AN ANALYSIS OF FACTORS AFFECTING CLIMATE CHANGE ADAPTATION STRATEGIES ON MAIZE PRODUCTION BY HOUSEHOLD. CASE OF SEKE DISTRICT.

BY

PALMMAH GUTU

A research project submitted in partial fulfilment of the requirements of a Bachelor of Science Honours degree in Agricultural Economics and Development

Department of Agricultural Economics and Development

Faculty of Natural Resources Management and Agriculture

Midlands State University

June 2014

CERTIFICATION OF DISSERTATION

The undersigned certify that they have read and recommended for submission to the department of Agricultural Economics and Development, in partial fulfilment of the requirements for the Bachelor of Science Honours Degree in Agricultural Economics and Development, a research project by Palmmah Gutu entitled:

AN ANALYSIS OF FACTORS AFFECTING CLIMATE CHANGE ADAPTATION STRATEGIES ON MAIZE PRODUCTION BY HOUSEHOLD. CASE OF SEKE DISTRICT.

Supervisor

Mr J. Mukarati

Signed...

Date………../………../………………….

ACKNOWLEDGEMENT

I would like to thank Lord the Almighty for guiding and providing me with every needs throughout this Research Project. To my supervisor Mr Mukarati, thank you for dedicating your limited time in the supervision of this project and special mention to the Agricultural Economics staff for their support. Lastly to my dearest friends and family thank you for your efforts in making this project a success.

ABSTRACT

Climate change has resulted in several effects which include floods, droughts and shifts in marginal agriculture systems leading to a reduction in agriculture output which has led to food insecurity in the country. Following some analysis, adaptation has been suggested as the way to combat the effects of climate change, but however, these adaptation strategies are area specific and affected by different factors thus the researcher sought to analyse the factors affecting climate change adaptation strategy by households in Seke district. The research employed a random sampling in collecting primary data and 156 questionnaires were administered randomly to household farmers. Results showed that 9 strategies were found to being used in Seke district to combat the effects of climate change of which three where found to be dominant which are minimum tillage, varying planting dates and dry and early planting. The researcher used the multinomial logit regression to analyse factors affecting the adaptation of the copying strategies. From the findings it could be concluded that the majority of the farmers are aware of climate change in the area shown by farmers' response through different strategies. It could also be drawn that different factors have different influence on copying strategy employed by the household such as; level of education, gender and household size has a significant effect on dry and early planting, education level, age, gender and farm size has a significant effect on varying planting date strategy. Age was proved to have a positive relation to adaptation strategy though statistically insignificant. The researcher recommends that a multidisciplinary extension approach be done to increase and strengthen the adaptation capacity of the households and also promotion of some forms of education other than the well known formal education.

Key words: climate change, adaptation strategy, multinomial logit

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Acronomys

AEM	Agronomic Economic Model
AEZM	Agronomic Ecological Zone Model
CBD	Central Business District
CGE	Computable general equilibrium
FAO	Food Aid Organisation
GDP	Gross Domestic Product
IIA	Independent from Irrelevant Alterations
IPCC	Intergovernmental Panel on Climate Change
LR	Likelihood Ratio
MNL	Multinomial Logit regression
MNP	Multinomial Probit regression
RESET	Regression Specification Error Test
WMO	World Meteorological Organisation

CHAPTER ONE: INTRODUCTION

1.1Background of the Study

Declining rainfall and increasing temperature have had a negative impact on agricultural production and food security in developing countries (Perry, Canziani, Palutikof, Van Der Linden and Hanson, 2007). These climatic changes are expected to have adverse socio-economic impacts mainly specifically on rural farmers because these rural household farmers depend on agriculture as their source of livelihoods thus making them more vulnerable to climate change (Mannak, 2009). In a scenario where majority of the population such as more than 80% is heavily relying on rain fed agriculture, rural livelihoods and food security are highly vulnerable to these climatic change (Kurukulakusuriya and Rosenthal, 2003).

According to World Meteorological Organisation (WMO, 2009) approximately 70 percent of Africans rely on farming for their livelihood with more than 95 percent of the agriculture being rain fed. Changing weather patterns are therefore expected to reduce agricultural yield in most areas by 50 percent as early as 2020. Agricultural production is the most sensitive to climate as its production processes depends heavily on the natural heat for energy and on water for irrigation, which are both climate-related variables. Although scientific evidence proves that there will be gains in some regions of the world where the climate has shifted towards favourable conditions, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security.

Mugandani (2012) showed that climate change and precipitation unpredictability have outcomes of changes in the rainfall patterns in many parts of the world. Empirical evidence has indicated that significant changes have been experienced in the size, structure and composition of the five natural regions. In Zimbabwe major shifts have occurred in the drought prone regions; region IV and V which have become drier than previously experienced. Climate change has greatly affected agriculture in Zimbabwe, especially in semi arid and arid regions, and this has resulted in increase in unemployment, food insecurity and food insecurity related problems. The negative influences of climate change and variability on agriculture in Zimbabwe has led to the point where effects have strangled the economic growth of the country.

The effects of climate change have been grossly felt by African countries that are already struggling with scarce food reserves and poverty. Adaptation to climate change should be prioritized by African governments as it is the only cheap and easy way to cushion the effects of climate change on food production (International Food Policy Research Institute, 2009). Adaptation is therefore critical and of greater importance to developing countries, particularly Africa where vulnerability is high because of a lower capacity and ability to adapt.

Climate change adaptation has become a popular agenda in research, policy making and program development in Africa as many people are becoming more aware that climate change is a real threat destabilizing social and ecological sustainability. In agriculture it is essential that governments engage in adaptation efforts focused on implementing measures that help build resilience to adverse effects of climate change variability and disaster (Nelson 2009; Feyissa 2007). Afrrica's quest for sustainable development depends heavily on the ability to adopt proper adaptation strategies that are aimed at mitigating the impacts of climate change.

Empirical studies that analysed the economic impact of climate change on agriculture in Africa include Kurukulasuriya and Mendelsohn (2006); Seo and Mendelsohn (2006); Mano and Nhemachena (2006). These studies have shown that the impacts of climate change can be significantly reduced through adaptation to certain strategies. Adaptation helps farmers achieve their food, income, and livelihood security objectives in the face of changing climatic and socio economic conditions that include climate variability, extreme weather conditions such as drought, floods and volatile short term changes in local and large scale markets (Kandlinkar and Ribsey, 2000). Farmers can reduce the potential change by making tactical responses to these changes.

According to Nhemachena and Hassan (2008) the adaptation strategies that the farmers perceived as appropriate in Zimbabwe include; crop diversification, different crop varieties, varying planting and harvesting dates, irrigation, soil and water conservation, shading and shelter, shortening the length of the growing season and diversifying from farming activities to non farming activities. Literature on climate change argues that with adaptation farmers' vulnerability can be significantly reduced (Kurukulasuriya and Rosenthal, 2003; Odekunle, Orinmoogunje and Ayanlade, 2007; Gbetibouo, 2009). However, limited information exists on the impacts, vulnerability and adaptation to climate change especially at micro level. Given this knowledge gap, there is need to carefully analyse factors affecting climate change adaptation strategies by households as these factors increase farmers vulnerability to the effects of climate change. According to Mugandani (2009) maize is a widely grown crop in Mashonaland East and is also a staple food crop that relies largely on rain fed, thus the researcher analysed the factors affecting climate change adaptation strategies on maize production.

1.2 Problem statement.

Climate change has negative consequences currently noted by frequency in floods, droughts and shift in marginal agriculture systems (Collier, Conway and Venables, 2008). Agricultural production in semi arid regions of Zimbabwe has been and continues to decline due to changes in precipitation patterns. This has negatively affected the livelihood for most rural households who depend mainly on agriculture. Climate change is affecting key developmental issues such as food security as a result of reduction in crop output. Food insecurity related diseases are likely to emerge at a rapid pace due to the changes in climatic conditions. As highlighted by IPCC (2007) the African continents' vulnerability to climate change primarily depends on location, dependency on agricultural products, and adaptive capacity among other economic and environmental factors.

1.3 Research Objectives

The main objective of the study is to analyse the factors affecting climate change adaptation strategies on maize production

i. To identify the copying strategies adopted by rural farmers in Seke district
ii. To analyze factors affecting the adoption of climate change adaptation strategies by farming households.

1.4 Research Questions

i. What are the current copying strategies?
ii. What are the factors affecting adoption of adaptation strategies?

