

FROM IRRIGATION PROMISE TO FOOD INSECURITY: CLIMATE CHANGE, LIVELIHOODS AND SMALLHOLDER VULNERABILITY IN MUSHANDIKE IRRIGATION SCHEME, MASVINGO DISTRICT, ZIMBABWE

TRYMORE KONYE¹ AND DEWIN SIKALUMBI²

Abstract

Climate change continues to threaten smallholder farmers' livelihoods within semi-arid regions of Zimbabwe despite the presence of irrigation infrastructure. This study investigates the impact of climate change on the livelihoods of farmers within the Mushandike Irrigation Scheme in Masvingo District, Zimbabwe. Guided by the Vulnerability-Resilience-Adaptation Framework, this study employs a qualitative case study design to investigate the impact of climate change on agricultural livelihoods within the study site through semi-structured interviews, focus group discussions and field observation. Data were analyzed using thematic analysis. Findings from this study reveal that climate change and the deterioration of irrigation infrastructure within the Mushandike Irrigation Scheme have led to a decline in agricultural productivity within the farm. Farmers within the study area reported a decline in the productivity of both their agricultural and livestock assets which has forced them to sell these assets to meet their daily food requirements. As a result of the decline in agricultural production, food insecurity within the area has led to the consumption of less diverse diets and an increasing dependence on food assistance programmes provided to them by the government and humanitarian agencies. The study concludes that without rehabilitating the irrigation infrastructure

¹ Africa Research University, Lusaka, Zambia, tkonye@staff.zegu.ac.zw, 0009-0007-6985-1953

² Africa Research University, Lusaka, Zambia, ewinarona@gmail.com 0000-0003-2882-5517

within the Mushandike Irrigation Scheme and implementing strategies to improve the climate resilience of its farming communities, livelihoods and food security of the area will continue to decline. To improve the livelihood resilience of farming communities within the irrigation scheme, it is recommended that infrastructure within the irrigation scheme is rehabilitated, climate advisory services are provided to farmers within the area, irrigation governance is made more inclusive of farming communities and livelihood diversification strategies are implemented.

Keywords: *food security, climate change, livelihoods, smallholder, vulnerability*

INTRODUCTION

Climate change has become a major global concern, a thorn in the flesh and a ticking time bomb that deeply affects many facets of human existence, especially food security (IPCC 2014: Gebeyehu *et al.*, 2025). Human activities, primarily emitting greenhouse gases (GHG) into the atmosphere, have in turn been the major factors driving massive changes in the earth's climate system (UN, 2015; Azine *et al.*, 2025). These changes interfere with ecosystems and agricultural productivity, thus bringing about shifts in temperature patterns, precipitation levels and an increased frequency of extreme weather events (Bitrus and Obidi, 2025). Hence, climate change is viewed as the foremost threat to agricultural production and food security in the 21st century, especially in many poor agrarian countries in Latin America and the Caribbean (LAC), Asia, Middle East and North Africa (MENA) and Sub Saharan Africa (SSA), (Mekonnen, 2024; Rehman *et al.*, 2024; Hassen *et al.*, 2025;).

Climate change phenomena, mostly caused by mankind, have brought drastic changes to weather variables such as temperature and precipitation, thereby adversely affecting global, regional and local agricultural productivity and food chain systems (D'Adamo *et al.*, 2022; Worakamol, 2023; Azine *et al.*, 2025; Hassen *et al.*, 2025). In Africa, since agriculture is predominantly rain-fed, these climatic trying changes have grievously and marginally affected smallholder farmers (Touch *et al.*, 2024; Saccone and Valino, 2025;). Being the most food-insecure continent, Africa is greatly exposed to the effects of climate change (Ogwu *et al.*, 2024; Azine *et al.*, 2025; Gebeyehu *et al.*, 2025).

According to Mutengwa *et al.* (2023), Zimbabwe is severely affected by climate change largely because of its dependence on rain-fed agriculture. The occurrences of extreme weather events linked with droughts promoted by El Niño and floods on the backdrop of La Niña substantially affected food availability and agricultural productivity in Zimbabwe (Franchi *et al.*, 2024). The Mushandike Irrigation Scheme, stands as an important case for assessing how irrigation could render resilience to smallholder farmers. Due to the shortage of water since 2002, however, the scheme has been unable to produce satisfactory output and farmers have since lost income.

