BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF CROP SCIENCE

Assessing farmer perceptions and experiences of climate change impacts on agricultural production: The case of Madziva Ward 4, Shamva District, Mashonaland Central

MWANGA OPERTIENCE

B1230908

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF AGRICULTURAL SCIENCE HONOURS DEGREE (CROP SCIENCE)

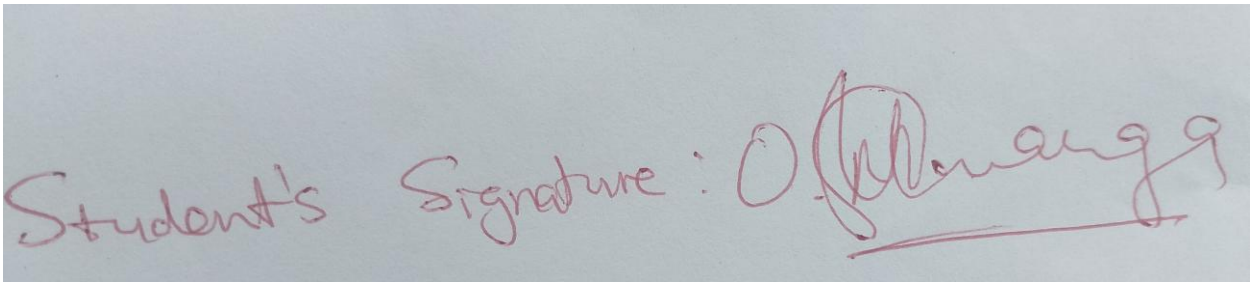
YEAR 2025

ABSTRACT

The researcher noted that there is a limited understand of how small holder farmers perceive and experience the impacts of climate change on their agricultural production and how they adapt to these changes. In order to explore the experiences and perceptions of smallholder farmers via a Vis maize production in Ward 4 Madziva in Shamva District, the researcher utilized a qualitative approach and sampled 30 participants as prescribed by Creswell. The study found out that smallholder farmers perceived that climate was changing and this is attributed to observable changes in weather variables such as rainfall, temperature and increased occurrence and severity of extreme weather events such as heavy rains in a short time causing intensive flush floods, excessive rainfall during early stages of crop development and prolonged drought periods or dry spells in the mid and later stages of the crop. It was also observed that majority of the maize farmers that participated in the survey were aware that the climate is changing and were already making various adjustments to maize production to stabilize or increase their yields. The study concluded that sustainable production of maize in Ward 4 Madziva in Shamva District will require farmers to effectively adapt to climate change. The different farming scales in the area indicate the need for a robust adaptation strategy that not only considers the implementation of good adaptation approaches and takes into account the differential vulnerability of the different farmer typologies, but also recognises the possibility of maladaptation if the perceived changes in climate are not well understood.

APPROVAL FORM

The undersigned certified that they have supervised and recommended to Bindura University of Science Education for acceptance of dissertation entitled, **Assessing farmer perceptions and experiences of climate change impacts on agricultural production: The case of Madziva Ward 4, Shamva District, Mashonaland Central** submitted in the partial fulfilment of requirements of Bachelor Honours Degree in Crop Science.



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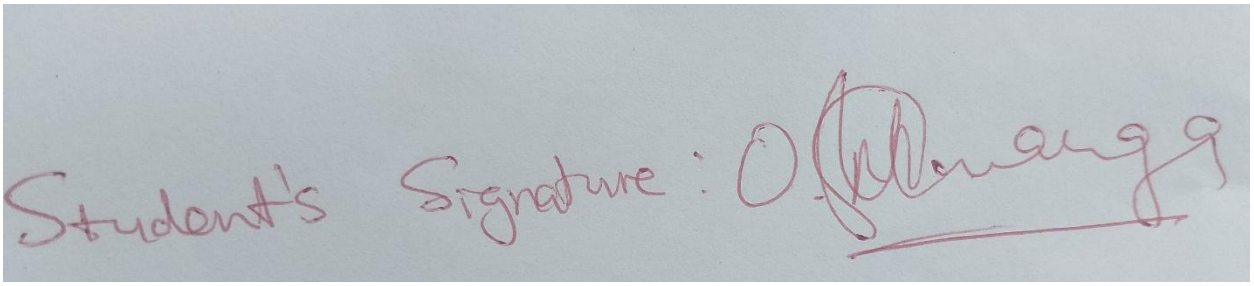
DECLARATION

I, Mwanga Oppertience, solemnly declare that this dissertation is the product of my own scholarly endeavours. Every concept, idea, and expression borrowed from other sources has been meticulously acknowledged. This work has not been submitted to any institution for academic purposes, and I take full responsibility for its content.



DEDICATION

I dedicate this write up to my family.

ACKNOWLEDGEMENTS

I would like to express my profound gratitude to the faculty of Agriculture and Environmental studies at Bindura University of Science Education in particular the guidance from the department of Crop Science and my supervisor Ms Kamota for her diligent effort to make my work related learning fruitful and success.