1.5 Justification of the study

The researcher gathered information on climate change and adaptation strategies at household level and analysed the factors affecting adaptation of copying strategies by household. The researcher further proposed recommendations to maize farmers participating in maize production, on policies, extension approaches and some improvements in order to increase adaptive capacity of the household. This information was intended to benefit the stakeholders in maize production including the farmers, extension officers and the government, assisting them to identify factors that affect adaptation and set policies that might assist them to having a better agricultural harvest

1.6 Organisation of the Study

The subsequent chapter focuses on reviewing related empirical and theoretical literature. Chapter three outlines research methodology used in carrying out the research, justifying the suitability of processes and procedures used to carry out the research. Chapter four is based on presentation of research findings and analysis of the gathered data. Chapter five concludes the study by looking at the conclusions drawn from the study and some recommendations. Suggestions for further study are highlighted at the end of the research.

1.7 Conclusion

This chapter was aimed at providing the logic of the need to carry out the study. It explains the background from which climate change emanates and brings out the motive behind the study. The objectives to be met, research questions to be answered, as well as justification of the study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter is an elaboration and citation of relevant literature of climate change, its nature and effect on agriculture and livelihood and enlighten more on adaptation. This is done so as to add light and serve as a foundation for the bases of the research. It reviews theoretical knowledge along with empirical evidence on the previous studies. It seeks to expose the gaps in the available literature justifying the understanding of the research, giving views of the accredited scholars and researchers helping broaden knowledge about the topic of analysis of factors affecting adaptation to climate change on maize production. This researcher will also give an insight of the study against the available literature.

2.1 Definition of terms

According to FAO (2006) Climate change refers to any significant change in the measures of climate change lasting for an extended period in time. This includes the changes in temperature, precipitation and wind patterns among other factors that occur several decades or longer. The World Bank (2008) asserts that climate change is a long term change in the statistical distribution of weather patterns over periods of time ranging from decades to millions of years. This might be changes in weather conditions or changes in distribution of weather events with respect to an average either of a specific region or may occur across the whole earth. It is usually as a result of natural factors, natural processing and human activities.

According to IPCC (2007a) climate change is the change in the state of climate that can be identified (via statistical tests) by changes in the mean and or variability of its properties that persists for an extended period typically decades or longer.

In the IPCC definitions and analysis sited by Smit, Burton, Klein and Wandel (2000) adaptation is a response to potential, environmental, stimuli that affects a given entity. Adaptation can be grouped into available means, those disposable by the operator example extension services, employed means, measures that are actually being used for a specific condition living out the issue of success and failure of the measure and necessary means which are conditions that are put in place either available to the farmer or not. Kandlinkar and Risbey (2000) define adaptation as adjustments in management strategies to reduce risks from actual or expected changes in climatic conditions.

The researcher used the definition of climate change as the long term changes in statistical distributions of weather patterns mainly focusing on changes in precipitation and temperature among other climatic variables as these factors are directly linked to maize production. Adaptation strategies were viewed as means that are being used by the rural farmers to fight the effects of climate change not specifically looking at their success or failures

2.2 Nature of Climate change

In European countries climate change has lead to temperature rises, shift in rainfall patterns, a rise in sea level, hazardous events such as floods and droughts (Fredrick and Schwarz, 2000). Climate change effects do include that of change in weather patterns. Areas that usually get an average of two rainfalls in a year will get more than two and those that often get one will get far less to the extent of receiving one rainfall season in three years, with a projection of 33% decrease in maize production (Masika, 2000)

According to the Actio Aid International (2006) Climate change is likely to result in high frequency of drought and floods that is likely to challenge farmers eroding their assets leaving them more vulnerable. Climate change is likely to cause hotter days and more frequent and larger heat waves. It might result in extreme events such as decrease in availability of fresh water and food, interact with health care services and also an enhancement of disease spreads as a result of increased rainfall and temperatures (Kelly and Adger, 2000). The researcher agrees with the above literature as evidenced by the unpredictable weather and frequent droughts and floods in Muzarabani eroding assets leaving the rural farmers more vulnerable.

2.2.1 Climate change and agriculture

It has been estimated that 70% of the world population rely on rain fed agriculture FAO (2010). According to Parry et al (2007) climate variability directly affects agriculture production, as agriculture is inherently sensitive to climate change and is one of the most vulnerable sectors to the impacts of global climate change. According to Dinar, Hassan, Kurukulasuriya, Benhin and Mendelsohn (2006); Kurukulasuriya and Rosental (2003) changes in temperature and rainfall will result in adverse changes in land and water systems that is likely to affect agriculture production.

Climate change effects are heterogeneous and region specific. According to IPCC (2007) agriculture is particularly vulnerable to climate change. Climate change worsens the conditions for rural famers as they lack of assets and adequate insurance to combat the effects. In the short run the effects of agriculture as carbon dioxide fertilization of plants could contribute to increasing production and security. However, in the long run climate change is likely to increase water stress, reduce biodiversity, damage ecosystem and increase social conflicts due to increased competition of resources (IPCC 2007).

The increase in temperature as a result of climate change will make agriculture inactive and fertile lands less productive and even make some completely barren (Rosenzweign and Solecki, 2010). According to IPCC (2001) poorest countries, mostly tropical and sub tropical regions would experience a decrease in crop yield due to decreased water availability, new and changed pest incidence. A 50% decrease in rain fed yield expected in Pakistan, UKMO, Africa and Latin America. Most crops are at its maximum temperature tolerance thus a slight climate change is likely to result in a sharp decrease with an estimation of up to 31% in the 21C.

An increase in temperature has been found to decrease yield and quality of many crops. A decrease in precipitation will affect the semi arid and arid an area in a negative way as there is a decrease in soil moisture but in areas with excess water agriculture is improved (Mano and Nhemachena, 2006). Climate change has also brought about seed varieties that are more resistant to harsh weather conditions and short season varieties allowing for maize production to being an all year round crop.

The researcher has the same opinion with the above literature as there have been notifiable decreases in yield and quality of maize in Zimbabwe to an extent of importing maize from neighbouring countries to secure the country. Efforts by seed companies of introducing new variety after the other are also a sign that climate change to an extent is affecting agriculture.

2.2.2 Climate change and livelihood

According to the United Nations Joint Press Kit for Bali Climate change Conference (2007), climate change is likely to cause;

i. An increase in hunger and malnutrition affecting the vulnerable and food insecure
ii. New patterns of pests and diseases will emerge; human plants and livestock will be exposed to new pests and diseases that will flourish only at specific temperatures and humidity, posing new risk for food security, food safety and healthy.

The IPCC (2007) adds on to say malaria in particular is expected to change its distribution as a result of climate change. Shaw, Mendelsohn and Nordhaus, (2007) pointed out that climate change has an effect on the four dimensions of food security**;** availability, stability access and utilization. Availability takes into account direct impacts on the yield through crop, pests and disease, soil fertility and holding properties. Indirectly it affects the economic growth, income distribution and agricultural demand. On the stability point of view focus is placed on the effects of constant supply of yields and food supplies.

Climate change is likely to affect supplies of yields with fluctuating supplies of yield and food supplies. Climate change is likely to indirectly affect the physical, economic and social access to food. As agricultural production decreases food prices rise and purchasing power decreases (Rosenzweig and Parry, 2005). The decrease in purchasing power may lead to a decrease in the production of food commodities which may result in retrenchment of workers in the industry thus increasing the rate of unemployment as a result subjecting the majority to continued hunger and prone to malnutrition strangling the economic growth of the country.

According to IPCC (2007) climate change has led to environmental hazards to human health, weather patterns and biodiversity. Food borne diseases, water borne and animal diseases are likely to emerge at a rapid pace due to the changes in climatic conditions (Kumar and Parikhl, 2001). High temperatures might lead to the enhancement of the salmonella bacteria causing gastrointestinal distress in humans. Floods may lead to the overflow from sewage treatment plants into fresh water reserves. It is believed that a greater percentage of the population is urbanised thus a majority of the nations' population is affected. As temperature increases a range of ticks breeding is promoted and they later expand leading to Lyme disease in animals.

Maddison (2007) asserts that extreme climate changes lead to floods, droughts and earthquakes thus destroying infrastructure such as hospitals, schools, roads to mention but a few, this would affect the economic performance of the country an increased mortality rate an increased expenditure on the government as buildings need to be restored.

2.2.3 Climate change and adaptation

Adaptation to climate change should be prioritized by African governments as it is the only way to cushion the effects of climate change on food production (International Food Policy Research Institute, 2009). FAO (2011) indicated that to protect livelihood and food security in developing countries adaptation is a key requirement even under moderate climate change.

