can fetch better prices are beyond their reach or if they do reach far-away markets their perishable produce would have gone bad. In addition, farmers mentioned untimely payments for their produce especially untimely payments for maize as a constraint because they need their payments on time to plan for the next season. In one of the FGDs, some farmers mentioned that they already had the irrigation pipes from a previous irrigation project that had collapsed but they indicated that if funds are made available they could resume the project. Another constraint mentioned by men in Murewa ward 1 was soil acidity. This was supported by one of the constraints mentioned by women in that same ward where they mentioned poor soil fertility as a constraint. Another constraint in Murewa ward 16 was crop diseases and wild animals. Women in this same ward mentioned that wild animals were eating their crops and that they did not have a dip-tank.

The results in Table 4.9 show dissimilarities of opportunities and constraints across gender. These results are supported by findings in a study by Legesse and Drake (2005) who also found that smallholder farmers do not face identical constraints and opportunities across gender. They also found out constraints and opportunities are not based on resources that are available. The constraints mentioned by farmers in Seke and Murewa district are similar to findings in a study done by Ishaya and Abaje (2008) in Nigeria where they found out that among the constraints that farmers face is lack of knowledge, lack of capital and lack of water for irrigation.

4.3.3 Agricultural production priorities

In Table 4.10 below, crops and livestock are listed in order of importance to the farmers. The term “The term

Table 4.10 Production priorities across gender

Food crops		Cash crops		Livestock priorities	
Men	**Women**	**Men**	**Women**	**Men**	**Women**
Maize	Maize	Tobacco	*Vegetables	Cattle	Cattle
*Leafy vegetables	*Leafy vegetables	*Vegetables	Tobacco	Goats	**Poultry
Sugar beans	Groundnuts	Maize	Groundnuts	Donkeys	Goats
Sorghum	Sugar beans	Sugar beans	Sweet potato	Chicken	Sheep
Groundnuts	Sorghum	Groundnuts	Sugar beans	Pigs	Rabbits

*Vegetables include leafy vegetables such as rape and covo, tomatoes, onions, carrots and green beans.
**Poultry include chicken, ducks, guinea fowls and turkeys. Source: Survey data

From the food crop priorities for both men and women there is sorghum, a small grain. Small grains are more drought tolerant than maize. This shows that small grains can be promoted in these two districts as farmers are already adopting small grains as a measure against droughts. The cash crop priorities between men and women differ significantly. Women prefer vegetables while men prefer tobacco most. For livestock priorities, women never mentioned donkeys but men did. These differences in priorities show that there is a gender aspect in agricultural production where men and women prefer different crops and different livestock. Results in this research have shown that there are more male-household heads than female-headed households. This means that those crops prioritized by men are most likely to be the ones grown in both districts.

4.4 Perceptions on climate variability induced hazards

Climate variability induced hazards include droughts, floods and tropical storms. Zimbabwe has been prone to climate variability particularly droughts and violent storms. Some parts of Zimbabwe have also been hit by floods but the area under study has been more prone to droughts and violent storms. Thus this study is going to exclude floods and focus on droughts and violent storms only.

4.4.1 Perceptions on frequency of droughts

Droughts can be as a result of below normal rainfall over an extended period of time or when temperatures are higher than normal for a sustained period of time. Either of the two will result in water scarcity. Agriculture is the economic sector that is usually the first to be affected when there is a drought.

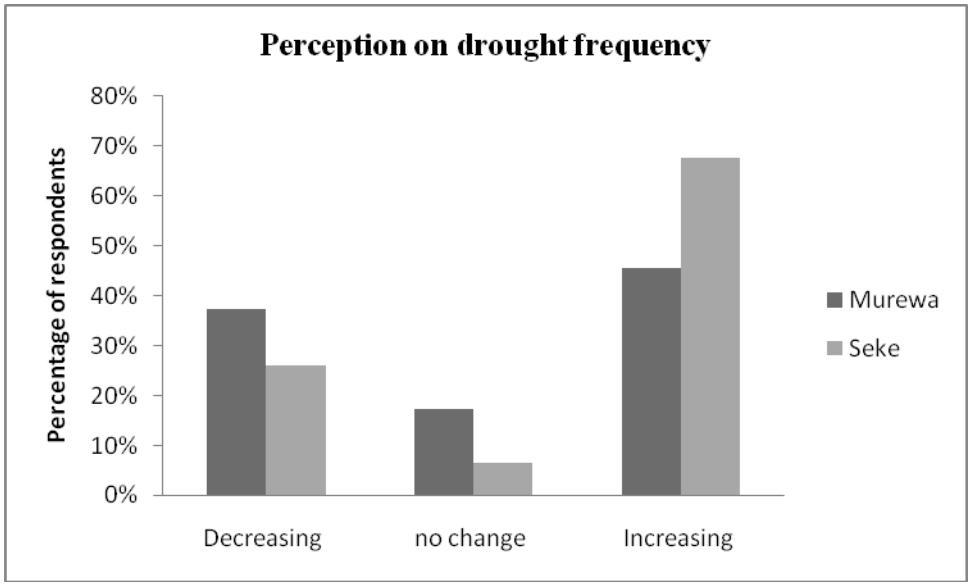

Figure 4.12 Perception on drought frequency

Results in Figure 4.12 above show that most households perceive that the frequency of droughts has increased. This perception is higher in Seke than Murewa district. Among the farmers there

are some who perceived that drought frequency is falling. The percentage of those perceiving a fall in drought frequency is higher in Murewa district than Seke district.

4.4.2 Perceptions on frequency of violent storms

Zimbabwe has been prone to thunderstorm and hailstorms. These are normally accompanied by heavy precipitation and strong winds which damage crops especially tobacco.

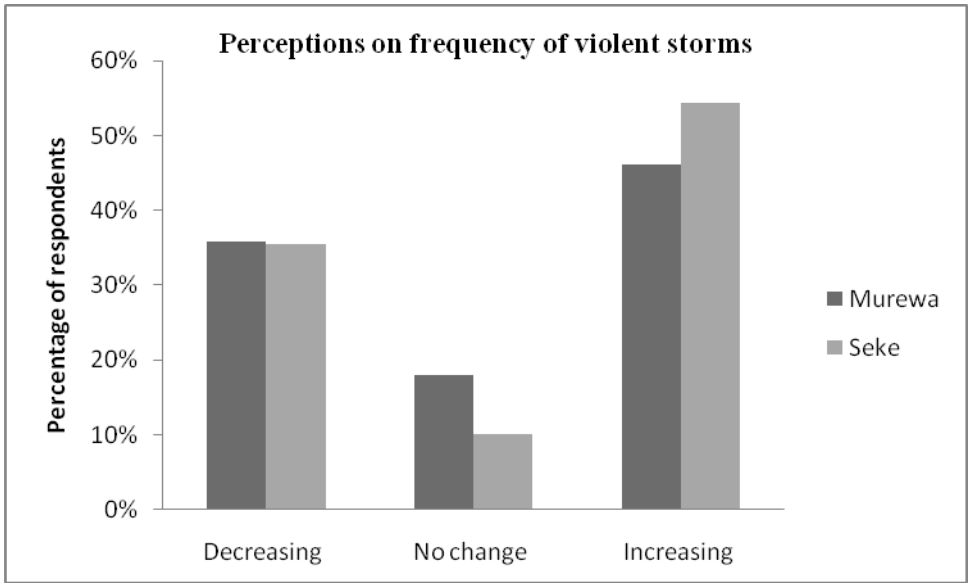

Figure 4.13 Perception on violent storms

Drawing from results in Figure 4.13 above, more famers perceive that frequency of violent storms has increased in both districts. However, the percentage of those who perceive a decrease in frequency of violent storms is just below 40% for both districts. There is need for secondary data from the meteorological data to make solid conclusions on the frequency of violent storms in these districts.