Smallholder farmers still face great obstacles. In fact, prolonged droughts in areas such as Muzarabani, Chiredzi, Matabeleland and Masvingo adversely affect some of their staple crops, especially maize, resulting in low yields and food shortages (Chakauya *et al.*, 2023; Muzerengi *et al.*, 2023; Jaison *et al.*, 2024). Floods have increased, destroying crops and causing serious post-harvest losses (Mutengwa *et al.*, 2023). Studies have shown that

smallholder farmers are most at risk from the devastating effects of climate change, for barriers such as limited access to modern farming techniques, climatic information and financial resources to undertake adaptive measures (Chakauya *et al.*, 2023; Touch *et al.*, 2024; Chisadza *et al.*, 2025).

Despite the irrigation scheme's contribution to the country's agricultural production, it is currently experiencing a decline in its productivity due to shortages in the water supply to the area, as well as the increasing effects of climate change on the region. For this reason, this study is designed to examine the climate change-livelihoods-food security nexus, using insights and experiences from the Mushandike Irrigation Scheme in Masvingo, Zimbabwe.

LITERATURE REVIEW

CLIMATE CHANGE AND FOOD SECURITY

Climate change is recognised as one of the greatest threats to food security in the world today, particularly in regions like Sub-Saharan Africa, which are heavily reliant upon climate and agricultural production to provide for their populations. The Intergovernmental Panel on Climate Change (IPCC) has indicated time and time again that impacts of climate change are reducing agricultural production in these regions. Smallholder farmers, whose livelihoods are reliant upon these natural and agricultural resources, are some of the most impacted by these threats to food security.

Studies have indicated that climate change and its effects on agriculture are impacting countries like Zimbabwe. For instance, Mwadzingeni *et al.* (2021) report that the decrease in rainfall and

the increase in temperatures within the country, have led to a reduction in the agricultural production of countries like Zimbabwe. Additionally, studies by Macheke *et al.* (2023), have indicated that these declining agricultural production amounts to declining food production within the country. Thus, these two studies help to establish one of the major ways that climate change impacts food security within the country: through the reduction in the availability of food produced within the nation.

In addition to food availability, climate change can also impact the access to food for populations with limited resources. Chitsungo (2023) have found that the decline in agricultural production within the country is leading to a decline in the income of smallholder farming communities. As a result, these communities are unable to provide for their populations with the food they require. Thus, these findings help to establish another way that climate change impacts food security within the country: through the inability of smallholder farming communities to gain access to the food that is required for their populations.

Additionally, the effects of climate change can also impact the ability of these populations to utilise the food that is produced within the country. Mureri *et al.* (2024) have determined that the effects of climate change force these communities to change their diets to include foods that contain less nutrients. These dietary changes lead to increased instances of health problems within the populations of smallholder farmers. Thus, these authors help to establish yet another way in which climate change impacts food security: through its impact upon the nutritional value and quality of the foods that are produced within the country.

Finally, climate change can also impact the stability of food production and availability within the impacted countries. Zvokuomba and Batisai (2023) aver that the climate variability occurring within the country has led to the reduced effectiveness of irrigation schemes which were created to provide stability to food production within the area. Consequently, climate change continues to impact food stability within the country, even though irrigation infrastructure exists to provide stability to agricultural production within the region.

Despite the number of studies that have been undertaken on the impacts of climate change upon food security in countries like Zimbabwe, there are some limitations to such literature. For instance, the majority of existing literature reviews the aspects of food security related to availability, access and stability, but has not reviewed the aspects related to food utilisation. Additionally, the it has focused upon the impacts of climate change upon food and livelihoods, but has not reviewed the relationship between those two aspects of food security. Thus, there is a gap within the existing literature regarding the relationship between climate change, livelihoods and food security - which topic this study investigates.

CLIMATE CHANGE AND LIVELIHOODS NEXUS

The concept of livelihood is understood to encompass many aspects of a community's means of living. Within the smallholder farming communities of rural areas in countries like Zimbabwe, the majority of the livelihoods are based on agriculture. Thus, these communities are exposed to the impacts of climate change on their livelihoods.

Several studies have examined the ways in which climate change impacts the livelihoods of farming communities. For instance, Chisadza *et al.* (2025) have determined that the rise in temperatures within the country, as well as the decline in rainfall, has led to declining agricultural productivity within areas that rely upon smallholder farmers for their agricultural products. Additionally, Mutengwa *et al.* (2023) posit that climate variability impacts the livelihoods of farming communities through the impact on agricultural and livestock productivity.