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CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 Introduction and Background

Climate change is a pressing global issue, with far-reaching impacts on agriculture. Rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events affect crop yields, quality, and distribution (WHO, 2017). Maize, a staple crop in many countries, including Zimbabwe, is particularly vulnerable to climate-related stresses. Maize is a crucial crop in Zimbabwe, contributing significantly to food security, employment, and the economy (*ibid).* Smallholder farmers, who dominate the agricultural sector, are heavily reliant on maize production for their livelihoods. However, climate change poses a significant threat to maize production, with potential impacts on yields, quality, and food availability (Thornton, 2020). The researcher is convinced that farmers' perceptions of climate change and its impacts on agriculture are critical in determining their adaptation strategies hence the study. Understanding these perceptions and the factors that influence them can inform policy and practice, supporting farmers in developing effective adaptation strategies.

Climate change is a threat to food security and livelihoods of the rural poor because climate change causes yield loss and uncertainty. A limited understanding of the impact of climate change among residents can impact on the adoption and implementation of climate resilient strategies hence leading to continued vulnerability to climate change among communities (World Bank, 2017). The change and uncertainty in rainfall patterns can affect the maize output and in the long run heavily impact smallholder farmers who rely heavily on rain-fed agriculture and have fewer alternatives and limited knowledge on how to cope (Abera et al., 2018).

In most Southern African countries maize farming is the source of livelihoods and climate change has emerged as one of the biggest threat in farming which has impacted negatively on maize yield. Maize farming sustain about 70 % of the population of the region and percentage can only be sustained if farmers are equipped with knowledge about climate change so that they can embrace climate change coping.

Due to climate change, maize yield in Southern Africa is expected to fall by an average of 18-22% by mid-21st century (IPCC, 2014). Similarly, simulation results of climate change scenarios by Thornton (2020) indicate that maize yield is expected to decrease by more than 5% by 2050 in the

northern part of East Africa. Farmer knowledge and perception of climate change is expected to help boost maize yields though to a lesser degree as this will empower farmers to adapt and implement climate resilient strategies which help them cope better with the effects of climate change and enhance their livelihoods.

1.2 Statement of the Problem

Limited understand of how small holder farmers perceive and experience the impacts of climate change on their agricultural production and how they adapt to these changes. This knowledge gap hinders the development of effective policies and interventions to support climate resilient agriculture and improve livelihoods among farmers.

1.3 Research Objectives

1.3.1 Main Objective

The main objectives of the study is to assess farmer perceptions and experiences of climate change impacts on agricultural production**.**

1.3.2 Specific Objectives

1. To explore the perceptions and experiences of smallholder farmers regarding the impacts of climate change on their agricultural production.

2. To assess farmers perceive changes in temperature, precipitation and rainfall when extreme weather events are affecting their crops and livelihoods.

3. To analyse farmer adaptation strategies that farmers employ to mitigate the impact of climate change.

1.4 Research Questions

1. What are the perceptions and experiences of smallholder farmers regarding the impacts of climate change on their agricultural production?

2. How do farmers perceive changes in temperature, precipitation and rainfall when extreme weather events are affecting their crops and livelihoods?

3. What adaptation strategies does farmers employ to mitigate the impact of climate change?

1.5 Significance of the Study

This study will help policy makers to create a blueprint or handbook which can be used to direct the maize farming Vis a Vis climate change. The manual will help farmers to understand ways through which farmers can grow maize and attain greater yields within a climate changing environment.

1.6 Limitations of the Study

The study limitations will be the following:

Participant Bias

The study will likely to experience participation bias. This is potentially because some participants' aim will be to participate in the study and this may lead to exaggeration of the exact results.

1.7 Delimitations of the Study

The study is delimited within the period 2018 - 2023 in Madziva Ward 4, Shamva District, Mashonaland Central.

1.8 Chapter Summary

The perception of smallholder farmer is crucial in understanding the impact of climate change to smallholder farmers. This is so because the impact is as severe as it is perceived hence the need to explore farmer perceptions and develop coping strategies that will help farmers address climate change effectively.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviewed other studies related to climate change and its impact on maize yields and food security in Africa. It also shows the theoretical frame work vis a vis climate change and the solutions thereof.

2.2 Changes in Africa

Climate change poses a significant threat to food security worldwide, with particularly severe implications for the African continent (Misra, 2014; Myers et al., 2017; Molotoks et al., 2021; Muluneh, 2021). Africa is highly vulnerable to the impacts of climate change due to its dependence on rainfed agriculture, limited adaptive capacity, and socio-economic challenges (Cooper et al., 2018; Awazi et al., 2021; Bedeke et al., 2021). As temperatures rise and weather patterns become more erratic, the continent faces a myriad of challenges ranging from reduced agricultural productivity to increased frequency of extreme weather events (El-Beltagy & Madkour, 2022; O'Leary et al., 2018; Adjei & Amaning, 2021). These impacts are exacerbated by factors such as rapid population growth, inadequate infrastructure, and limited access to resources, exacerbating food insecurity among vulnerable populations (IPCC, 2014; Mbow et al., 2020; Townsend et al., 2021).