Climate change is affecting agriculture at a rapid pace(Fussel and Klein, 2006).This short and rapid impact is likely to give famers no room and time to recovery from previous impacts through either assets accumulation or accruing skills and knowledge necessary for adapting to future climatic change. The rapid action of the climate change gives plants and animals no room to adapt even the human research and development crew cannot adapt and find coping strategies to such changes (Brayn, Deressa, Gbetibouo and Ringler, 2009)

According to Masika (2002) adaptation measures must be guided by prioritization of measures, government intervention and financing solutions. There is need for implementing strategies that are effective and with no regrets; with this measure the extension officers tend to take time testing the measure and also the farmer at most might not be willing to adapt to changes so easily hence creating a challenge in copying with the incessant changes in climate. The issue of government intervention might be subject to delays in decision making and also the involvement of political affiliations hence creating a challenge in adapting to climate change.

Traditional knowledge is defined as wisdom, knowledge and policies of local people that is gained over time through experience and orally passed from one generation to the other (Rockstorm, 2004). Some families are not willing to let go practices they have learnt from their elders for this reason most of the farmers recoil from some strategies taught to them and others even think the adoption of such strategies might even cause more problems in their society.

Although climate change adaptation has been proved to being key effective, numerous factors have been identified as barriers to adaptation. Reidsma, Ewert, Lansink and Leemans (2009) elaborates that adaptation to climate change depends on technical and economic factors, farmers' attitude and the political framework. Choice of adaptation to a certain strategy depends on the variable positively or negatively affecting a particular adaptation strategy. For a developing country like Zimbabwe to obtain accurate scientific data, securing funding for agriculture, main streaming adaptation into existing work and communicating nature of the problem, communicating the need for adaptation to elected officials to mention but a few might be some of the challenges being faced by both the extension officers and the farmers.

To cope with the effects of climate changes farmers have adapted to irrigation, drought resistant seed varieties, shifting to other crops, conservation agriculture preserving both soil and water, dry and early planting, varying planting dates and others do nothing (Boko, Niang, Vogel, Githeko, Medany, Osmanelasha and Yanda, 2007). According to Nhemachena and Hassan (2008) farmers in Zimbabwe undertake strategies such as new dry and early planting, zero fertilizer, minimum tillage, multiple cropping, water harvesting, varying planting dates, grow drought resistant crops, short season varieties, irrigation and winter ploughing. Poonyth, Deressa and Hassan (2002) added some strategies on Nhemachena and Hassans' strategies such as crop diversification, shortening length of growing season, change the amount of land under cultivation and move to different sites. Farmers can embark on one or more of these strategies, depending on the availability, accessibility and affordability given this research gap the researcher identified the copying strategies being employed by rural farmers and analysed factors affecting climate change adaptation strategies by households in Seke district.

2.3 Measuring the Impact

According to Adams and M^{C}Carl (2001) to access the impact of climate change on agriculture, models can be used which include; Production function, Agronomic Economic Model (AEM), Agronomic Ecological Zone Model (AEZM), Ricardian cross-section Model (RM), Computable General Equilibrium model (CGE) and the Multinomial regression models.

2.3.1 Theoretical framework

According to Reinsborough (2003) the production function takes into account yield then examines them under different climatic conditions. It assumes different species of crop do not have any means of adapting to changing climatic conditions. It also assumes that land used in a given year for a specific crop will be used for that same crop in other years.

The use of the production function is limited in that it does not control for adaptations (Mendelsohn, Dinar and Dalfelt, 2000). Farmers are likely to respond to climate change and environmental factors by use of different crop varieties, irrigation, diversify into non farming activities and increasing plant space. The production function model is also limited in that it does not consider the introduction of new crops, technology changes and changes in land use. Although the model includes adaptation, it is restricted to limited test sites and fails to make conclusions about climate change.

The AEM employs controlled experiments on crops under different climatic scenarios of temperature, precipitation and carbon dioxide. An agronomic modelling is then implied to analyse the results obtained from the controlled field or laboratory through economic models to predict climate change impact (Adams and McCarl, 2001). The AEM has an advantage in that it directly predicts the way climate change affect crop yield through its use of elaborated controlled experiments. But however, it has some weakness that it encompasses such that they do not take into account adaptations to climate change such as the use of new variety seeds that are drought tolerant. It is also criticized in that lack of sufficient controlled experiments to determine agronomic response.

The AEZM is just like the AEM where crops are under supervision, controlled fields or laboratories, but in AEZM crops are assigned in different ecological zones as implicit in the name and their crop yields produced (FAO, 2011). The changes in the experimental crops collected in different agronomic ecological zones and fed into economic model. The model is however criticized in that it does not clearly point out which crops to be grown or their yield (Mendelsohn, 2000). This model also does not clearly point out adaptations to changing climate.

The CGE model captures the impact of changes in agriculture on the rest of the economy and arising feedback effects on the agricultural sector. It provides a consistent, realistic and accurate picture of economic systems. According to Deke, Hooss, Kasten and Springler (2001) the CGE model is used to analyse the adaptations to climate change in various regions in the world. The model result show that vulnerability to climate impact differs significantly across regions and that the overall adjustment of the economic system somewhat reduces the direct economic impacts. Although this model captures arising feedback effects on the agricultural sector it fails to point out the adaptation strategies that can be employed by the farmer and cannot analyse factors affecting climate change adaptation strategies hence could not be the appropriate model for the study.

The Ricardian Model is theoretically deeply rooted in the theory of economic rents by David Ricardo (1815) however, its application to climate change land value analysis draws extensively from the work of Mendelsohn et al, (2000). It examines how climate change in different places affects the net revenue and value of land. According to Soe and Mendelsohn (2006a) the model accounts for direct impacts of climate change on yield of different crops as well as indirect substitution of different input of different activities and other potential adoption by farmers to different climates. The Ricardian Model has an advantage in that it can incorporate changes that farmers would make to adapt in order to combat effects of climate change such as copying strategies (Mendelsohn et al, 2000).

But however, the Ricardian model is criticized in that it is not subject to controlled experiments, it also does not take into account for future change in technology and policies. It assumes a constant price which is unrealistic since prices do change in the real world market and if these changes are significant enough they can invalidate the prediction of the model built on constant price (Mendelsohn, 2008) The model fails to account effects of factors that vary across space (Hassan 2008 and) and also does not recognize the fertilization effects of increased carbon dioxide (Maddison, 2006; Mendelsohn, 2008 and Kurukulasuriya and Rosenthal, 2006). Some crops might benefit from abundance of carbon dioxide and larger growing season. Ignoring such effects may cause an overestimation of climate change impacts.

Although the RM addresses on climate change adaptation the model is too complex and the variables needed in the model were not in reach of the researcher hence could not be the appropriate model to be used in the study. The model does not analyse factors affecting adaptation to a certain strategy but rather chooses a strategy that is appropriate at individual farm level.

In analysis of agriculture technology adoption multinomial probit (MNP) and multinomial logit (MNL) models are commonly used. According to Gujarati (2004) multivariate models are normally used when numbers of choices available to the household are more than two. They allow explaining of combination of choices and take care of self selection and interactions between alternatives. When there is more than one step in decision of choosing a technique then there is need to use models like Heckmans two step models. The MNP assumes the minimum utility using a certain adoption model subject to given factors. The MNL model has an advantage that it assumes that farmer i maximises perceived utility using a certain adoption model subject to given factors. It also assumes independent from Irrelevant alterations (IIA) such as the choice of adding a strategy does not change relative probability of existing models.

The model seem appropriate for the study as the number of adaptation strategies are more than two and allows explanation of combination choice made by the farmer. The study is assumed to being a one step model basing on the assumption that everyone is aware of climate change and adaptation strategy therefore one chooses one strategy among the strategies.

2.3.2 Empirical framework

Climate change in agriculture is now a subject of concern globally, evidenced by the number of empirical literature available on the subject. Most of the studies pertaining the adaptation to climate change have been undertaken at a macro level (Jain, 2006) leading to difficulties in generalizing specific household adaptation option. Thus laying a foundation for the increasing number of developing country studies of factors affecting adaptation to climate change at micro level that are emerging (Mendelsohn, 1999).

According to the IPCC (2007) adaptation measures help farmers guard against losses that can be incurred by the farmer due to changes in weather patterns. Different factors affect different copying strategies at different level. Thus the researcher aimed to look at the factors affecting the dominating strategies in Seke to help increase the adaptive capacity of the farmers so that they guard against losses that they can incur due to climate change.