Beyond the impact of climate variability on agricultural productivity, studies have also examined the way in which livestock and productive assets within these communities are depleted as a result. Moyo *et al.* (2023) state that as the impacts of climate change threaten the livelihoods of smallholder farming communities, those communities begin to sell their assets and resources as means of survival during periods of drought and climate instability.

Additionally, studies have examined the impact of climate change on livestock and migration within the communities. For example, Morales-Muñoz *et al.* (2020) observe that climate change is leading to the movement of individuals from their home communities to other areas within the nation in search of alternative means of livelihoods. As a result, these communities are exposed to vulnerabilities within their livelihoods resulting from the movement of their members.

Within irrigation-based farming communities, individuals and their livelihoods are expected to be less impacted by climate change due to the ability of the irrigation systems to provide the

amount of water necessary for agricultural systems to remain productive despite changes in rainfall. However, studies within areas like the Mushandike Irrigation Scheme reveal that these irrigation systems are experiencing issues that threaten the sustainability of their irrigation methods. For instance, Zvokuomba and Batisai (2023) note that irrigation systems within these farms are experiencing a decreased availability of water resources, leading to reduced effectiveness in irrigation methods. Additionally, Malancho (2018) assert that dams that provide the water to these irrigation systems are experiencing a decline in their inflow of water resources.

Despite the wealth of studies that have been undertaken on the impacts of climate change and livelihoods, there are some limitations to the existing literature. For instance, few studies have investigated the relationship between livelihoods and food security. Additionally, few they have investigated the impacts of climate change on smallholder farming communities, their livelihoods and their food security.

THEORETICAL FRAMEWORK

THE VULNERABILITY-RESILIENCE-ADAPTATION (VRA) APPROACH

One of the theoretical approaches that helps to explain the relationship between climate change, livelihoods and food security within the Mushandike Irrigation Scheme is the Vulnerability Resilience Adaptation (VRA) approach to understanding climate change impacts. The VRA approach was developed from existing literature regarding vulnerability and resilience as a means of explaining how populations are exposed to, impacted by and respond to climatic changes. Thus, the approach is useful in

examining the relationship between climate change and food security within the region.

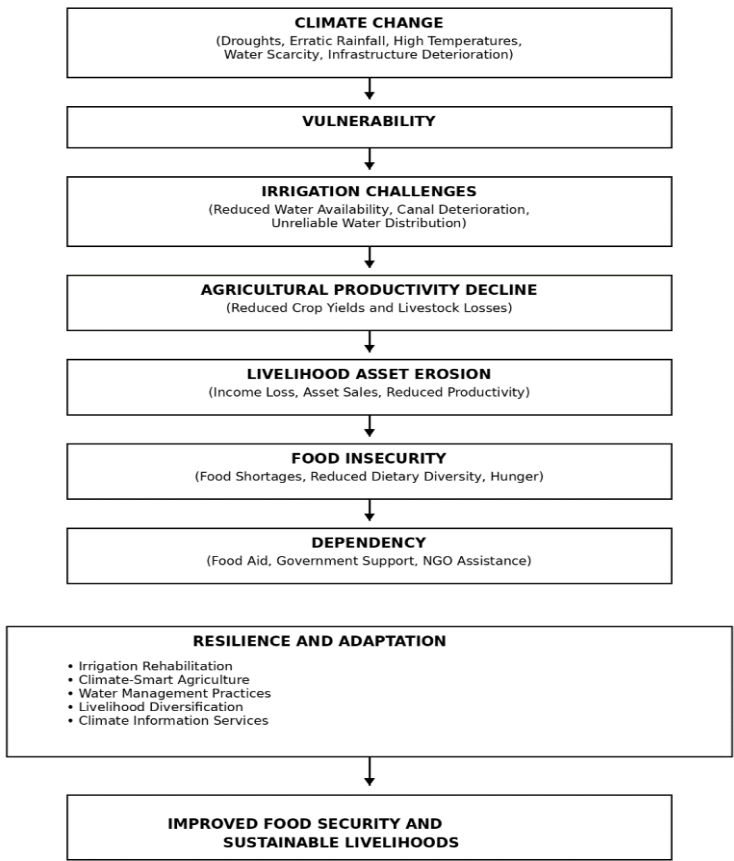


Figure 1: Vulnerability-Resilience-Adaptation Approach (*Mutu and Hart, 2014*)

The VRA framework is a suitable approach to understanding the relationship between climate change, livelihoods and food security within the Mushandike Irrigation Scheme. Climate change is the primary source of vulnerability within the framework due to the impact that climate change variables have on the irrigation

scheme, such as increased temperatures, erratic rainfall patterns, droughts and the deterioration of the irrigation infrastructure.