Understanding the complex interactions between climate change and food security in Africa is crucial for designing effective adaptation and mitigation strategies to safeguard livelihoods and ensure food security for all (Connolly-Boutin & Smit, 2016). By synthesizing existing knowledge and identifying key research gaps, this review aims to inform evidence-based decision-making and support efforts to build climate-resilient food systems in Africa.

Climate change poses a significant threat to food security in Africa, exacerbating existing challenges and vulnerabilities (Thornton et al., 2014; Myers et al., 2017; Kogo et al., 2021). The current situation is dire, with millions of people across the continent already experiencing food insecurity due to climate-related impacts on agricultural production and livelihoods (Sova et al., 2019; Mukwada et al., 2020). The Intergovernmental Panel on Climate Change (IPCC) warns that without urgent action, the situation is likely to worsen, leading to increased hunger and malnutrition (IPCC, 2014). Previous research efforts have made strides in understanding the

complex interactions between climate change and food security in Africa. Studies have examined the impacts of changing weather patterns on crop yields, livestock productivity, and food access, highlighting the diverse challenges facing different regions and socio-economic groups (Simeltonet al., 2022; Thornton & Herrero 2024; FAO, 2019; Godde et al., 2021).

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Previous research efforts have made strides in understanding the complex interactions between climate change and food security in Africa. Studies have examined the impacts of changing weather patterns on crop yields, livestock productivity, and food access, highlighting the diverse challenges facing different regions and socio-economic groups (Simelton et al., 2022; Thornton & Herrero 2024; FAO, 2019; Godde et al., 2021). However, despite these efforts, significant gaps remain in our understanding of the extent and magnitude of climate change impacts on food security in Africa. One key gap is the lack of comprehensive, integrated analyses that consider the multiple dimensions of the problem, including regional variations and socio-economic contexts. While individual studies have provided valuable insights into specific aspects of the issue, there is a need for a systematic synthesis of existing knowledge to identify emerging trends, vulnerabilities, and adaptation strategies across the continent (FAO, 2019). Addressing these gaps is essential to inform evidence-based decisionmaking and to develop effective strategies for building climate-resilient food systems in Africa.

2.3 The impact of climate change on production

Climate change is a threat to food security and livelihoods of the rural poor. Reported projections on climate change indicate that Africa will be the hardest hit because many smallholder farmers largely or totally rely on rain-fed agriculture and have fewer alternatives ((IPCC) 2021; Boko et

al. 2017; Tesfaye et al., 2015; Abera et al., 2018), due to high levels of poverty, low levels of human and physical capital, and poor infrastructure (IFPRI) 2019).

In Sub-Saharan Africa, the agriculture sector is one of the most important sectors providing employment for about 70 % of the population of the region (World Bank 2017). Rainfed agriculture is very important in this part of the world (Ringler et al. 2020; Webber et al. 2014). The spatial and temporal variability of rainfall, which is reflected by recurrent dry spells and floods, is the most important factor affecting crop productivity, hence reducing food security (Laux et al. 2010; IPCC 2014). In addition, rainfed agriculture is dominated by smallholder farming that have limited options for investment (i.e. fertilizers, pesticides, machines) and irrigation, making it a highly vulnerable agricultural system (Roudier et al. 2011; Calzadilla et al.
2013).

It is well accepted in literature that interand intra-seasonal rainfall variability are the major causes for crop failure (e.g. Usman et al. 2005; Mishra et al. 2008; Laux et al. 2008, Laux et al. 2009; Waongo et al. 2014; KyeiMensah et al., 2019). Thus, the amount and distribution of rainfall within the cropping season is very important for crop growth, crop development and yield formation. In the semiarid regions of Africa, Agricultural systems reliant on rainfall as a sole source of moisture for crop production inevitably experience highly variable production levels and risks due to seasonal rainfall variability. This phenomenon is gradually shifting to the subhumid regions, where increasing variability in seasonal rainfall totals and distribution is occurring more frequently (Cooper et al. 2006).

While total seasonal rainfall and the season-to-season variability are themselves important (Siegmund et al. 2015), the nature of the within-season variability can also have a major effect on crop productivity, especially at certain critical stages (flowering and grain filling stage) of the crop. The onset of the season is another important variable that affects crop production (Ingram et al. 2022; Ziervogel and Calder 2003), particularly if the end of this season does not shift concomitantly as plant available water depends on the onset and the length of the season.Thus, climate change and variability are expected to have significant negative impacts on crop growth and developmental processes although the extent of these effects are known to be dependent on the nutrient status of the soil.