4.5 Test for association between variables

Tests for association were computed between several variables and drought frequency. No tests for association between variables and frequency of violent storms were computed in this section. The justification for this was that the column on frequency of droughts had less missing cases than the column on frequency of violent storms.

i. Summary of results on Pearson chi-square

Table 4.11 below summarizes the Pearson chi-square values for variables that describe household characteristics, socioeconomic characteristics, institutional characteristics and cultural factors. Pearson chi-square values are used to show whether there is some association on the selected variables with perceptions on climate variability.

Table 4.11 Cross-tabulation of variables and perceptions

Variables	Pearson chi-square value
District	0.001***
Gender of household head	0.400
Religion of household head	0.006***
Access to extension services	0.201
Rainfall information from weather station	0.053*
Land tenure	0.005***
Get credit information	0.009***
Get income from selling field crops	0.069*
Get income from livestock sales	0.516
Hiring out labor	0.290
Distance to markets	0.023**
Experienced violent storm	0.084*
Experienced drought	0.160
Experienced floods	0.487
Experienced food shortages	0.01***

*; **; *** Significance at 10%; 5%; 1%respectively Source: Survey data

Results in Table 4.11 above show that the variables district, religion, get rainfall information, land tenure, get credit information, get income from selling field crops, distance to markets, experienced violent storm and experienced food shortages are significantly associated with the way smallholder farmers perceive climate variability. The variables experienced violent storms; sell field crops and get rainfall information are significant at 90% significance level; distance to markets is significant at 95% significance level; and district; religion of household head; type of farming; get credit information and experienced food shortages are significant at 99%. These results show that institutional factors top the list of variables that are closely associated with perceptions.

4.6 T-test

Table 4.12 T-tests of differences in households with different perceptions.

Compared variable	Perception				
	Change (%)	**No change (%)**	**t**	**Sig. (2-tailed)**	**Std. Error Difference**
Proportion within district	43.9	5.7	-2.151	.032**	.084
Proportion who link climate variability to religious beliefs	46.8	5.8	3.056	.003***	.273
Proportion who get rainfall information	54.9	7.5	2.519	.012**	.082
Proportion communal farmers	72.0	12.5	1.664	.097*	.061
Proportion get credit information	74.1	12.6	-3.674	.000***	.057
Proportion sale field crops	45.9	10.1	-1.702	.090*	.083
Distance to markets			-1.342	.181	3.057
Proportion who experienced violent storms	49.7	2.7	-.928	.354	.084
Proportion who experienced any food shortages	78.2	13.9	-3.104	.002***	.045

*; **; *** Significance at 10%; 5%; 1% respectively

Source: Survey data

T-test results from Table 4.12 show that there is no significant difference in perceptions to climate variability due to distance to markets and for households that have experienced violent storms. However, the variables type of farming and those households that sell field crops are significant at 10% level. District is significant at 5% level which shows that the distance from urban areas affects smallholder farmers' perceptions and responsiveness. The variables religion of household head, access to credit information and experiencing food shortages are significant at 1% level. This shows that cultural factors as symbolized by religion and institutional characteristics as symbolized by access to credit information are very significant in shaping smallholder farmers' perceptions and responsiveness to climate variability.

4.7 Summary of findings and discussion

Most of the sampled household heads are between 41years and 70 years of age. The majority of household heads had attended formal school with most of them completing either primary school or secondary school. For policy implications this can mean awareness campaigns to teach people about climate variability induced hazards; new technology or for any other developmental projects can even be done through ICTs as the majority is literate. Despite having high access to extension services in both districts, it is still not clear how much farmers know about responding to climate variability induced hazards. As such it is necessary to undertake capacity building projects for the extension officers so that they can improve the package they are delivering to farmers especially on climate-related issues.

Among the interviewed households, the majority is dependent on agriculture as a source of income and very few get income from non-agriculture related sources. This means that to

increase responsiveness to climate variability induced hazards, creating other sources of income is necessary so that farmers can be flexible between agricultural and non-agricultural income sources. Despite the majority of these farmers having access and knowledge to credit, very few have managed to borrow. Of the few who have managed to borrow, they have borrowed from friends and relatives. This can be attributed to rigid demands in the current credit sector. Thus to improve farmers' level of borrowing it may be necessary to revise some of the rules and regulations that govern the loan society. This will not only cushion farmers financially but will also improve their adaptive capacity to climate variability induced hazards.

The sole farming system existing in both districts is mixed crop and livestock production. The trend among households has been an increase in both cash crop and very little changes in livestock production despite most people perceiving an increase in the frequency of droughts. This can be because farmers are dependent on agriculture as a source of livelihood; they can only increase agricultural production so as to maintain their livelihood. To support this notion, the results show that farmers have made some changes within the existing farming system itself. The policy implication of this is to improve seed varieties, access to irrigation or to promote any other adaptation strategy which is likely to build on the existing foundations.

On top of the list for vision for men is irrigation while on the women's list is food security. The most important opportunity that the farmers have so far is market gardening but they are being constrained by low output prices, lack of capital and unreliable rainfall. However, there is no significant difference in food-crop priorities across gender but there is a significant difference in cash-crop priorities across gender. Livestock priorities for men and women are almost similar.

Though there are some differences in priorities, both sexes are constrained by unreliable rainfall and both have sorghum on the list for food-crop priorities. Even though both sexes mention unreliable rainfall as a constraint, unreliable rainfall is not given top priority. These results are similar to findings in a research by van Aalst *et al.* (2008) who found out that while communities are aware of hazards they face, these hazards do not normally get top priority.

Most of the household heads perceived an increase in the frequency of droughts and an increase in the frequency of violent storms. These findings are supported by Jennings and Magrath (2009) who did a study on smallholder farmers' perceptions in a community in Nepal. Their findings showed that smallholder farmers perceived changes in the timing of seasons, and changes in characteristics within seasons e.g. extreme events such as droughts, floods and destructive hailstorms becoming more common. Perceptions of smallholder farmers are shaped by proximity to major towns or cities, religion, access to weather information and personal experiences like food shortages as evidenced by farmers in Seke and Murewa districts. These findings are further supported by Legesse and Drake (2005) who argue that perception varies with the socioeconomic, cultural, gender, environmental and historical context and to some extent personal experiences of the risks are also important in influencing perception.