Yesuf et al (2008) confirmed that household wealth, non farm income and livestock ownership increase the likelihood of climate change adaptation. Deressa (2008) identified age, household size, information, social capital and agro ecological settings have significant impact on perception of adaptation. According to Madison (2006) showed that lack of information was a barrier to adaptation to climate change. On a general perspective it seems that adaptation is affected by different factors differently hence it was the aim of this study to analyse the factors that affect adaptation strategies.

Literature has it that there has been a mixed influence of the age of household head on the adoption of a strategy, its influence varies. Some studies found that age had an influence on farmers' decision to participate in forest, soil and water management activities. A study in the Eastern Highlands of Ethiopia by Wegayehu and Drake (2003) found out that age had an influence on farmers' decision to participate in soil and water conservation activities. Studies by Dolisca et al (2006) and Nyangena (2007) found age being significantly and negatively related to farmers decision to adapt in soil and water conservation. But however, Bayard, Jolly and Shannon (2007) and Okoye (1998) found that age is negatively related to adoption of conservation agriculture.

From the empirical evidence mentioned age seem to have mixed influence depending on copying strategy that is being employed, country and the norms and values. The researcher postulates that age also has an effect on adaptation strategy, as an individual grows there are some strategies that they can easily accept, some may find it forbidden to adapt to certain strategies basing on the norms and values. Thus the researcher seeks to find out the influence of age of household head on the dominating strategies in Seke

According to Nhemachena and Hassan (2008) a larger farm size paves way for farmers to take labour intensive adaptation strategy. Nyangena (2007) objected this and concluded that farmers with small land are the ones that are likely to invest in soil conservation practices. Other studies found out those farmers with larger farms to allocate for the construction of soil bund (Anim, 1999). The researcher postulates that the effect of farm size is also dependant on the availability of cheap labour to the farmer. If the farmer has a larger piece of land and at the same time has readily available cheap labour there is a high probability of adaptation to labour intensive strategies and in contrary if there is no readily available cheap labour then the farmer is likely to shun labour intensive strategies. The researcher however, hypothesises that farm size can also have an independent influence on the adaptation of certain strategy. Thus the researcher seeks to analyse the effect of farm size on the dominating strategies being employed by rural farmers.

Aymone (2009) found out that a large household is likely to choose adaptation options that are labour intensive as compared to the labour extensive adaptations. Deressa et al., (2009) found out that an increase in the household size did not significantly increase the probability of adaptation though the coefficient on adaptation had a positive relation. Large family size is expected to embark on labour intensive (Nyangena, 2006; Anley et al 2007; Birungi, 2007).

Empirical evidence seem to base more on household size reflecting labour readily available to a farmer and that one can adopt to labour intensive adaptation strategy. The researcher suggests that the household size can affect adaptation strategy given the level of education of the households. Since Seke is close to the central business district some literate family members may look for other income generating projects reducing dependence on farming activities. The researcher also suggests that adaptation to a strategy is based on the availability of labour when most needed rather than it's readily availability. Thus the researcher seeks to analyse the effect of household size on adaptation strategy.

Gender of the household head was seen as an important variable affecting adaptation decision at farm level (Deressa, Hassan, Teike, Mahmud and Ringler, 2009). According to Nhemachena and Hassan (2008) male headed households adapt more readily to climate change. But however Aymone (2009) found out that gender had an impact on the probability of choosing an adaptation technique. Females tend to adapt to resource management and conservation practices (Bayard et al, 2007; Dolisca et al., 2006; Burton et al., 1999). A study by Bekele and Drake (2003) found that gender was not a significant factor influencing farmers' decision to adopt to soil conservation measures.

Literature has it that gender has a mixed influence at different level but the researcher hypothesises that there are certain adaptation strategies that males are likely to adapt more rapidly compared to women and the opposite being true for women. Thus the researcher seeks to identify the influence of gender on the adaptation strategies being employed by rural farmers to observe if gender of the household head was to change what effect would that have on a given strategy, identify if there is going to be a change in strategy or one would continue using the strategy at hand.

According to Reardan and Kangasnieum (1998) education is an insignificant determinant in influencing adaptation measures to climate change. Okoye (1998) found out that education was negatively correlated with adaptation to climate change. Basing on these two studies the researcher premise that educations' influence depends more on the type of education it can be formal, non formal and informal. Formal education is where one learns the basic, academic or trade skills, non formal being maybe due to own study or from job skills, skills that are taught outside formal sector. Informal education involves teachings from magazines, other colleagues and from the mass Medias. These levels of education have different influence on adaptation strategy; the increase in non formal and informal education might positively influence adaptation. Thus the researcher seeks to identify the effect of level of formal education on adaptation strategy employed by rural farmers.

Other studies have also found income as a factor that affects adaptation strategies. Income can be grouped into off farm income and farm income. Smallholder farmers' access to off farm income source increases the probability that they will invest in farming activities. Ownership of livestock is negatively related to adaptation, the marginal impacts are not significant (Aymone 2009). According to Deressa et al (2009) livestock is positively related to methods like conserving soil and changing planting dates but negatively related to the use of different crop varieties and irrigation although not statistically significant.

Some farmers can rarely note the differences in amount of rainfall and temperature, access to agricultural services is a vital source of information on climate change and agricultural practices. Studies done by Bekele and Drake (2003) Tizale (2007) showed that extension education is a motivating factor on the use of soil and water conservation. Other studies however found out that extension was not a significant factor affecting adaptation of soil conservation measures (Pender et al 2004); Nkanya et al 2005; Birungi 2007). According to Kandlinkar and Ribsey (2000) access to climate and agricultural information help farmers make cooperate decision to help farmers better cope with changes in climate.

This study hypothesises that climate change and agricultural information has an influence on adaptation strategy. But however, information pertaining access to agricultural services and information was not clearly provided by the farmers and the researcher could not quantify the factor hence to avoid giving biased and misleading results the researcher did not analyse the effect of access to information.

A study by Nhemachena and Hassan (2008) showed that in Zimbabwe 32% of the studied population did nothing to alleviate climate change effects, 21% dry and early planting, 1% zero fertilizer usage, 2% minimum tillage, 4% multiple cropping, 4% water harvesting, 5% varying planting dates, 7% grow drought resistant crops, 8% short season varieties,7% irrigation and 9% winter ploughing. According to FAO (2001) as noted in Dixon et al (2001) more than ten categories represent the main strategic adoption measures to climate change. The study hypothesis that studied population is aware of climate change effects and has embarked to different strategies in order to combat the effects of climate change. The researcher also postulates that different areas have certain adaptation strategies that they can adapt to with some failing to fit in some areas. Thus the researcher seeks to identify the copying strategies employed by the household in Seke.

2.4 Insights

The researcher has found out there are different copying strategies being used to alleviate the effects of climate change in an area and these adaptation strategies can be influenced by many factors such as gender, household size to mention but a few. Amongst the models appropriate in analysing the factors affecting climate change adaptation the researcher found the multinomial logit regression as the appropriate model for the study since the number of adaptation strategies being analysed are more than two and also assumes independent from irrelevant alterations.

2.5 Conclusion

This chapter was aimed at showing the effects of climate change on maize production. It has been evitable that climate change is likely to cause drought in some areas leaving some areas totally barren, and in some areas causing floods. Literature has also shown that climate change has an effect on agriculture, adaptation strategy and livelihood by reducing the level of output, directly affecting food security indirectly affecting economic growth, income distribution and the demand for agricultural products. It has been shown that there are many different strategies that farmers can adopt in order to reduce the effects of climate change in an area and these strategies can be positively or negatively be influenced by some factors thus the researcher seeks to analyse the factors affecting climate change adaptation strategies.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The following chapter intends to highlight and justify the approaches and techniques used to collect required primary data for the completion of the research. It aims to give the full description on how study was carried out, methods and techniques, logic behind methods and their justifications.

3.2 Research design

A research design is a structure that guides the execution of a research method and the analysis of the data (Bryman and Bell, 2003). It guides the logical arrangement for the collection and analysis of data paving way for conclusions being drawn from the data set. DeVos and Fonche (1998a) defines research design as a detailed plan on how a research study is to be concluded, alter variables into measurable variables and selecting sample of interest that best represent problem under investigation. According to Best and Khan, (1993) research design is a systematic and orderly approach taken towards the collection of data so that information can be obtained

According to Bryman and Bell (2003) a descriptive research is a research carried out with specific objective(s) and one then attains results and draw conclusions from the research. The main objectives that were addressed in the study as mentioned above were to analyse the factors affecting adaptation strategies to climate change on maize production and identify strategies employed by rural farmers to fight effects of climate change. To attain the objectives a descriptive research was used. The research technique was used because it encompasses richness in understanding of the context of the research and has the ability to answer research questions.