Kimball (1983) stated that photosynthetic rate of plants can be affected by an increase in carbon dioxide (CO2) which will in some cases lead to higher yield. Similarly, changes in temperature and precipitation will affect crop photosynthesis, crop development rates, as well as water and nutrient availability to crops (Long 1991). IPCC (2014) indicates that an increase in temperature of 2º C or more in the late 20th century is expected to negatively affect major crops (i.e. wheat, rice, and maize) in both temperate and tropical regions. Climate impacts, however, are expected to differ depending on the geographical location.

Lobell et al. (2021) reported that each degree-day temperature above 30º C reduces crop yield by 1% under optimal rainfed conditions and by 1.7% under drought conditions in Africa. In Southern Africa and across SSA, respectively, crop yields are expected to decrease averagely by 18% and 22% by mid-21st century (IPCC 2014). Similarly, simulation results of climate change scenarios by Thornton et al. (2010) indicate that maize yield is expected to decrease by more than 5% by 2050 in the northern part of East Africa. For the 2020s, however, yields are likely to benefit from the CO2 fertilization effect. An algorithm to adapt the planting dates in order to increase the attainable yields and reduce its variability at the same time was introduced as a potential adaptation measure to reduce the negative impacts on crop productivity.

In general, the value of agriculture followed the rise in the GDP between the period 1946 and 2004, but experienced some dips in the 1980s and the early 1990s (Greyling, 2022). The reductions in GDP occurred in conjunction with the droughts mentioned above. The contribution of agriculture to GDP, however, fell within the same period. The adverse climate trends can explain this decrease in the agricultural contribution to the GDP. However, some explanations can be derived from other sectors that increased their contributions to the GDP. To accurately assess the extent of climate trends in South Africa it is, therefore, essential to use not only the value of the agricultural GDP, but also the trends in the production and harvest of critical crops such as maize.The total acreage under maize fell during the period 1966 to 2004, and total production experienced an irregular cycle with extreme lows in the early 1980s and 1990s. The plummet in total production is a further reflection of the fall in total acreage rather than in yield; that is, maize yield did not change significantly over the period. The slight fall in maize production shows that there is an appropriate adaptation in the sector, such as the improved use of inputs. However, the decrease in the area

under maize may indicate that some areas, especially in the arid agro-ecological zone, may be becoming too hot for the crop.

From the above, it is, therefore, possible to deduce a clear link between temperatures and land area under crops, but not a similar link between precipitation and land area under crops. Higher temperatures over the period may have made some areas, especially the arid areas, less suitable for field crops, which is one reason why the total land area for maize has declined, particularly since the 1980s. But it can be observed that, despite the decrease in total area planted by crops in response to higher temperatures, the yields for each of these crops have not changed significantly over the years, and total production has not seen a significant reduction Agricultural Research Council, 2018).

2.4 Farmer Perception on Climate Change Impact

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties (IPCC, 2013). This change can be due to natural internal processes or external forcings, such as changes in solar radiation or volcanic eruptions. Farmer perceptions refer to the understanding and interpretation of climate change and its impacts on their agricultural practices. Farmer perceptions are critical in determining their adaptation strategies and responses to climate change.

Changes in temperature and precipitation patterns can impact crop growth, development, and yields (Knox et al., 2012). Warmer temperatures can lead to increased evapotranspiration, reducing crop water availability and impacting yields. Increased frequency and severity of droughts, floods, and heatwaves can damage crops and impact agricultural productivity (FAO, 2017). Extreme weather events can also lead to loss of livelihoods and assets for farmers. Climate change can alter the distribution and prevalence of pests and diseases, affecting crop health and yields (Bebber et al., 2013). Changes in temperature and precipitation patterns can create favorable conditions for certain pests and diseases.

Farmer perceptions of climate change and its impacts on agriculture are critical in determining their adaptation strategies. Studies have shown that farmers' perceptions are influenced by factors such as: Farmers' personal experiences and observations of climate change impacts on their

agricultural practices (Maddison, 2007). Farmers who have experienced climate-related shocks are more likely to perceive climate change as a threat.

Social and cultural norms, values, and beliefs can influence farmers' perceptions and adaptation strategies (Roncoli et al., 2001). For example, some farmers may view climate change as a natural phenomenon, while others may see it as a result of human activities. Farmers' access to climate information, extension services, and other resources can impact their ability to adapt to climate change (Ziervogel et al., 2006). Farmers who have access to climate information and resources are more likely to adopt adaptation strategies.

Farmers can employ various adaptation strategies to mitigate the impacts of climate change on agriculture, including; practices such as minimum tillage, mulching, and crop rotation can improve soil health and reduce erosion (Kassam et al., 2009). Conservation agriculture can also help to reduce greenhouse gas emissions. Efficient irrigation management can help farmers adapt to changing precipitation patterns and reduce water waste (FAO, 2012). Irrigation management can also help to improve crop yields and quality. Growing multiple crops can help farmers spread risk and improve resilience to climate-related shocks (Lin, 2011). Crop diversification can also help to improve soil health and reduce pests and diseases.