CHAPTER 5: MULTIVARIATE ANALYSIS OF FACTORS AFFECTING PERCEPTIONS

5.0 Introduction

The objective of this chapter is to identify socioeconomic factors influencing smallholder farmers' perceptions to climate variability induced hazards. Frequency of drought perception of household head is the dependent variable. Perceptions on frequency of droughts are divided as follows: *0=No change; 1=decreasing; 2=increasing;* and *3= I don't know*. The factors that are used to predict the dependent variables include household demographics such as gender of household head, age of household head, education level of household head, access to weather information among others. The assumption being that though farmers may already have perceived a rise in climate variability induced hazards, it is access to weather information be it from extension officers or ICTs enhances awareness of these hazards. Principal component analysis will be used to identify a set of uncorrelated factors called principal components (PCs). The identified PCs will be used in Multinomial Logit model. MNL will be used to show the effect of household characteristics on farmers' perceptions.

5.1 Principal component analysis for factors affecting perceptions

5.1.1 Test for sampling adequacy

Kaiser-Meyer-Olkin (KMO) measures sampling adequacy and the Bartlett test of sphericity tests for the assumption that the variables are not correlated. PCA requires that the probability associated with Bartlett's test of sphericity be less than the level of significance. In this study, the probability associated with the Bartlett's test[7] is less than 0.001 which satisfies the PCA

[7] Bartlett's test results are in appendix B: annex3

requirement. From the results, KMO measure at 0.642 shows that the data is appropriate for this type of analysis. In this case, principal component analysis can be performed. From the Anti-image matrices[8], the measure of sample adequacy for each variable was greater than 0.5 which also supports that PCA can be performed.

5.1.2 Communalities for the retained components on factors affecting perceptions

Communality refers to the percent of variance in an observed variable that is accounted for by the retained components. A given variable will display a large communality if it loads heavily on at least one of the study's retained components.

Table 5.1 Communalities for the retained components on factors affecting perceptions

Variable	Extraction
District	.635
Gender of Household head	.850
Age of household head	.830
Marital status	.822
Education level of household head	.680
Farming experience	.780
Own a radio	.689
Own a television	.766
Experienced any food shortages	.581

Extraction Method: Principal Component Analysis. Source: Survey data

The results in Table 5.1 show that all the variables have communalities above 0.5. The variable with the highest communality is gender of household head with 0.850 followed by age of household head with 0.830. The variable with the least communality is experienced any food shortages with 0.581. This shows that the retained variables load heavily on the retained components.

[8] Anti-image matrices referred to are attached in the appendix section of this thesis.

5.1.3 Total variance explained by retained components

Total variance explained helps in showing which components to include in factor solution. It also shows the cumulative percentage of loadings on the retained components.

Table 5.2 Total variance explained by the retained components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.697	29.966	29.966	2.697	29.966	29.966	2.108	23.419	23.419
2	1.689	18.762	48.728	1.689	18.762	48.728	1.781	19.788	43.207
3	1.204	13.379	62.107	1.204	13.379	62.107	1.526	16.958	60.165
4	1.042	11.579	73.687	1.042	11.579	73.687	1.217	13.522	73.687
5	.816	9.062	82.748						
6	.528	5.864	88.612						
7	.449	4.992	93.604						
8	.326	3.626	97.230						
9	.249	2.770	100.000						

Extraction Method: Principal Component Analysis.

Source: Survey data

From Table 5.2, only the first four components displayed eigenvalues greater than 1. The first component extracted in a principal component analysis accounts for 23.419% of total variance in the observed variables. The second component extracted accounts for 19.788% of variance in the data set that was not accounted for by the first component. The cumulative percentage of the four components is 73.687% of the total variance. The results suggest that only the first four components were meaningful and thus only the first four components were retained for rotation.

5.1.4 Factor loadings of socioeconomic factors into their respective components

The factor loadings displayed in the component matrix help to show the statistical pattern in the variables. It is used to show which sets of variables in the selected group of variables form coherent subsets that are relatively independent of one another.

Table 5.3 Correlation between variables and extracted components

	Component1	Component2	Component3	Component4
District	-.106	-.006	.116	.781*
Gender of Household head	-.109	.912*	.056	-.045
Age of household head	.907*	-.055	.006	-.064
Marriage status	.157	-.880*	-.148	.008
Education level Household head	-.690*	.376	.242	-.060
Farming experience	.871*	-.063	.097	-.085
Own a radio	.010	.141	.804*	-.150
Own a television	-.033	.059	.866*	.106
Experienced any food shortages	.019	-.043	-.150	.746*

Notes: Source: Survey data

Rotation Method: Varimax with Kaiser Normalization. * is factor loadings.

The components identified are as follows:

Component1: This component is “human capital-related”. It includes age of household head; education level of household head; and farming experience. These variables were put into the same category because they are highly correlated with factor loadings above 0.69. These are the only variables that load heavily into component1.

Component2: This component is “gender-related”. It includes gender of household head and marital status of household head. Gender of household head and marital status are highly correlated and they also load heavily into component2. Their factor loadings are above 0.800.

Component3: This component is related to “access to information”. It includes own a radio and own a television. Own radio and own television were selected into the same category because of high factor loadings which are above 0.800.

Component4: This component is related to “geographical location”. It includes district and experienced food shortages. These two are highly correlated with factor loadings above 0.700.

A standardized regression factor score was created for each of the four components using linear combination of the variables that loaded on each factor. These regression factors were then used in further analysis in the multinomial logit analysis.

5.2 Empirical results for the socioeconomic factors influencing perceptions

5.2.1 Test for reliability using Cronbach’s alpha

Cronbach’s alpha is a measure of internal consistency that is how closely related a set of items are as a group. The assumption is that if variables measure the same thing they should be highly correlated and thus alpha increases. For this reason the coefficient can test the internal consistency and reliability of variables for multinomial logit analysis. A high value of Cronbach’s alpha is used as evidence that the items measure the underlying construct (StataCorp, 2001).The results in Table 5.2.2 below show an alpha value of 0.839. The alpha value is above 0.500; this shows that the underlying variables are closely related. On the basis of this alpha value, the variables can be used in multinomial logit analysis. Though the alpha value is high, Cronbach’s alpha is not a statistical test and thus these interpretations have to be taken with caution (Foster *et al.*, 2006).

5.2.2 The socioeconomic factors influencing perceptions

Table 5.4 Results from multinomial logit analysis

	Reg1:No change		Reg2:Increasing		Reg3:I don't know	
Variable	**Coef.**	**z**	**Coef**	**z**	**Coef**	**z**
Component1	-.059(0.795)	-0.26	.04(0.835)	0.21	.63(0.377)	0.88
Component2	-.056(0.800)	-0.25	.28(0.156)	1.42	.04(0.940)	0.07
Component3	-.42(0.066)*	-1.84	.10(0.613)	0.51	-.41(0.470)	-0.72
Component4	-.44(0.047)**	-1.99	-.51(0.005)*	2.79	.97(0.264)	1.12
Religion	-.36(0.463)	-0.73	-.32(0.407)	-0.83	-2.42(0.065)*	-1.85
Information	1.15(0.050)**	1.96	-.37(0.360)	-0.92	22.14(-)	-
Markets	-.79(0.256)	-1.13	.01(0.106)	1.62	.03(0.078)*	1.76
Extension	-1.76(0.000)***	-3.58	-.04(0.737)	-0.34	-1.78(0.231)	-1.20
Experienced violent storms	-.77(0.101)*	-1.64	-.50(0.193)	-1.30	1.58(0.340)	0.95
_cons	-.60(0.269)	-1.11	-1.09(0.002)	-3.13	-24.99(0.000)	-13.12
LR $chi^2(36)$	79.12					
Prob> chi^2	0.00					
Pseudo R^2	0.18					
Log likelihood	-181.94					
Cronbach's Alpha	0.839					

*; **; *** Significant level 10%; 5%; 1% respectively

Source: Survey data

The model has a pseudo R^2 of 0.1786 which means that only 17.86% of the variation in the dependent variable is due to the variations in the independent variables. Though this value is low Gujarati (2004) noted that in dichotomous dependent variable models, the R^2 as a measure of goodness of fit is of questionable value.