A qualitative approach was used to analyse factors affecting adaptation strategies. As reviewed in literature to analyse the factors affecting climate change adaptation a MNL regression was used. To identify the copying strategies being employed by rural farmers the research used a questionnaire and grouped different strategies according to responses given by the rural farmers. From the questionnaires the researcher carried out a purposive sampling of the dominating strategies and analysed factors affecting the dominant strategies.

3.3 Study Area

The research was done in Seke District located at an elevation of 1455meters above sea level with an estimated population of 38231 (2012 population census). The research mainly looked at ward 7 focusing on three villages; Dzumbunu Mungate and Gombe with an estimated population of the study of 1500 households. The researcher has chosen Mashonaland East as it is part of region 2 which is said to account for the most maize grown in Zimbabwe.

3.4 Sampling and data collection

According to Bogdan and Biklen (2003) sampling is when a number of individuals selected from a population for a certain study, in such a way that they represent the population at study. Cooper and Schindler (2003) describe sampling as a procedure by which some elements of a given population are selected as a representative of the entire population. Sampling is done so as to approximate the measurement of whole population well enough within acceptable limits providing an insight into the population from which it has been obtained

To identify the copying strategies being employed by the rural farmers, random sampling method was used where everyone in the target population had an equal chance of participation. From the results obtained the researcher then used the deliberate sampling method. According to Kothari (2004) deliberate sampling is a purposive or non probability sampling which involves deliberate selection of the units of the universe for constituting a sample. The researcher selected questionnaires which were considered as representative, in the study farmers using the dominating strategies, known as judgement sampling.

The researcher used a structured questionnaire to collect data needed to attain the objectives. To identify the copying strategies being employed by the rural farmers 156 questionnaires were distributed randomly to the rural farmers. The researcher used this tool as it was cheap, free from bias and gives time for the respondents to give well thought answers. The researcher then selected questionnaires with households using the dominant strategies and used the data obtained to analyse the factors affecting the adaptations strategies.

3.5 Analytical framework

To carry out the study a multinomial logit (MNL) model was used to analyse factors affecting climate change adaptation strategies. The researcher used this model as it was seen to be all encompassing, consistence with the theory and also data admisable.

The decision of whether to undertake or not a strategy was considered under the general framework of utility or profit maximisation (Deressa et al, 2008; Norris and Batie, 1987). Households would adapt to a strategy when they recognize utility that is greater than the base category. In this study utility was observed through choices being made by the households. Supposing U_j and U_k represent utility for two strategies β_j and β_k respectively, the linear random utility model could be specified as;

$$U_j = \beta_j' X_i + \varepsilon_j \quad \text{and } U_k = \beta_k' X_i + \varepsilon_k \qquad (1)$$

U_k and U_j are perceived utility of adaptation strategy j and k

X_i vector of explanatory variables influencing the desire of strategy

ε_j and ε_k error terms

If household decides to use option j then perceived utility from j is greater than utility from strategy k, and is depicted as;

$$U_{ij}(\beta_j' X_i + \varepsilon_j) > U_{ik}(\beta_k' X_i + \varepsilon_k) \qquad j \neq k \qquad (2)$$

Based on the equation (2) we could define probability that household will use option j from the set of strategies as follows;

$$P(A_i = 1/X) = \ (U_{ij} > U_{ik}) \qquad (3)$$

simplified as;

$$P(\beta_j^* X_i + \varepsilon^*) > 0/X = F(\beta_k^* X_i) \qquad (4)$$

P probability function

$\varepsilon^{*} = \varepsilon_{j} - \varepsilon_{k}$ random disturbance term

$\beta^{*} = \beta_{j}^{'} - \beta_{k}^{'}$ net influence of the vector of independent variables influencing adaptation

$F(\beta_{k}^{*} X_{i})$ cumulative distribution function of ε^{*}

The MNL model for choice specifies the following relationship between the probability of choosing option A_i (0, 1, 2,..., j) and set of explanatory variables x_i (Green 2003) specified as;

$$\text{Prob}(A_i = j) = \frac{e^{\beta_{jx}}}{\sum_{k=0}^{j} e^{\beta_{kx}}} \qquad j = 0,1,\ldots, j \qquad (5)$$

β_j vector of coefficient on each of the independent variables x_i

β_k is a vector of the base alternative

j denotes the specific one of the j+1 possible choice

A_i indicates variable of choice

To remove the indeterminacy we normalise equation (1) by assuming that $\beta_0 = 0$ and the probabilities can be estimated as

$$\text{Prob}(A_i = j_{xi}) = \frac{e^{\beta_{jx}}}{1+\sum_{k=1}^{j} e^{\beta_{kx}}} \text{, } j = 0, 2, \ldots, j \qquad \beta_0 = 0 \qquad (6)$$

The dependant variable is log of one alternative relative to the base alternative. To interpret the effects of the explanatory variables on the probabilities, marginal effects are usually derived as follows (Green 2003);

$$\delta_j = \frac{\delta p_j}{\delta p_x} = p\left(\beta_j - \left|\sum_{k=0}^{j} p_k \ \beta_k\right.\right) = p\left(\beta_j - \left|\bar{\beta}\right.\right) \qquad (7)$$

These marginal effects measure the expected change in probability of a particular choice x being made with respect to a unit change in an explanatory variable (Green, 2000; Long, 1997)

3.6 Diagnostic test

3.6.1Model Specification test

According to Gujarati (2004) one of the assumptions of the classical linear regression model is that the model should be correctly specified. If the model is not correctly specified then problems of specification errors or bias are likely to arise. The Ramsey RESET test was used for model specification. The model is said to be correctly specified if probability F > p value of 0.05. The consequences of under fitting or over fitting a model will arise if the probability of F statistic is less than the p value. The hypothesis of the test was stated as;

H_0: model is correctly specified

H_1: model is incorrectly specified

3.6.2 Multicollinearity test

According to Gujarati (2004) multicollinearity is the existence of a perfect or exact linear relationship among some or all variables of a regression. The hypothesis of the test was stated as;

H_0: no perfect linear relationship among regressors.

H_1: there is perfect linear relationship among regressors

. Decision rule is drop a value if the pair wise correlation is greater than 0.8 to avoid the acceptance of a null hypothesis and misleading results

3.6.3 Likelihood Ratio (LR)

According to Gujarati (2004) Likelihood Ratio is based on max likelihood principle which is identical through estimated error variances are differently. The LR follows a χ^2distribution with degrees of freedom equal to the number of explanatory variables. The hypothesis states that;

H_0: slope coefficients are simultaneously equal to zero

H_1: slope coefficients are not simultaneously equal to zero

Decision criterion; accept the null hypothesis if p value is 1 and otherwise.

3.7 Conclusion

This chapter was a highlight of area of study and procedures followed in carrying out the research. The researcher carried out a descriptive research done in Seke district ward 7. Primary data was collected from the households using the simple random sampling technique and purposive sampling method was used to select households employing the dominating strategies. Three diagnostic tests were carried out in the research model specification test, multicollinearity test and log likelihood ratio test to avoid misleading results in the analysis. Data obtained from the households using the dominant strategies was analysed using the Multinomial logit regression model. The next chapter will look at data presentation.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter focuses on presentation and analysis of findings in line with the research design assumed in the preceding chapter. Data will be presented and analysed in line with the research questions to be answered.

4.1 Diagnostic tests

4.1.1Model Specification test

F(3,71)	2.54
Prob > F	0.0632

The Ramsey RESET test results above show that the model is correctly specified as probability F > our p value of 0.05.

4.1.2Multicollinearity test

Table 4.1.2 correlation matrix

	Gender	**Age**	**Education**	**Household size**	**Farm size**
Gender	1				
Age	-0.1623	1			
Education	-0.2779	0.0117	1		
Household size	-0.1307	0.0107	-0.2743	1	
Farm size	0.1647	0.0673	0.0120	0.0499	1

From the pair wise correlation matrix above there is no sign of multicollinearity such that no value is greater than 0.8 between the explanatory variables hence we conclude that there was no presence of multicollinearity in our data.