2.5 Theoretical Framework

Reddy (2008) conceptualized climate change to a broader set of alterations in climate patterns, which include warming as well as cooling trends and other meteorological changes. Reddy further argues that to some extent climate change may be as a result of natural causes but notes that increasingly human activities are now playing a huge role in causing climate change. Harmful human activities include deforestation, burning of fossil fuels and environmental pollution. These and other activities result in emissions of the greenhouse gases including carbon dioxide, chlorofluorocarbons, methane and water vapor. The change in climate patterns has greatly affected people especially in issues to do with food security. According to CARE (2009), they define climate change as an observed and projected increase in average global temperature and the associated impact including an increase in extreme weather reports and changes in the timing and amount of rainfall. The IPCC (2007) asserted that climate change is any change over times of the earth’s climate weather due to natural variability or because of human activity.

Chambers and Conway (1992) define livelihood as comprising the capabilities, assets and activities required for a means of living. An element of sustainability is brought out where scholars noted that a livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets while not undermining the resource base. Therefore, it becomes of importance to investigate the impact of climate change on livelihoods security in Tsholotsho since it compromises food security and has negative impact on women. Once again, Chambers (2004) noted that climate change is a threat and shock to the sustainability of livelihoods. Thus in livelihood terms, protection entails mitigating the impact of shocks and protecting livelihood assets such as livestock.

2.6 Chapter Summary

Climate change is becoming a reality even in Zimbabwe as confirmed by IPCC (2007) which observed that climate change has altered the predictability, intensity and geographical distribution of hydro meteorological hazards the world over. Drimie and Mini (2010) assert that climate change seriously affecting the livelihoods of developing countries. This being the case, Zimbabwe a developing country means it is not immune to the shock and impact of climate change. The livelihood strategies of Zimbabwe are equally at risk. Exposures to hazards such as climate change undermine livelihoods, simultaneously causing rural poverty, which has a negative impact on women especially in the rural areas. Poor people suffer the most since they have limited income-generating opportunities compared to those in urban areas. The use of the sustainable livelihood framework is therefore an attempt that could be employed to cope with shocks such as climate change.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The study utilized a qualitative research methodology. The choice to use this methodology was because the study that sought to explore perceptions and experiences of smallholder farmers in Ward 4 Madziva in Shamva District. This is because perceptions and experiences are unique and subjective (Aksoy, and Uzay, 2021). The qualiative methodology is thus suitable in this study.

3.2 Research Design

A qualitative research method was used in order to address the objectives of this research given that the research aim at exploring smallholder farmer experiences and percetions about climate change's impact on maize production in Ward 4 Madziva in Shamva. This phenomelogical study unpacked the perceived impact of climate change on maize production and how, based on the perception, did the farmers in Ward 4 Madziva in Shamva District adapted to climate change.

3.3 Population and Sample

This qualitative study adopted Creswell (1998)'s sample categorization. Creswell (1998) stated that a sample of 5-25 participants is a standard for phenomenalogical studies and a sample of 2030 for grounded theory. This sample categorization is in line with Warren (2002) who stated that a sample of 20-30 participants was standard for a qualitative study. This study will utilize a sample of 30 participants. In this study, the experiences, perceptions and responses will not be generalized as subjectives experiences are unique.

3.4 Data Collection and Analysis

Data Collection Methods

Semi-structured interviews will be conducted with farmers to explore their perceptions and experiences of climate change impacts on maize production. In order to obtain data, in-depth interviews and open ended questionnaires were used for data collection. Participants were asked about their experiences and perceptions in regard to the impact of climate change of agriculture production in particular maize production and we're also asked of the strategies that can be adopted in the future to help them cope with the impacts of climate change.

Data obtained from the study was analysed thematically. A thematic analysis was employed in order to help generate and develop themes from the findings and literature.

3.5 Ethical Considerations

In order to protect the participants, the research used pseudonyms. These helped in keeping the identify of participants private. Therefore participants are not blamed for the bad repute that may be caused by some responses that were given not will they suffer harm.

Limitations

The study's sample size may not be representative of all farmers in the region. The study will rely on farmers' subjective perceptions, which may be influenced by various factors.

Expected Outcomes

The study provided an in-depth understanding of farmer perceptions on the impact of climate change on maize production. It also led to the identification of adaptation strategies used by farmers to cope with climate-related impacts.

CHAPTER IV: DATA PRESENTATION, ANALYSIS AND INTERPRETATION 4.0 Introduction

This chapter is concerned with the presentation of the research findings, their analysis and interpretation. This will be done per thematic area as it appears on the household questionnaire. The data was captured from respondents through the use of questionnaires, interviews and focus groups discussions. The research was carried out to find the Impact of climate change on maize yields in Madziva Ward 4, Shamva.