From the results[9] in Table 5.4, there are five variables that significantly influence the perception that there is no change in frequency of droughts. These are Component3; Component4; access to weather information; access to extension and access to credit information. Component3 and credit information are significant at 10% level while Component4 and access to weather information are significant at 5%. Access to extension is highly significant; it is significant at 1% level. Of all the variables that are significant only access to weather information is positively correlated to the "no change" perception; the others are negatively correlated to "no change" perception. Component3 comprises of "access to information" related variables which are own a radio and own television. These results show that access to information is significant in shaping farmers' perceptions thus households who owned either radio or television would perceive change in frequency of droughts. Component4 is made up of district and experienced food shortages. Personal experiences are also very significant in influencing perceptions as is evidenced by Component4. Farmers who had experienced food shortages or experienced storms would perceive that drought frequency has changed. Institutional factors also shape perceptions as is shown by the high significance level of access to extension and access to credit information, farmers who have access to extension and access to credit information perceived changes in frequency of droughts.

From results in Table 5.4 above, only Component4 is significant at influencing the perception drought frequency is increasing. This variable is significant at 1% level. Component4 is positively correlated to the "increasing" perception. This shows that farmers who had experienced food shortages were not likely to perceive that drought frequency had decreased.

[9] Rainfall perception==decreasing is the base outcome

They were most likely to perceive that drought frequency is increasing. Geographical location as symbolized by district also influences perception. Geographical location is linked to farmers' experiences so farmers in the same area would have similar experiences and would perceive the changes in rainfall amounts.

From results in Table 5.4 above, it can be noted that only religion and distance to markets are significant. Both are significant at 10% level. Religion is negatively correlated but markets are positively correlated. This shows that households who link climate variability induced hazards to some religious belief are likely to know about changes in droughts frequency. Those who link climate variability to some religious belief were not likely to say, "I don't know" anything about drought frequency. Distance to markets is positively correlated with the "I don't know" perception because distance can hinder market participation. However, markets are also a crucial source of up-to-date information thus those who are far away from markets are likely not to get current climate information updates.

5.3 Summary of findings and discussion

At the beginning of this chapter in Table 5.1, several variables had been defined as independent variables for analysis but only part of them were retained in the final solution after multinomial logit analysis. This is because gaining a satisfactory solution is an iterative process which requires repeating the procedure a number of times to get a meaningful solution. In the end fewer variables will be remaining after removing variables that make little contribution to the results.

The findings from the analysis in this chapter show that PCA and multinomial logit regression model were appropriate for this kind of analysis. PCA was tested using Kaiser-Meyer-Olkin measure of sampling adequacy. From the principal component analysis, only four principal components were extracted. These were Component1: Human capital-related; Component2: Gender-related; Component3: Access to information and Component4: Geographical location and farmer experiences. From the multinomial regression results only Component3; Component4; access to weather information; access to extension; access to credit information; religion and distance to markets were found to be significant. This shows that those farmers who own radio or television have access to information and would perceive a change in drought frequency. Previous research done by Mano and Nhemachena (2007) in Zimbabwe also supports this notion that access to weather information is critical in shaping farmers' perceptions. Farmers who had previously experienced food shortages would also perceive changes in drought frequency. The reason why those who had experienced food shortages perceive that drought frequency had increased could be because farmers normally associate changes in weather conditions with crop productivity. Whenever they have crop failure they associate it with poor rains/drought. The human capital-related characteristics were not significant and thus do not significantly influence farmers' perceptions.

The interpretation of the findings is inconsistent with previous research on perceptions conducted by Legesse and Drake (2005) in Ethiopia. They found out that the main determinants of perceptions of sources of risk are gender, human capital (represented by family size, education level, and experience), access to information, and religion/ethnic origin among others. From findings in this study, the main determinants are neither gender-related nor human capital

related. Findings are more related to access to information, religion and farmers' direct personal experiences like experiencing storm or food shortages. However, findings in this study show that perceptions are influenced by local setting i.e. risk is spatially bound which is supported by findings in Legesse and Drake (2005).

CHAPTER 6: MULTIVARIATE ANALYSIS OF FACTORS AFFECTING RESPONSIVENESS

6.0 Introduction

The main objective of this chapter is to determine the influence of socioeconomic factors and perceptions on responsiveness to climate variability induced hazards. To meet the objective, the study employs the logit model with the dependent variable taking two categories; *1=adaptation* and *0= no-adaptation*. The two categories show the level of responsiveness where the adaptation strategies that farmers have adopted are used to show how responsive farmers can be given their socioeconomic characteristics, available resources, perceptions and geographical location. The independent variables will be identified through use of Principal Component Analysis. The identified PCs will be used in logit model. Relevant tests of association are used in the analyses to infer the existence and degree of association between socioeconomic characteristics, farmers' perceptions and responsiveness. Socioeconomic factors such as household characteristics, livestock endowment, draft ownership, land size, access to credit were incorporated into this analysis to aid explaining the relationships that exist between these socioeconomic factors and perceptions to responsiveness.

6.1 Principal component analysis for factors affecting responsiveness

6.11 Test for sampling adequacy

Kaiser-Meyer-Olkin measure of sampling adequacy tests whether the partial correlations among variables are small. Bartlett's test of sphericity tests whether the correlations matrix is an identity matrix, which would indicate that the factor model is inappropriate (Foster *et al.*, 2006). From results in appendix B: annex5, Bartlett test shows significant differences in the variables and KMO measure at 0.662 shows that the data is appropriate for this type of analysis. From the

Anti-image matrices[10], the measure of sample adequacy for each retained variable was greater than 0.5. In this case, principal component analysis can be performed.

6.1.2 Communalities for the retained components on factors affecting responsiveness

Table 6.1 Communalities for the retained components on factors affecting responsiveness

	Extraction
Age of household head	.803
Education level Household head	.740
Highest education level in family	.710
Household size	.791
Farming experience	.713
Total land	.753
Draft power	.706

Extraction Method: Principal Component Analysis. Source: Survey data

The results in Table 6.1 above show that all the variables have communalities above 0.5. The variable with the highest communality is age of household head with 0.803 followed by household size which has 0.791. The variable with the least extraction is farming experience which has 0.713. This shows that the retained components account for much of the variance in the observed variables.

6.1.3 Total variance explained by the retained components

Table 6.2 Total variance explained by the retained components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.432	34.746	34.746	2.432	34.746	34.746	2.290	32.712	32.712
2	1.717	24.530	59.275	1.717	24.530	59.275	1.679	23.992	56.705
3	1.066	15.227	74.503	1.066	15.227	74.503	1.246	17.798	74.503
4	.609	8.701	83.203						

[10] Anti-image matrices referred to are attached in the appendix section of this thesis.