4.2 Justification of Variables.

Table 4.2.1 gender of household head and adaptation strategy

Gender	Dry and early planting	Minimum tillage	Varying planting dates	Total
Male	12%	9%	5%	26%
Female	14%	32%	8%	54%
Total	26%	41%	13%	80%

Pearson chi 2(2) = 4.4998 Pr = 0.105

An analysis of a farmer adapting to either of the three dominating strategy result show that 32.5% of the farmers adapting to climate change are males and 67.5% were females showing that majority of the households are female headed. The chi-square test results (table 4.2.1) show that there was an association between adaptation strategy but statistically significant at 10% level of significance. On average female were dominating household heads, since Seke is near the central business district maybe this was because most of the men were involved in non farming activities.

Table 4.2.2 age of household head and adaptation strategy

Age	Dry and early planting	Minimum tillage	Varying planting dates	Total
18-29 years	15%	30%	7%	52%
30^+ years	11%	11%	6%	28%
Total	26%	41%	13%	80%

Pearson chi2 (2) = 2.5244 Pr = 0.283

A comparison was made between adaptation strategy and age, the results showed that 65% of the household head was between the age of 18-29 and the remaining 35% was above the age of 30. The chi-square results (table 4.2.2) showed that there was an association between the age of the household head and the adaptation strategy, the results also show that age was statistically insignificant at 10% level of significance. Majority of the sample interviewed was between the age of 18 and 29 because of early marriages dominating the area and also since Seke is near the CBD many young families after the 2007 'murambatsvina' built homes in Seke district.

Figure 4.1 level of education

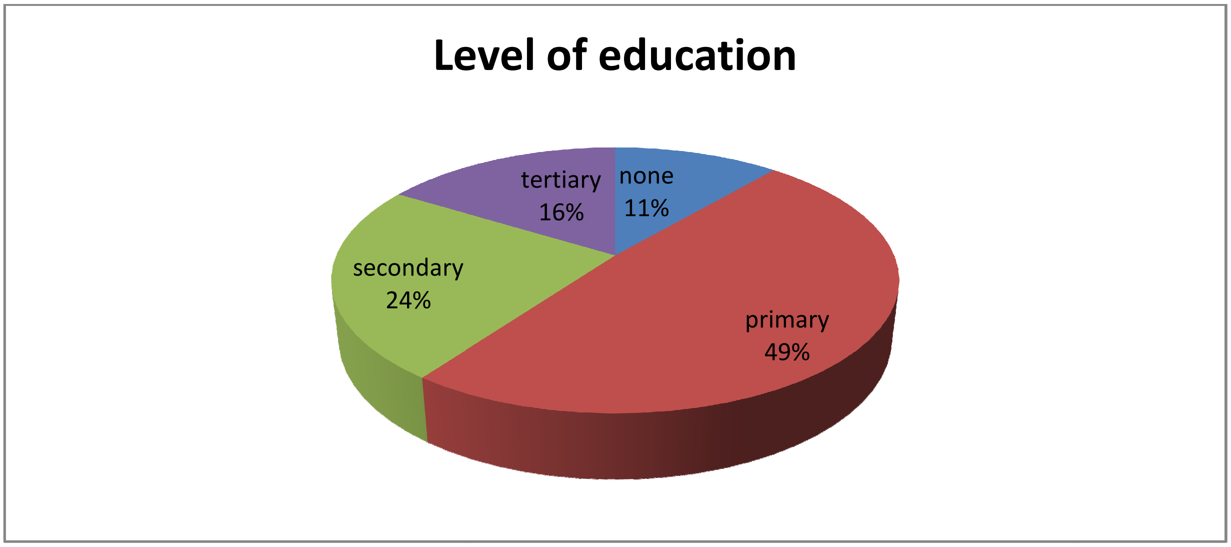

Table 4.2.3 level of education of household and adaptation strategy

Level of education	Dry and early planting	Minimum tillage	Varying planting dates	Total
None	7%	0%	2%	9%
Primary	11%	19%	9%	39%
Secondary	6%	12%	1%	19%
Tertiary	2%	10%	1%	13%
Total	26%	41%	13%	80%

Pearson chi2 (6) = 17.2474 Pr = 0.008

Level of education of the household head was analysed and the results obtained are displayed in figure 2 below. Chi- square result (table 4.2.3) above show that there is an association between the level of education and adaptation strategy and level of education is statistically significant for adaptation strategy. The majority of the population is literate such that they can read and write hence increasing the likelihood of them noting effects of climate change on their yield and as an end result adapt to some strategies.

Table 4.2.4 household size and adaptation strategy

Household size	Dry and early planting	Minimum tillage	Varying planting dates	Total
<6	1%	31%	0%	32%
6^+	25%	10%	13%	48%
Total	26%	41%	13%	80%

Pearson chi 2(2) = 44.4895 Pr = 0.0000

The researcher also took into account the household size as a factor that could affect adaptation to a strategy and found out that of the interviewed farmers, 40% had a household size of less than six and 60% had a household size of more than six people indicating availability of cheap labour that is contained by the household. The chi-square result (table 4.2.4) showed that there is an association between the household size and adaptation to a strategy and was found to being statistically significant at 10% significance level. According to Aymone (2009) the number of household size has an influence on the adaptation of copying strategies.

Table 4.2.5 farm size and adaptation strategy

Farm size	Dry and early planting	Minimum tillage	Varying planting dates	Total
<0.5ha	24%	34%	5%	63%
>0.5ha	2%	7%	8%	17%
total	26%	41%	13%	80%

Pearson chi2 (2) = 15.8927 Pr = 0.000

The farm size distribution reviewed in the study showed that majority of the farmers had less than 0.5ha with 78.75% of the sample and 21.25% of the sample had above 0.5ha.This can be a sign that most of the maize grown is for family consumption with little or no to spare. The chi-square test results (table4.2.5) show that there is an association between farm size and adaptation strategy and that household size was statistically significant at 5% significance level. Since the majority has less than 0.5ha then there is greater chance of them adopting strategies that require vast pieces of land.

4.3. Copying strategies employed by rural farmers

Table 4.3.1 adaptation strategies employed by rural farmers

Adaptation strategy	Percentage
Minimum tillage	19%
Varying planting dates	17%
Dry and early planting	15%
Multiple cropping	15%
Shifting to tobacco	10%
Drought resistant varieties	9%
Non farming activities	8%
Do nothing	5%
Irrigation	2%

A brief review of farmers' way of cushioning the unremitting effects of climate change showed that at least 95% of the population responded to climate change, showing that the people in Seke are aware of the changes in climatic conditions and majority have find ways in adapting to climate change.

Dry and early planting, irrigation and varying planting dates are some of the ways that farmers are combating effects of climate change. 15% of the farmers have adapted to dry and early planting, this could be that they had ready availability of inputs as they are close to the market. Only 2% of the farmers have engaged in irrigation, this low response might be was as a result of few farmers with access to the Nyatsime River and income to buy irrigation equipments. Varying planting date strategy occupied 17% of the farmers; this might be because they had large farm size and readily available source of income.

Other farmers have engaged in conservation agriculture, multiple cropping and drought resistant crop varieties. 19% of the farmers practised zero tillage, this response maybe because of the labour intensiveness of the strategy. 15% of the farmers practised multiple cropping with most of the farmers favouring horticultural crops as they have easy access to the Chitungwiza market. 9% engaged to drought resistant varieties, as farmers are well vested with knowledge pertaining seeds they can use in their area.

10% of farmers are shifting to tobacco, proving that farmers are losing confidence in maize due to the price instability and also the reduction in maize quantity due to climate change. 8% of the farmers have shun farming and looked for other sources of income as a way of living. 5% of the population has done nothing about climate change; maybe because these farmers have large farm size thus the impact of climate change is unnoticed.

The results (table4.3.1) above show that there are four dominating strategies; varying planting dates, dry and early planting, minimum tillage and multiple cropping had larger adoption rates which were 17%; 15%; 19% and 15%, proving its accessibility availability and affordability. The researcher looked at factors affecting adaptation to dry and early planting, varying planting dates and minimum tillage. The researcher excluded multiple cropping strategy because the study was mainly focusing on maize production.