4.1 Demographic analysis 4.1.1 Distribution of respondents by sex

The majority of the participants in the household survey were female 60 per cent and 40 per cent were male. This can be explained by the fact that it is more likely to find females at home than males. The majority of men are outside the country in search of employment or in the cities. Therefore, the findings indicate that women are likely to suffer more than men in climate change situations since they are the majority in the districts.

The data is presented below:

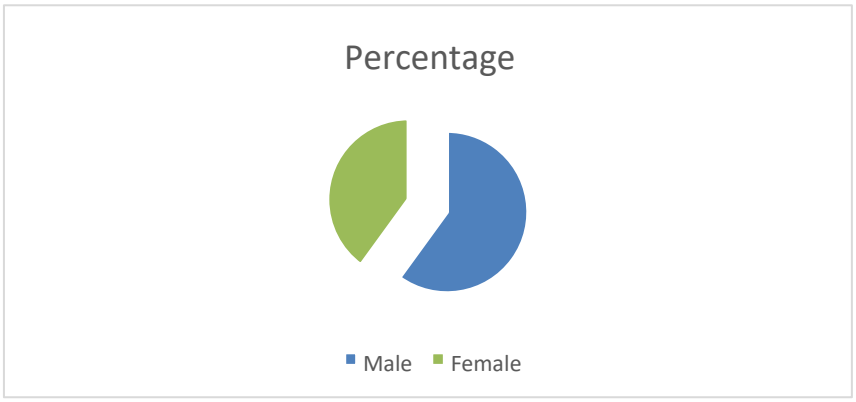

Figure 4.1 Distribution of respondents by marital status

Generally, most of the respondents are married, 62 per cent. The next majority is widowed 17 per cent followed by people who are single 13 per cent. Ward 4 in Madziva has the highest number of people who are single and ward 13 has the highest number of divorcees. The marital status may be linked to the vulnerability of the respondents.

4.2 Local perceptions and experience of climate change in Madziva Ward 4, Shamva

"The changing rainfall patterns and rising temperatures have made it difficult for us to predict when to plant and harvest our crops. We've experienced significant losses due to droughts and floods." , Smallholder farmer, Madziwa Ward 4

"The El Niño-induced drought was particularly devastating for our crops. We lost a significant portion of our yield, which affected our food security and livelihoods." Farmer, Shamva District

"We've noticed that the climate is becoming more unpredictable, and it's affecting our ability to plan and manage our farms. We need support to adapt to these changes." Farmer, Madziwa Ward 4

"The droughts and changing weather patterns have affected not only our crops but also our livestock. We've had to sell some of our animals at low prices, which has reduced our income." Smallholder farmer, Shamva District

"The climate-related challenges have forced us to look for alternative livelihoods, such as selling firewood or working as casual labourers. It's not what we want to do, but we have to survive." Farmer, Madziwa Ward 4

"We've started using Conservation Agriculture practices, such as minimal soil disturbance, pfumvudza and crop rotation, which have helped us to improve our crop yields and resilience to climate change." Farmer, Shamva District.

The following graph show the responses provided above:

Table 4.1 Pfumvudza

Conversation Strategies for Climate Resilience	**Farmer Participants**	**Expert Responses**
Minimal Soil Disturbances	2	3
Mulching	2	3
Crop Rotation	10	10

"The China-Aided Agricultural Demonstration Village has provided us with training on sustainable farming practices and access to high-yielding drought-resistant seed varieties. This has been very helpful in improving our productivity and adapting to climate change."

Smallholder farmer, Madziwa Ward 4

"The agricultural transformation project has helped us to shift from subsistence farming to a more business-oriented approach. We're now producing more crops and selling them at a better price, which has improved our livelihoods." - Farmer, Shamva District.

"We're learning new skills and techniques through the project, which is helping us to become more efficient and productive farmers. We're hopeful that this will help us to adapt to climate change and improve our food security." - Smallholder farmer, Madziwa Ward 4

These quotations provide insights into the perceptions of farmers on the impact of climate change and their experiences with adaptation strategies and agricultural transformation projects in Madziwa Ward 4, Shamva District.

Results from the survey reveal that the majority of the respondents have a clear understanding of climate change which they described in terms of change in weather parameters such as rainfall patterns 47 per cent, change in seasons 32 per cent and change in temperature 20 per cent. This knowledge is critical in reducing their vulnerability to the potential effects of climate change on food security. The respondents were the residents association together with the chief. This has a positive impact on the fight against climate change since leadership is well aware of the challenges they are facing. Therefore, 70 per cent of the respondents showed knowledge on the climate issue.

Ninety-three per cent of the respondents had noticed change in climate in their communities or in other communities and this was manifested in form of change, 31 per cent seasonal patterns, 15 per cent increase in drought intensity, 26 per cent frequency, decrease in precipitation 21 and increase in precipitation 7 per cent.