5	.483	6.900	90.103		
6	.425	6.075	96.178		
7	.268	3.822	100.000		

Extraction Method: Principal Component Analysis. Source: Survey data

Table 6.2 above revealed the presence of three components with eigenvalues greater than 1. From the rotation sums of squared loadings in the table above, component1 accounts for 32.712% of the total variance; component2 accounts for 23.992% of the total variance and component3 accounts for 17.798%. Thus three components were retained for rotation and the three components cumulatively explain 74.503% of the total variance in the observed variables.

6.1.4 Component matrix

This is used to identify sets of inter-related variables which will help in explaining any underlying dimensions and in the process reduce the number of variables.

Table 6.3 Factor loadings of variables on the components

	Component		
	1	2	3
Age of household head	.853*	.249	.115
Education level Household head	-.818*	.181	.198
Highest education level in family	-.374	.314	.687*
Household size	.317	-.098	.826*
Farming experience	.786*	.247	.186
Total land area	.007	.865*	.068
Draft power	.192	.817*	.032

Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 5 iterations. Source: Survey data

Table 6.3 above shows that the components identified are as follows:

Component1: This component is related to “characteristics of household head”. It includes age of household head; education level of household head; and farming experience. These variables were categorized into one group because they are highly correlated with factor loadings above 0.700. These two variables load heavily into component1.

Component2: This component is related to “productive assets”. It includes total land owned by a household and draft power (number of cattle owned). Total land owned and draft power load heavily into component2 with factor loadings above 0.800.

Component3: This component is related to “human capital”. It includes highest education level in the family and household size. Highest education level in the family and household size were categorized into one group because of high factor loadings on component3 which are above 0.600.

A standardized regression factor score was created for each of the three components using linear combination of the variables that loaded on each factor. These regression factors were then used in further analysis i.e. logistic analysis.

6.2 Empirical results for the factors influencing responsiveness

The dependent variable was regressed against 17 independent (socio-economic and household) variables namely: component1; component2; component3; perceptions; gender and religion of the household head; marital status; land tenure; distance to markets; distance to livestock water source; irrigation; farming experience; irrigation use; access to weather information; own television; access to credit and extension. However some of the variables were dropped during the analysis due to multicollinearity. The results are presented in table 6.4.

6.2.1 The Logistic regression analysis

Table 6.4 Results for logit regression model

Variable	Odds Ratio	Std. Err.	z	P>z
Perception	.519	.272	-1.25	0.210
Component1	189.982	520.393	1.92	0.055*
Component2	1.19e+07	8.59e+07	2.25	0.024**
Component3	4.898	5.312	1.46	0.143
Gender	.532	1.085	-0.31	0.757
Religion	1.061	.035	1.80	0.073*
Marital status	.0182	.038	-1.90	0.057*
Own television	18.076	38.998	1.34	0.180
Extension	.065	.188	-0.95	0.344
Livestock water source	.999	.0186	-0.04	0.969
Credit	3.796	7.285	0.70	0.487
LR $chi^2(11)$	31.95			
Prob> chi^2	0.0008			
Log likelihood	-9.230			
Pseudo R^2	0.634			
Hosmer-Lemeshow chi^2 (8)	0.005			

*; ** Significant at 10%; 5% Source: Survey data

From results in Table 6.4, only Component2 significantly influences responsiveness at 5% significant level. Component2 is productive assets which comprises of total land owned and cattle for draft power. This shows that an increase in productive assets will directly increase the

responsiveness of smallholder farmers. The results also show that principal component1; religion and marital status are significant at 10% significance level. Marital status is however negatively correlated to responsiveness. This means that single, widowed and divorced household heads are more responsive than married household heads. This can be because decision making can be made slow if there are a lot of people to consult, but for those who are single, widowed or divorced decision making is much faster which significantly improves responsiveness. Component1 comprises of age of household head; education level of household head and faming experience. This means that increase in age of household head; education level of household head and faming experience will result in an increase in responsiveness to climate variability induced hazards. Although farmers who are older, more experienced and more educated are likely to be more responsive, it is better access to information that will help them in taking effective and efficient measures.

Component3 is not significant which shows that having highly educated household members and large household sizes does not translate to responsiveness. This can be because the household head is the one with the final say for all issues concerning the household. Findings on household size are supported by Polson and Spencer (1991) who found that family size above the mean rural family size was not significant in the adoption of new cassava variety. They argued that because subsistence households are resource poor , larger family size may (in real terms) not contribute significantly in increasing the resource pool of the farm family.

Perceptions are also not significant; this can be because all the interviewed households were aware of climate variability and change despite the differences on household characteristics and

socioeconomic characteristics. Given such a scenario then it is no longer perceptions at play but other factors which are now contributing to responsiveness or no-responsiveness. Access to extension and gender are also not significant in influencing responsiveness. This can be because in both districts access to extension is high and both sexes have equal access to extension. Besides marital status, perceptions, gender of household head, access to extension and distance to water source are also negatively correlated to adaptation.

An odds ratio that is greater than one implies that a unit increase in the continuous variable or discrete change in the categorical variable in the regression leads to a decrease in the odds of a household being an adapter versus being a non-adapter. The odds ratio shows the strength of association between a predictor and the response of interest. Component1 has an odds ratio of 189.982. Contrary to findings from a research by Maddison (2006), farmers in Seke and Murewa district tend to be less responsive as they grow older, get more educated and get more farming experience. Findings by Maddison (2006) showed that educated farmers are more likely to respond by making at least one adaptation. Componet2 which is productive assets has an odds ratio of 1.19e+07 which shows that a unit increase in productive assets will result in an increase in responsiveness. Marital status has an odds ratio of 0.0182 which shows that a unit increase in household heads being monogamously married will result in increase in responsiveness.

The model has a chi-square value of 31.95 and was significant at 99%. This means that none of the log ratio of the independent variables was linearly related to the log odds of the dependent variable. The model has a pseudo R^2 of 0.634 which means that 63.4% of the variation in the dependent variable is due to the variations in the independent variables. Log likelihood is a

badness of fit indicator; large numbers mean poor fit of the model to the data. Log likelihood from results in the table is -9.230 which is a small number and suits well with the requirement.

The Hosmer-Lemeshow goodness of fit test helps to determine whether the model adequately describes the data. The Hosmer-Lemeshow goodness-of-fit test statistic in Table 6.3.1 above is not significant; this shows that there is a linear relationship between the predictor variables and the log-odds of the criterion variable. Thus we accept the null hypothesis that household characteristics and perceptions have an influence on responsiveness to climate variability induced hazards. The p-value for the Hosmer-Lemeshow goodness-of-fit test is 0.9997 which shows that the model fits well with the data.

6.3 Summary of findings and discussion

The findings from the analysis in this chapter show that PCA and Logit regression model were appropriate for this kind of analysis. These were tested using Kaiser-Meyer-Olkin measure of sampling adequacy and Hosmer-Lemeshow test of goodness-of-fit respectively. From the principal component analysis, only three principal components were extracted. These were Component1: Household head characteristics; Component2: Productive assets and Component3: Human capital. From the logistic regression model only Component1; Component2; religion and marital status were found to be significant. This shows that an increase in productive assets can significantly increase smallholder farmers' responsiveness. Though marital status was found to be negatively correlated to responsiveness, it was significant at 10% significance level. The characteristics of household head symbolized by Component1 were also significant and positively correlated to responsiveness. Thus the more the household head is educated, the more

the farming experience and the older the farmer is the more responsive the household is. Any farmer education is thus necessary as it significantly improves responsiveness to climate variability induced hazards.