4.3 Factors affecting climate change adaptation strategies

A multinomial regression was carried out to analyse factors affecting climate change adaptation. The MNL was made by normalising one adaptation strategy and minimum tillage was considered as the 'base category' and the following results were obtained;

Table 4.3.2 MNL regression results

Copying strategy	Coefficient.	Standard error	z	p>|z|
Dry and early planting				
Gender	-2.6578	1.323111	-2.01	0.045**
Age	2.155705	1.263057	1.71	0.088
Education	-1.7479	0.6717033	-2.60	0.009**
Household size	5.0622	1.4497	3.49	0.000**
Farm size	0.3490	1.2383	0.28	0.778
Constant	-7.70369	4.048661	-1.90	0.057
Varying planting dates				
Gender	-4.2485	1.7461	-2.43	0.015**
Age	2.7635	1.4940	1.85	0.064
Education	-2.2886	0.8184	2.80	0.005**
Household size	20.8468	1981.761	0.01	0.992
Farm size	4.5948	1.63555	2.81	0.005**
Constant	-44.8791	3963.523	-0.01	0.991
Note **-significance at 10%				
Number of observations	80			
Log likelihood chi2(10)	90.71			
Prob > chi2	0.0000			
Pseudo R^2	0.5652			
Log likelihood	-34.895372			

The table 4.3.2 above shows the computed multinomial regression to identify the factors that affect adaptation strategies by households in Seke. The research was done on 80 households. Although the independent variables have an effect on copying strategies there was a likelihood ratio statistic of 90.71 with an associated p value of 0.0000, meaning we reject the null hypothesis that all slope coefficients are equal to zero in favour of the alternative hypothesis that they are not equal to zero.

According to Gujarati (2004) a negative constant shows the impossibility of an event occurring when all explanatory variables are at zero, in this study the negative constants are the impossibility of adaptation to a strategy when all explanatory variables are at zero. According to Green (2000) the R^2 obtained suggest that the regression line obtained is a good fit of the model if the multiple coefficient of determination is above 50%. The obtained Pseudo R^2 of 0.5652 supposes that 56.52% of the likelihood of choosing an adaptation strategy is explained by the independent variables.

Age of the household head tend to be statistically insignificant for both strategies but has been shown that adaptation to climate change is positively influenced by age. As age of household increases the more likely the farmers are going to adapt to climate change adaptation strategies. The positive relation could be explained that as age of household head increases, the more likely the household head will acquire more knowledge about weather forecast and at the end have a weather pattern in mind thus increasing one's chances of adapting to different adaptation strategies. In this study age was found to being insignificant as it would take time for one to note these changes in climate such that an increase in one age by a year does not mean that one will be well vested with weather patterns but rather it takes more years for one to note climatic changes.

Education level was found to be statistically significant with a negative relation to the adaptation of varying planting dates and dry and early planting strategy with a p value of 0.005 and 0.009 respectively showing that as the level of education increases the probability of farmers shunning copying strategies also increases. As shown in the study by Okoye (1998) and Gaukd et al (1989) where level of education was found to be negatively correlated with adaptation, the more people learn the more they become resilient to change. As level of formal education increases individuals are likely to reduce dependence on farming by diversifying to non farming activities, some shifting to cash crops like tobacco.

Farm size was shown to be statistically insignificant for dry and early planting adaptation strategy. Since dry and early planting seem to be more of a capital intensive strategy, having readily available finances to purchase inputs earlier. Farm size was statistically significant and had a positive relation to varying planting date strategy. If the farm size was to increase then the probability of adaptation to varying planting dates is likely increase while holding all other variables in the model constant. Since varying planting dates requires a larger piece of land, farmers with a greater portion of land are the ones that are more likely to adapt to this strategy as asserted by Anim (1999) in a study done in South Africa.

Gender proved to be statistically significant with a negative relation on dry and early planting and varying planting dates relative to the minimum tillage with an associated p value of 0.045 and 0.015 respectively. If the gender of the household head was to change then the probability of adaptation to any of the strategies will decrease while holding all other variables in the model constant. Female heads tend to adapt to conservation practices compared to male heads as shown by studies done by Bayard et al (2007) and Dolisca et al (2006). The more labour intensive the strategy is the less likely female headed households are likely to adapt to climate change. Male headed households are relatively flexible as compared to female household head, they can easily drive their labour force to either of the strategies as compared to women.

Household size proved to have different effects on the adaptation of strategies. Dry and early planting; household size was found to be statistically significant with a positive relation to adaptation with an associated p value of 0.000 meaning that as household size increases the probability of adapting to dry and early planting will also increase. But however, an increase in household size was found to being statistically insignificant for the probability of adaptation of varying planting date strategy. The positive relation between varying planting dates and household size could be that adaptation strategy can respond to household size but with an insignificant effect. This could be dry and early planting demands more labour yet varying planting date is rather an income driven strategy. The study is in line with the investigation of Aymone (2009) that a larger household size is more likely to choose an adaptation strategy that is labour intensive in this study assuming that dry and early planting is a labour intensive strategy than varying planting date.

4.4 Marginal Effects

According to Green (2000) the marginal effects measure the expected change in probability of particular choice being made with respect to unit change in an explanatory variable. It also reports the discrete change in the probability for dummy variables. According to Green (2002) for a multinomial logit, a unit change in explanatory variable, relative to base group is expected to change by a relative coefficient

Table 4..4.1 Marginal effects for dry and early planting

Variable	δy/δx	Standard error	z	p|z|
Farm size	0.796296	0.34299	0.23	0.816
Household size	1.157281	0.85635	1.35	0.177
Education	-0.39984	0.20873	-1.92	0.055
Age	0.4931285	0.31867	1.55	0.122
Gender*	-0.3789036	0.59322	-0.98	0.329

(*)dy/dx is for discrete change of dummy variable from 0 to 1

The marginal effect results for dry and early planting showed that a unit change in farm size, household size and age has a positive and statistically insignificant effect. Gender has a negative and statistically insignificant effect on adaptation to dry and early planting. Education was found to being statistically significant, a unit increase in level of education of the household head will lead to a 40% decrease in the probability of adapting to dry and early planting strategy.

4.10 Marginal effects of minimum tillage

Variable	δy/δx	Standard error	z	p|z|
Farm size	-0.08027	0.4289	-0.19	0.8552
Household size	-1.16002	1.1275	-1.03	0.304
Education	0.40008	0.19171	2.09	0.037*
Age	-0.493416	0.30175	-1.64	0.102
Gender*	0.5797691	0.26775	2.17	0.030*

(*)dy/dx is for discrete change of dummy variable from 0 to 1

The marginal effects for minimum tillage show that farm size, household size and age have got negative and statistically insignificant effect on adaptation to minimum tillage strategy. Education was found to be statistically significant with a positive relation. A unit increase in level of education increases the probability of adapting to minimum tillage by 40% and a change in gender of household head will increase the probability of adaptation to minimum tillage by 58%.

4.11Marginal effects for varying planting dates

Variable	δy/δx	Standard error	z	p|z|
Farm size	0.0006433	0.5098	0.00	0.99
Household size	0.0027412	1.8872	0.00	0.99
Education	-0.0002401	0.1903	-0.00	0.99
Age	0.0002877	0.22797	0.00	0.99
Gender*	-0.0008655	0.68545	-0.00	0.99

(*)dy/dx is for discrete change of dummy variable from 0 to 1

From the marginal effects obtained farm size, household size and age have a positive relation but statistically insignificant. Level of education and gender has a negative and statistically insignificant relation to the adaptation of varying planting date strategy.

4.4 Conclusion

This chapter looked at the climate change copying strategies employed by the rural farmers in Seke district, the researcher went on to analyse the factors that affect the adaptation of strategies to combat the effects of climate change on maize production using the multinomial logit regression. The researcher found out that majority of the farmers has employed copying strategies to combat the effects of climate change on maize production. It has also been proven that different factors affect copying strategies differently; age, farm size, gender and education have an effect on varying planting dates and age, and household size, gender and education affect dry and early planting. The next chapter will look at conclusions drawn from the results and recommendations from the study.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The research was undertaken in quest of analysing the factors affecting climate change adaptation strategies, identifying the strategies that are employed by rural farmers in Seke district in combating the effects of climate change. This chapter will focus on summarising and giving implications and proposing recommendation to concerned stakeholders.

5.1 Research Findings

The research findings show that dry and early planting, varying planting date, multiple cropping and minimum tillage are dominating strategies being employed by farmers in Seke district. Other competing strategies are shifting to tobacco and non farming activities.

It has been proved that not all factors that affect one strategy will also affect the other strategy in the same way. Age proved to be statistically insignificant for both strategies but however, it had a positive relation to both strategies. Household size has a positive and statistically significant effect on dry and early planting whereas gender and education level have a negative statistically significant effect on dry and early planting. For varying planting date strategy age and farm size have a positive and statistically effect whereas gender and level of education have a negative and statistically significant effect on varying planting date.