Furthermore, analysis revealed that respondents reported increased change in seasonal patterns and drought intensity. Similarly, 65 per cent of the majority of the participants in qualitative interviews defines climate change as the change in average weather conditions such as temperature and rainfall over a long period of time. It was noted in literature that changes in temperature and precipitation will affect crop photosynthesis, crop development rates, as well as water and nutrient availability to crops (Long 1991). IPCC (2014) indicates that an increase in temperature of 2º C or more in the late 20th century is expected to negatively affect major crops (i.e. wheat, rice, and maize) in both temperate and tropical regions. Climate impacts, however, are expected to differ depending on the geographical location.

'Climate change is the shift in the current state of the climate over at least several decades. These changes can be due to either natural variables or human activities. These changes are observed or projected increase in global temperature, extreme weather events, sea level rises and melting of glaciers.'(Agric extension officer, Agritex Tsholotsho, July 2013).

The majority of respondents (70%) interviewed acknowledged that climate was changing and this is attributed to observable changes in weather variables such as rainfall, temperature and increased occurrence and severity of extreme weather events such as heavy rains in a short time causing intensive flush floods, excessive rainfall during early stages of crop development and prolonged drought periods or dry spells in the mid and later stages of the crops whilst 30% were ignorant. Literature shows that changes in temperature and precipitation patterns can impact crop growth, development, and yields (Knox et al., 2012). Warmer temperatures can lead to increased evapotranspiration, reducing crop water availability and impacting yields. Increased frequency and severity of droughts, floods, and heatwaves can damage crops and impact agricultural productivity (FAO, 2017).

For example, during tasseling of maize. Flush floods destroy top soil causing severe soil erosion and damage to crops. This calls for adoption of critical technologies at household and community level such as conservation agric which entails soil cover, crop rotation, minimum tillage and early planting to preserve soil and water. Furthermore, changes in rainfall patterns weaken farmers' capacity to predict weather using Indigenous Knowledge systems which in turn affects their decision making capacity.

Akin to this, several authors have argued that climate change and variability pose challenges to Indigenous Knowledge in terms of coping strategies, (ICIMOD, 2009). Indigenous knowledge provides important opportunities for context and culturally specific early warning systems modes of engineering and architecture that are often less expensive and take little time and resources to reconstruct, (Verna, 2007).

The historical trend analysis revealed re occurrence of drought over a decade, with the reoccurrence interval shortening over the years. In the entire three wards communities experienced drought in 2008, 2020 and 2024. Although some groups reported increase in drought severity since 1992, other groups and individuals noted a decline in drought severity over the years. Shortening of drought recurrent interval will have severe effects of food production and household food security especially on women since they are the most affected

The farmers expressed their perceptions based on their observation of warmer summer and colder winter temperatures and rainfall variation over the years. Our assessment of maize farmers' perceptions of climate change, its impacts, coping mechanisms and adaptations in Ward 4 Madziva in Shamva suggests that the majority of the maize farmers that participated in the survey were aware that the climate is changing and were already making various adjustments to maize production to stabilize or increase their yields.

Evidence of adaptive responses in Ward 4 Madziva in Shamva Distrct is therefore seen as a promising move in the right direction, especially in the context of the warnings issued by Oduniyi et al. (2019), Adisa et al. (2018) and Shoko et al. (2019) about the future impacts of changes in rainfall and temperature in relation to maize production. The adaptive responses already discernable in Ward 4 Madziva Shamva are therefore in alignment with the call made by Nhamo et al. (2020) for proactive adaptation interventions in a region plagued with increasing aridity, low adaptive capacity, underdevelopment and marginalization.

Respondents' perceptions of climate change included their observations about decreases and delays in rainfall, increased incidences of temperature extremes, floods, droughts and storms, amongst others. These observations are in agreement with the findings of Elum et al. (2017) in other parts of the current study area. Thinda et al. (2020) recorded a similar trend in their study of climate change adaptation strategies among smallholder farmers, who are beneficiaries of the Zimbabwean land reform programme. It was also particularly noteworthy that the perceptions of the farmers were informed not just by their own observations of climatic conditions, but also by the information that they are receiving from the media and from farmer associations.

4.6 Chapter Summary

The chapter presented findings. The researcher distributed questionnaires to traditional leaders and the response rate was 67%. Plan staff was also given and 82% was the response rate. An impressive 100% was obtained from social services since all the questionnaires were completed and collected. From the councilors, the researcher got a response rate of 67%. Therefore of the total number of respondents which was 22, the researcher managed to obtain 17 of the respondent's .The researcher noticed that 78% of the respondents from all the departments and residents association are well aware of the climate change issues and they have noticed a decline in crop yields. Only a small per cent of 10% from ward 4 Madziva which have never experienced hunger and they have their normal three meals everyday unlike the majority, 70% which claim to have two meals a day and 20% only have one meal a day. The next chapter goes on to present summary, conclusions and recommendations on the impact of climate change on food security.