Component3, perceptions, gender, own television and extension do not significantly influence responsiveness. Component3 is made up of highest education level in the family and household size. Owning a radio or television is insignificant for smallholder farmers because normally information spreads through their social networks. Land tenure was dropped due to multicollinearity but land tenure has been noted as one of the factors that affect responsiveness. Shuch *et al.* (2002) as cited in Maddison (2006) found out that land tenure issues may limit the effectiveness of extension education in Cameroon. This might be the explanation why access to extension is not significant in this study. Maddison (2006) also found that level of education is significant but gender is not significant which further supports findings in this study.

From the odds ratio in Table 6.4, farmers in Seke and Murewa district tend to be less responsive as they grow older, get more educated and get more farming experience. The odds ratio has also shown that a unit increase in productive assets will result in an increase in responsiveness. The odds ratio for marital status shows that one unit increase in household heads being monogamously married will result in increase in responsiveness.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.0 Introduction

Natural hazards present considerable challenges to smallholder farmers. The hazards affect a wide range of social and ecological system which impact negatively on poverty reduction prospects. This calls for a multi-hazard approach where disaster risk reduction, environmental management, climate change and variability adaptation and poverty reduction are merged (van Aalst *et al.*, 2008). There has not been much loss of life due to hazards in Zimbabwe but the impacts these natural hazards have on livelihoods is considerable. Impacts of climate variability induced hazards have occurred simultaneously with environmental and socio-economic processes causing detrimental effects on livelihoods of smallholder farmers in Zimbabwe.

This chapter provides the conclusion of the study where policy recommendations on enhancing adaptive capacity of smallholder farmers are going to be given based on research findings. The first section gives summary of results of the whole study and the conclusions. This first section gives a link between objectives outlined in the Chapter1 to findings from the three analytical chapters. The second section is dedicated to recommendations. The last section gives areas for further study so as to add to the existing information on how to encourage participatory local adaptation to climate variability induced hazards that is focused on people's vulnerability, livelihoods, coping and adaptive capacity.

7.1 Summary of results and conclusions

The first specific objective was to identify characteristics of households with similar perceptions to climate variability induced hazards with the hypothesis that households with different

characteristics have different perceptions. Despite the majority of these farmers having access to credit, very few have managed to borrow. Of the few who have managed to borrow, they have borrowed from friends and relatives. The sole farming system existing in both districts is mixed crop and livestock production. Most households in both districts perceived an increase in frequency of droughts and violent storms. The trend among households has been an increase in both cash crop and livestock production despite most people perceiving an increase in the frequency of droughts. Proximity to major towns or cities using the proxy of district, religion, access to weather information and personal experiences like food shortages are the characteristics that shape perceptions in Seke and Murewa districts. The conclusion is that, households with varying degrees of access to weather information, proximity to urban areas, belong to different religions and have different personal experiences would have different perceptions to climate variability induced hazards.

The specific objective2 was to identify socioeconomic factors influencing smallholder farmers' perceptions to climate variability induced hazards. Empirical results from the multinomial regression analysis show that only access to information, geographical location, farmer experienced food shortages, access to weather information, access to extension, access to credit information, religion and distance to markets affect perceptions. The human capital-related and gender-related characteristics were not significant and thus have insignificant influence on farmers' perceptions. The conclusion is that socioeconomic factors have significant influence on perceptions and perceptions are highly influenced by local setting i.e. risk is spatially bound.

The third specific objective was to determine the influence of socioeconomic factors and perceptions to responsiveness to climate variability induced hazards. From the logistic regression model only household head characteristics, productive assets, religion and marital status were found to be significant but marital status was found to be negatively correlated to responsiveness. Highest education level in the family and household size, perceptions, gender, own television, and extension do not significantly influence responsiveness. The odds ratios have also shown that a unit increase in productive assets will result in an increase in responsiveness. Findings show that household characteristics have an influence on responsiveness to climate variability induced hazards but perceptions do not influence responsiveness.

The overall conclusion is that differential access to markets and credit is very crucial to improve farmers' responsiveness to climate variability induced hazards and when these become inaccessible to households, they become more vulnerable as they fail to make the necessary adjustments to the risk posed by climate variability induced hazards.

7.2 Recommendations

The following are the recommendations made from this study:

- Heterogeneity in household characteristics has been found to result in different perceptions but it has also been found that perceptions have no significant influence on responsiveness. Therefore, policy makers should focus on improving household characteristics so as to improve responsiveness.

- Though household characteristics have been found to significantly influence responsiveness; factors like age and gender of the population of farmers are completely beyond the control

of policy makers. Policy makers should therefore focus at enhancing those household characteristics which they can improve e.g. farmer education and access to information when devising packages that are tailored to the perceived and actual needs of farmers.

- Constraints being faced by both men and women have been found to significantly influence responsiveness to climate variability induced hazards. Policy makers should aim at improving rural infrastructure so that farmers can access better markets with better prices inputs and credit among others; this will in-turn improve adaptive capacity.

- Farmers in both Seke and Murewa are highly dependent on agriculture as a source of income however with more frequent droughts they are likely to realize less income. The recommendation is that these farmers should adopt more drought tolerant crops, drought resistant crops and livestock breeds or short season varieties so that they can maintain their income source. Another option is to depend on non-agricultural income sources.

7.3 Areas for further research

The following are proposals for further research:

- This study focused on two districts both in natural region II, there is need to carry out this study in other natural regions especially IV and V to assess the levels of responsiveness and adaptation to climate variability.

- The issue of non-separability of production and consumption decisions for smallholder farmers might be influencing responsiveness. A study to show the extent to which

responsiveness is affected by production and consumption decisions of smallholder farmers is necessary.

- Results from this study showed that direct personal experiences have an influence on both perceptions and responsiveness but it would add more to literature if a study is done to find out the extent to which these personal experiences influence perceptions and responsiveness. A trend analysis can also be done to show changes in personal experiences and the respective responses to climate variability induced hazards for each season for several years.

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APPENDICES

APPENDIX A

Annex1: Household questionnaire

HOUSEHOLD QUESTIONAIRE ON FACTORS AFFECTING SMALLHOLDER FARMERS' PERCEPTIONS AND RESPONSIVENESS TO CLIMATE VARIABILITY INDUCED HAZARDS.