5.2 Conclusion

Knowing factors that affect climate change adaptation can help in the formulation of policies and investments strategies cushioning the effects of long term climate change. Since most rural farmers depend on rain-fed agriculture as their source of livelihoods and have a low capacity to adapt to changes in climate change, policies to help farmer adopt are of great importance. An understanding of the adaptation measures employed by the household will enhance policy towards tackling the effects of climate change. Adaptation strategies employed by households in Seke included; dry and early planting, irrigation, varying planting dates, minimum tillage, multiple cropping, drought resistant varieties, shifting to tobacco, non farming activities and others do nothing.

A multinomial logit regression model was employed to analyse the factors affecting choice of adaption strategy related to climate change. The results showed that education level, gender, age and household size had a significant effect on dry and early planting, education level, farm size, age and gender had a significant effect on varying planting dates.

5.3 Recommendations.

Based on evidences obtained from the findings and the low adaptive capacity of climate change there is need to address factors influencing adaptation strategies in the study and promote the unrevealing strategies employed by the household.

i. There is need for multidisciplinary approach of extension so that there is an increased and strengthened adaptive capacity of the households. There is need to bring together farmers all stakeholders to develop common understanding of different perceptions to facilitate a better and acceptable strategy. To strengthen and increase adaptive capacity there is also need to improve the social and infrastructure and institutions dealing with climate related issues.
ii. Policy making, it appears that education would do most of the hasten adaptation and increase household decision regarding the key adaptation techniques. There is need to teach individuals the essence of agriculture and the contribution of rural farmers to the nation. There is also need to promote non formal and informal education to help farmers cope with climate change.
iii. In policy making there is need to include the elderly as they are well vested with weather patterns hence having an influence on adaptation and may increase the acceptability of a strategy by households.

5.4 Area of further study

The copying strategies that are being employed by farmers in Seke district ward 7 have been identified and an analysis of factors affecting the dominant strategies has been done. The researcher suggests that the studies be done in areas other than Mashonaland East. Other researchers may look at factors affecting other strategies besides the three dominating strategies done in this study. More variables that influence adaptation strategies such as income, access to market, access to information, may be added and analysed to see their effects on adaptation strategies of maize production.

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Appendix1 Questionnaire

My name is Palmmah Gutu an Agricultural Economics and Development student at Midlands State University doing a research topic on analysis of factors affecting climate change adaptation strategy. I hereby ask for your support by filling in questions below. There is no wrong answer and the following is only for academic use only.

Name of Respondent ....

Gender ....1 female 0 male

Age...(0 (18-29) 1 (30^{+})

Household size...

Farm size...

Access to information...yes/no

Level of education none ☐ primary ☐ secondary ☐ tertiary ☐

The following table is a list of potential adaptation strategies tick to indicate the measure you have been using.

Copying strategy	Tick the strategy being used
Winter ploughing	
Dry and early planting	
Irrigation	
Varying planting dates	
Multiple cropping	
Drought resistant varieties	
Shifting to tobacco	
Noon farming activities	
Reduce area of planting	
Increase plant spacing	
Zero fertilizer usage	

Do nothing	
Zero tillage	

If the strategy being used is note indicated above please indicate below ....

Comment on the strategy being used

....

Indicate any assistance that you think will aid in your situation

....

Copying strategy 1 dry and early planting. 2 minimum tillage. 3 varying planting dates

Appendix 2 results

Model Specification test

```
Ramsey RESET test using powers of the fitted values of copyingstrategies
       Ho:  model has no omitted variables
                  F(3, 71) =      2.54
                  Prob > F =      0.0632
```

Correlation

	gender	age	edu	househ~d	farmsize
gender	1.0000				
age	-0.1623	1.0000			
edu	-0.2779	0.0117	1.0000		
household	-0.1307	0.0107	-0.2743	1.0000	
farmsize	0.1647	0.0673	0.0120	0.0499	1.0000

Multinomial logit regression

```
Multinomial logistic regression                   Number of obs   =         80
                                                  LR chi2(10)     =      90.71
                                                  Prob > chi2     =     0.0000
Log likelihood = -34.895372                       Pseudo R2       =     0.5652
```

copyingstr~s	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dryandearl~g						
gender	-2.657831	1.323111	-2.01	0.045	-5.251082	-.0645803
age	2.155705	1.263057	1.71	0.088	-.3198417	4.631251
edu	-1.747916	.6717033	-2.60	0.009	-3.06443	-.4314012
household	5.062241	1.449734	3.49	0.000	2.220814	7.903669
farmsize	.3490246	1.238386	0.28	0.778	-2.078168	2.776217
_cons	-7.703699	4.048661	-1.90	0.057	-15.63893	.2315304
minimumtil~e	(base outcome)					
varyingpla~s						
gender	-4.248516	1.746148	-2.43	0.015	-7.670904	-.8261283
age	2.763579	1.494077	1.85	0.064	-.1647586	5.691917
edu	-2.288663	.8184802	-2.80	0.005	-3.892855	-.6844715
household	20.84685	1981.761	0.01	0.992	-3863.333	3905.026
farmsize	4.594822	1.635509	2.81	0.005	1.389283	7.800361
_cons	-44.87919	3963.523	-0.01	0.991	-7813.242	7723.484

Chi-square tests

. tab gender copyingstrategies,chi2

gender	copying strategies dryandear	minimumti	varyingpl	Total
male	12	9	5	26
female	14	32	8	54
Total	26	41	13	80

Pearson chi2(2) = 4.4998 Pr = 0.105

. tab age copyingstrategies,chi2

age	copying strategies dryandear	minimumti	varyingpl	Total
18-29	15	30	7	52
30+	11	11	6	28
Total	26	41	13	80

Pearson chi2(2) = 2.5244 Pr = 0.283

. tab edu copyingstrategies,chi2

edu	copying strategies dryandear	minimumti	varyingpl	Total
none	7	0	2	9
primary	11	19	9	39
secondary	6	12	1	19
tertiary	2	10	1	13
Total	26	41	13	80

Pearson chi2(6) = 17.2474 Pr = 0.008

. tab household copyingstrategies,chi2

household	copying strategies dryandear	minimumti	varyingpl	Total
<6	1	31	0	32
>6	25	10	13	48
Total	26	41	13	80

Pearson chi2(2) = 44.4895 Pr = 0.000

. tab farmsize copyingstrategies,chi2

farm size	copying strategies dryandear	minimumti	varyingpl	Total
<0.5ha	24	34	5	63
>0.5ha	2	7	8	17
Total	26	41	13	80

Pearson chi2(2) = 15.8927 Pr = 0.000

Marginal effects for dry and early planting

. mfx, predict(p outcome(1))

Marginal effects after mlogit
y = Pr(copyingstrategies==dryandearlyplanting) (predict, p outcome(1))
= .35446821

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
farmsize	.0796296	.34299	0.23	0.816	-.592624	.751883	1.2125
househ~d	1.157281	.85635	1.35	0.177	-.521139	2.8357	1.6
edu	-.3998422	.20873	-1.92	0.055	-.808953	.009269	1.45
age	.4931285	.31867	1.55	0.122	-.131445	1.1177	1.35
gender*	-.5789036	.59322	-0.98	0.329	-1.74159	.583784	.675

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects for minimum tillage

```
. mfx, predict(p outcome(2))

Marginal effects after mlogit
      y  = Pr(copyingstrategies==minimumtillage) (predict, p outcome(2))
         =  .64538789
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
farmsize	-.0802729	.4289	-0.19	0.852	-.920901	.760355	1.2125
househ~d	-1.160022	1.12753	-1.03	0.304	-3.36994	1.0499	1.6
edu	.4000823	.19171	2.09	0.037	.024344	.775821	1.45
age	-.4934161	.30175	-1.64	0.102	-1.08484	.09801	1.35
gender*	.5797691	.26775	2.17	0.030	.05498	1.10456	.675

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Marginal effects for varying planting date

```
. mfx, predict(p outcome(3))

Marginal effects after mlogit
      y  = Pr(copyingstrategies==varyingplantingdates) (predict, p outcome(3))
         =   .0001439
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
farmsize	.0006433	.5098	0.00	0.999	-.998551	.999837	1.2125
househ~d	.0027412	1.8872	0.00	0.999	-3.69611	3.70159	1.6
edu	-.0002401	.1903	-0.00	0.999	-.373226	.372745	1.45
age	.0002877	.22797	0.00	0.999	-.446523	.447098	1.35
gender*	-.0008655	.68545	-0.00	0.999	-1.34431	1.34258	.675

(*) dy/dx is for discrete change of dummy variable from 0 to 1