CHAPTER 5: SUMMARY, DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter presents a summary of the study and the conclusions drawn from it. The chapter further outlined the policy recommendations, as well as suggestions for further studies.

5.2 Summary

Climate change is a serious global threat to humanity. This is through its warming effects to sectors such as agriculture which provides food for most of the world population. In this case, yields of major crops such as maize, rice and wheat will become volatile due to increased climate variability thus driving up the price volatilities of food. The food price volatilities are not favorable especially in Africa where many people are poor. Climate change does not only undermine crop yields, it also makes other crops produced less nutritious; cause geographical shifts in fisheries; increased number of pests that thrive in warmer environments; and increased farm loses (due to natural disasters) in cases where farmers are not insured. As a result, there will be some developmental challenges which lead to poor economic performance which is a characteristic of many African countries.

In Madziva Ward 4 in Shamva District, agriculture contributes less than 2% to the country's GDP which means that its function of backward and forward linkages to the other sectors of the economy are not well performed. However, it has been empirically proven that the change in climate is mainly anthropogenic (human induced) through various economic activities some of which include agricultural practises.

While most of the farmers observed the change in climate, not all of them are able to respond with remedial actions in the form of adaptations, due to barriers including financial constraints, lack of institutional support, limited information on climate change and adaptation options, stringent insurance requirements etc. The extent to which farmers in the catchment can respond to the impacts of climate change is dependent in large part on their ability to effectively deploy available adaptation and coping mechanisms. Given the diversity of constraints faced by the different farmer typologies, the adaptive capacity of the smallholders is considered to be low.

Respondents are actively participating in approaches that allow them to adapt to the threats associated with climate change, as signified by the alignment of their adaptation strategies with identified adaptive good practices. However, there is danger in the over or under-application of some of these approaches without the knowledge of either their environmental or agronomic consequences, which could result in increased vulnerability of the farmers. As reported by Work et al. (2019), maladaptation are described as actions or inactions that may lead to increased risk of

adverse climate-related outcomes, increased vulnerability to climate change or diminished welfare now or in the future. The possibility for maladaptation at present or in the future is particularly noticeable for the smallholders in the study area, which should be a key indicator for future policy interventions.

According to the respondents, in response to the delay in the onset of rainfall and the shortening of the planting season, they have adapted their planting dates. Respondents reported that they will only plant after the first set of rain. However, according to Mangani et al. (2019), maize grain yield is negatively affected by the number of days in the planting season with temperatures above 30°C, while temperatures below 10°C result in the halting of all active development (Walker & Schulze 2008)

5.3 Conclusion

Sustainable production of maize in Ward 4 Madziva in Shamva District will require farmers to effectively adapt to climate change. The different farming scales in the area indicate the need for a robust adaptation strategy that not only considers the implementation of good adaptation approaches and takes into account the differential vulnerability of the different farmer typologies, but also recognises the possibility of maladaptation if the perceived changes in climate are not well understood. While some of the adjustments made by the farmers in response to climate change may result in an initial increase in productivity, they may also result in increased agricultural vulnerability (Neset et al. 2019). Transformational adaptation plans that are facilitated by policy reforms are required to avoid future unintended outcomes in adaptation and sustainable production of maize in the study area. Providing support in capacity building, awareness, credit access, advance access to meteorological information, cohesive/aligned policies and extension support will be a step in the right direction.

5.4 Policy Recommendations

Based on the results generated in this study, it is recommended that maize farmers increase the usage of heat tolerant maize species (for example open pollinated varieties) as projections show that heat will decrease yields and revenues. There should be increased research and development to come up with heat resistant maize varieties which farmers can choose from. This will help

enhance the maize yields under hot climatic conditions which will help sustain food production. There should also be increased irrigation in maize farming so that the effects of temperature increases will be lessened on the production of maize. This will help reduce the effects of water loses in crops due to temperature warming and reduced rainfall. However, setting up irrigation schemes requires large capital outlay and as a result, investments in agriculture should be improved to make some of these mitigation strategies possible.

Further, there should be increased crop insurance to cover for unexpected losses that may be caused by extreme weather conditions such as droughts, floods, hailstorms and tornadoes that are witnessed because of climate change. This will help farmers to continue sustain their livelihoods in the world of changing climate.

In addition, it also recommended that climate smart practices be adopted when carrying out maize production to reduce the amount of GHGs emitted into the atmosphere that cause climate change. These activities can be termed climate smart agriculture, and they include biochar soil amendments, minimum tillage and balanced fertilization.

5.5 Suggestions for further research

It is suggested that further research examine the sustainability of climate smart agricultural activities. This will help in creating more innovative ways that produce more maize to feed the continuously rising population at the same time reducing the rate at which the climate is changing. It is also important for further studies to model causalities between agricultural production and carbon emissions to assess the footprint of agriculture on the climate.

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