Collaborative Master's degree in Agriculture and Applied Economics (CMAAE)
University of Zimbabwe

SECTION A: IDENTIFYING INFORMATION

(a) Questionnaire ID_____ (b) Date of interview_____

1. Name of enumerator	
2. District	
3. Ward	
4. Village	
5. Name of household head	
6. Name of respondent	
7. Is respondent the household head *(yes=1 and no=0)*	
8. Relationship of respondent to household head *1=wife 2=husband 3= Adult son 4=Adult daughter 5=Other (please specify)*	

SECTION B: HOUSEHOLD DEMOGRAPHIC INFORMATION

Household characteristic	**Response**	**codes**
1. Gender of household head		*1=Male 0=female*
2. Age of Household Head		Years
3. Head Marital status		*1=Single 2=Monogamously married 3=Polygamously married 4=Widowed 5=Divorced/ Separated 6=Other (Specify)_____*
4. Spouse's age		Years
5. If married to more than one spouse, Age of spouse 2		Years
6. 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*
7. Highest level of education in household		

8. Household size		
9. Number of years household has been farming		
10. What religion does the head of the household practice?		*1. Nonreligious; 2: Islam; 3:Christianity; 4; African Traditional Religion.*
11. Does household head link climate change to this religion?		*1=Yes 0=No*
12. Do you hold any position of authority in your area?		*1=Yes 0=No*
13. If yes in 11 above, please state your position.		
14. Does anyone who stays at this compound own a radio?		*1=Yes 0=No*
15. Does anyone who stays at this compound own a television?		*1=Yes 0=No*
16. Do you have access to extension?		*1=Yes 0=No*
17. Do you get rainfall forecasting information from weather stations?		*1=Yes 0=No*

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

Livelihood activities			
1. Type of farming		*1=communal subsistence 2=commercial 3=other (specify)_____*	
2. No. of years household has been farming.			
3. Area under/was under cultivation 2010-11 season			
4. Total land area owned			
5. Did you borrow from any of the following sources for farming in the last 2 years?		*1.Relatives/Friends 2.Farmer associations/ co-operatives 3.Commercial banks 4.Thrift and loan Society*	
6. Do you get income from agricultural activities?		*1=Yes 0=No*	
7. If yes in (6), 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 amount of produce) 2=Strong market participation (sell*	c. Annual Income (US$) *(Approximate)*

		a large amount) *3=Other_____*	
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 labor			
iv. Other……			
8. Do you get income from the following non-agricultural activities	*a. 1=Yes 0=No*	*b.* Please rank *(1=most important)*	*c.* Annual Income (US$) *(Approximate)*
i. Business			
ii. Technical activities e.g. brick molding; building; carpentry			
iii. Hiring out non-agricultural labor within the community			
iv. Hiring out non-agricultural labor outside the community e.g. nearest business centre/ town			
9. How far is it to the nearest market _____(km)			

Asset ownership

Do you own the following assets	**No. owned**
1. Chicken	
2. Goats	
3. Draft cattle	
4. Scotch-cart	
5. Wheel barrow	
6. Water pump	
7. Ox-drawn plough	
8. Bicycle	
9. Car	

Access to water

Variable	**Response**	**Codes**
1. Do you use irrigation in your farming activities?		*1=Yes 0=No*
2. If yes in (1) what is the size of the irrigated land?		*Please specify (hectares or acres)*
3. What is the main source of water for		*1= Piped water; 2=Borehole; 3=Protected well; 4=Unprotected well; 5=River; 6=Other (Specify)*
i. Household use (Drinking and		

cooking)?		
ii. Livestock?		
4. What is the distance from home to your water source?		
i. Household use (Drinking and cooking)?		*Km*
ii. Livestock?		*Km*
5. Have you experienced any water shortages	a) In the last 5 years *1=Yes 0=No*	b) If yes in (a), Please indicate the severity of the water shortages *1=Not severe 2=Severe 3=Very Severe*
i. Household use (Drinking and cooking)?		
ii. Livestock?		
iii. Crops		

SECTION C: CLIMATE VARIABILITY PERCEPTIONS AND RESPONSIVENESS

	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 7)		*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* *4=Late rains for a slightly longer period* *5=late rains for a shorter period* *6=Other_____*
c. Prioritize the adjustments you have made in response to a shift in rainfall.	*1=Yes 0=No*	*Please rank starting with the most important*
i. Choice of planting dates		
ii. Choice of crop varieties		
iii. Choice of land preparation method		
iv. How much fertilizer and other inputs to add		
v. Area to plant		
vi. Harvesting time		
vii. Marketing decisions e.g. how much to sell and what to store (food crops)		
4. What mostly influences your farming decisions?		*1= output price expectations 2= crop rotations 3= climate information 4= input costs 5= soil tests 6= other*
5. From your own experience, are the temperatures changing? (Are the winters		*1=Yes 0=No*

as cold or summers as hot as they used to be)		
6. If yes in 5, how are temperatures changing?		
a. Winter temperatures		*1=colder 2=warmer*
b. Summer temperatures		*1=colder 2=warmer*
7. Have you ever experienced any drought?		*1=Yes 0=No*
8. If yes in 7, 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*
9. If yes in 7, how many times in the last ten years have you experienced a drought?		
10. If yes in 7, Is the frequency of droughts increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
11. Have you ever experienced any flooding?		*1=Yes 0=No*
12. If yes in 11, 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*
13. If yes in 11, how many times in the last ten years have you experienced some flooding?		
14. If yes in 11, Is the frequency of flooding increasing or decreasing?		*1=increasing 2=no change 3=decreasing*
15. Have you experienced any violent storms?		*1=Yes 0=No*
16. If Yes in 15, when did you first experience 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*
17. If yes in15, how many times in the last ten years have you experienced some violent storms?		
18. If yes in15, is the frequency of violent storms increasing or decreasing?		*1=increasing 2=not changing 3=decreasing*

SECTION D:FOOD AVAILABILITY

1) Have you experienced any food shortages in the last ten years?		*1=Yes 0=No*
2) If yes in 1), how many years in the last ten years?		

3) How severe were the food shortages?		*1=not severe 2=severe 3=very severe*
4) Did you use any of the following to overcome the food shortages?	*Please tick*	*Please rank them starting with the most important/ used*
a. Bought from the market		
b. Food and/or money send by relatives		
c. Government support		
d. NGOs support		
e. Food for work		
f. Changed to other local available edible foods		
g. Reduced the amount of food eaten		
h. Hired out labor for food		
i. Sold assets/ livestock		
j.		
k.		

ANY FURTHER COMMENTS

_____

_____

_____

_____

THANK YOU FOR YOUR TIME

Annex2: Focus Group Discussions

FOCUS GROUP DISCUSSIONS QUESTIONAIRE ON FACTORS AFFECTING SMALLHOLDER FARMERS' PERCEPTIONS AND RESPONSIVENESS TO CLIMATE VARIABILITY INDUCED HAZARDS.

Collaborative Master's degree in Agriculture and Applied Economics (CMAAE)
University of Zimbabwe

Identification information

Name of Village_____ Name of Ward_____

Name of District_____ Name of province_____

1. **What is the main farming system?_____Codes:** *1=mixed cropping 2= livestock production 3= mixed crop-livestock production*

2. **Have there been changes in farming systems; types of food and cash crop since 2008?**

a) Farming system	
b) Cash crops	
c) Food crops	

Codes: *1= yes 2=No*

3. **If yes; please report below the changes**

a) Farming system	
b) Cash crops	
c) Food crops	

Codes:-*2= decreased a lot -1=decreased 0=no change 1=increased 2= increased a lot*

4. **What is the main land tenure system? _____ Codes**: *1=State owned 2= individually owned with title 3= Communal/ village owned*

5. **Access to markets**

a) Does the community have markets within the village?	
b) Number of markets within the village	
c) Number of markets within 50km radius	
d) In no market within the village, how far is the nearest output market?	
e) In no market within the village, how far is the nearest input market?	
f) Who controls these markets	
g) People's **perceptions** of changes in the markets	

CODES

Access and control: *1= both men and women, 2= men only, 3= women only, 4= other*

Perception of change*: 1= declined, 2= no change, 3= improved*

Resource Mapping

The resource mapping is important as it provides the resources/ infrastructure in the community and shows who has access to those resources.

Resources	a. Does the village have?*1=yes 2=No*	b. Indicate **number** if necessary	c. Who has **access**	d. Who **controls** those resources	e. People's **perceptions** of changes in the resource
1.Pastures/Grazing land					
2.Wetlands/Springs					
3.River/ stream					
4.Borehole					
5.Village woodlots					
6.Roads					
7.Health facility/clinic					
8. School					
9. Churches					

CODES

Access and control: *1= both men and women, 2= men only, 3= women only, 4= other*

Perception of change*: 1= declined, 2= no change, 3= improved*

Community livelihood strategies; constraints and opportunities

1) **What is the community vision?**

Community vision for men	**Community vision for women**

2) **What are the resources that are available within your community?** ***Please list below.***

_____
_____
_____
_____

3) **What are the opportunities and constraints for men?**

Opportunities	**Constraints**

4) **What are the opportunities and constraints for women?**

Opportunities	**Constraints**

Crop Information

1) **Priority crops for food security.** ***Please list starting with the most important***

Men priority/ preference	**Women priority/ preference**

2) **Priority crops for income.** ***Please list starting with the most important***

Men priority/ preference	**Women priority/ preference**

Livestock Information

1) **Livestock priority/ preference.** ***Please list starting with the most important***

Men priority/ preference	**Women priority/ preference**

Farmers perception of various factors limiting agricultural production

FACTOR	**RANK (In order of importance)**	**COMMENTS**
Lack of information on weather		
High input prices		
Low output prices		
Inadequate rainfall		
Poor access to farming inputs e.g. fertilizers		
Poor access to markets to sell harvest		
Lack of labor		
Lack of draught power		

Perception of importance of climate variability and droughts awareness

1. Is it important for people to know about climate change?

Number saying YES	Number saying NO	Number with no decision	TOTAL

2. Reason/s for the answer in 1 above?

---

3. If the answer in 1 above is Yes, what can be done to increase people's awareness of climate change?

---

4. How can the effects of droughts be reduced?

---

5. Are there any initiatives that you are undertaking to reduce the effects of droughts?

THANK YOU FOR YOUR TIME

APPENDIX B

Annex1: Rainfall Characteristics in the Five Natural Regions of Zimbabwe

Natural Region	**Area (km^2)**	**% of total land area**	**Rainfall Characteristics**	**Type of farming**
I	7 000	2	More than 1, 050 mm rainfall per year, with some rain in all months	Specialized and diversified farming region
II	58 600	15	700-1,050 mm rainfall confined to summer	IIA Intensive farming region; IIB Intensive farming region
III	72 900	18	500 – 700 mm rainfall per year, subject to seasonal droughts	Semi-Intensive farming region
IV	147 800	38	450 – 600 mm rainfall per year, subject to frequent seasonal droughts	Extensive farming region
V	104 400	27	Normally less than 500 mm per year, very erratic and unreliable. Northern lowveld may have more rain but topography and soils are poorer	Extensive farming region
TOTAL	390 700	100		

Source: Rukuni and Eicher (1994)

Annex2: KMO and Bartlett's Test for factors affecting perceptions

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.642
Bartlett's Test of Sphericity	Approx. Chi-Square	689.375
	df	36
	Sig.	.000

Annex3: Anti-image Matrices for factors affecting perceptions

		District	Household head gender	Age of household head	Marital status	Education level household head	Farming experience	Own radio	Own television	Experienced any food shortages
Anti-image Covariance	District	.916	.017	-.014	.007	-.006	.077	.087	-.131	-.169
	Household head gender	.017	.502	-.065	.308	-.108	.040	-.033	.046	.011
	Age of household head	-.014	-.065	.420	-.033	.189	-.269	.050	-.062	.091
	Marital status	.007	.308	-.033	.497	.052	.006	.050	.048	-.008
	Education level household head	-.006	-.108	.189	.052	.536	.041	-.011	-.121	.081
	Farming experience	.077	.040	-.269	.006	.041	.491	-.082	-.002	-.036
	Own a radio	.087	-.033	.050	.050	-.011	-.082	.740	-.313	.051
	Own a television	-.131	.046	-.062	.048	-.121	-.002	-.313	.734	.009
	Experienced any food shortages	-.169	.011	.091	-.008	.081	-.036	.051	.009	.925
Anti-image Correlation	District	.507[a]	.025	-.023	.010	-.008	.114	.106	-.159	-.183
	Household head gender	.025	.615[a]	-.141	.617	-.208	.080	-.054	.075	.016
	Age of household head	-.023	-.141	.603[a]	-.073	.398	-.593	.089	-.111	.145
	Marital status	.010	.617	-.073	.665[a]	.101	.013	.082	.079	-.012
	Education level household head	-.008	-.208	.398	.101	.776[a]	.080	-.018	-.193	.115
	Farming experience	.114	.080	-.593	.013	.080	.660[a]	-.136	-.004	-.053
	Own a radio	.106	-.054	.089	.082	-.018	-.136	.601[a]	-.424	.062
	Own a television	-.159	.075	-.111	.079	-.193	-.004	-.424	.550[a]	.011
	Experienced any food shortages	-.183	.016	.145	-.012	.115	-.053	.062	.011	.518[a]

a. Measures of Sampling Adequacy(MSA)

Annex4: KMO and Bartlett's Test for factors affecting responsiveness

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.662
Bartlett's Test of Sphericity	Approx. Chi-Square	544.218
	df	21
	Sig.	.000

Annex5: Anti-image matrices for factors affecting responsiveness

		Age of household head	Education level household head	Highest education level in family	Household size	Farming experience	Total land area	Draft power
Anti-image Covariance	Age of household head	.399	.192	-.008	-.064	-.236	-.019	-.116
	Education level Household head	.192	.560	-.217	.013	.060	-.090	-.039
	Highest education level in family	-.008	-.217	.769	-.192	.001	-.113	-.024
	Household size	-.064	.013	-.192	.864	-.084	.060	-.011
	Farming experience	-.236	.060	.001	-.084	.494	-.081	.009
	Total land area	-.019	-.090	-.113	.060	-.081	.675	-.302
	Draft power	-.116	-.039	-.024	-.011	.009	-.302	.676
Anti-image Correlation	Age of household head	.662[a]	.407	-.015	-.110	-.532	-.036	-.224
	Education level Household head	.407	.677[a]	-.330	.019	.114	-.146	-.064
	Highest education level in family	-.015	-.330	.584[a]	-.236	.002	-.157	-.033
	Household size	-.110	.019	-.236	.685[a]	-.129	.079	-.014
	Farming experience	-.532	.114	.002	-.129	.719[a]	-.140	.015
	Total land area	-.036	-.146	-.157	.079	-.140	.605[a]	-.448
	Draft power	-.224	-.064	-.033	-.014	.015	-.448	.644[a]

a. Measures of Sampling Adequacy(MSA)

Annex6: Hosmer-Lemeshow goodness-of-fit test

Number of observations	287
Number of groups	6
Hosmer-Lemeshow chi^2 (8)	0.005
Prob> chi^2	0.9997