The livelihoods of individuals within the Mushandike Irrigation Scheme are the most affected by the vulnerability that results from climate change. The vulnerability impacts the ability of farmers within the irrigation scheme to produce as much as they would like due to the decline in available water for irrigation, leading to declines in income and the availability of livestock.

As a result of these declines in the livelihoods of the farmers within the irrigation scheme, food security within the area declines as well. The farmers are unable to produce as much food as they would like, their diets become less diverse and they become increasingly reliant on food aid to supplement the food that they would be able to produce under more favourable conditions. The concept of resilience within the VRA Framework refers to the ability of the livelihoods and food systems within the irrigation scheme to withstand the impacts of climate change and still maintain their production levels.

Finally, adaptation refers to the specific actions that are undertaken within the irrigation scheme in order to reduce their vulnerability to the impacts of climate change and to increase their resilience to those impacts. Actions, such as rehabilitating the irrigation infrastructure, implementing agricultural techniques that require less water and diversifying the livelihoods of the farmers, can help to increase the resilience of the farmers to climate change.

Overall, the VRA Framework helps to explain the way that climate change has the potential to negatively impact the livelihoods and food security of the population within the Mushandike Irrigation Scheme through the concept of vulnerability, the way that vulnerability leads to the decline of those livelihoods and food security systems and the potential counteractive effects of enhancing the resilience of those systems through adaptation measures. Thus, the VRA Framework is an appropriate approach to analyzing the relationship between climate change, livelihoods and food security within the Mushandike Irrigation Scheme.

METHODOLOGY

RESEARCH PHILOSOPHY, APPROACH AND DESIGN

RESEARCH PHILOSOPHY

The research philosophy adopted for this research study is that of Interpretivism. Interpretivism is a philosophy that focuses on the understanding of the meaning of the experiences of the individuals involved with the phenomenon studied (Saunders *et al.*, 2022). The use of this philosophy is appropriate for this study due to the desire to understand how the farmers within the Mushandike Irrigation Scheme experience climate change and its effects on their livelihoods and food security.

RESEARCH APPROACH

The research approach used in this research study is that of an inductive research approach. An inductive research approach is one that enables the researcher to gain an understanding of the phenomenon that is being studied through the experiences of the individuals observed within the research study (*ibid.*). Therefore,

through this research approach, the insights and understanding of the relationship between food security, climate change and the livelihoods of the farmers in the study and will emerge from the research study itself.

RESEARCH DESIGN

The qualitative case study design was used in this research study. The case study research design enabled the research to gain a thorough understanding of the experiences of the smallholder farmers within the Mushandike Irrigation Scheme. Additionally, the case study research design is appropriate for this study due to the desire to gain an in-depth understanding of the various factors that impact the farmers and their livelihoods within the area.

SAMPLING PROCEDURE, SAMPLE SIZE DETERMINATION AND DATA COLLECTION

Purposive sampling was employed to select participants with relevant knowledge and experience regarding the topics of climate change, irrigation farming, livelihoods and food security within the Mushandike Irrigation Scheme. This sampling strategy was chosen as it allows the research to identify participants who have information that will provide insight into the phenomenon being studied (Palinkas *et al.*, 2015; Etikan, 2016).

There was a total of 31 participants involved in the study. Interviews were conducted with 21 participants consisting 15 smallholder farmers, 2 government representatives, 2 local experts and 2 community leaders. Furthermore, one FGD with 10 smallholder farmers was conducted. Participants were selected they had a relationship with the irrigation scheme and were either

involved in agriculture within the scheme or played a leadership role within the community.

The sample size was determined via the principle of data saturation (Guest *et al.*, 2020). This principle states that data collection is conducted until no new information is \ provided by the participants. This principle is widely accepted in the qualitative research area as it ensures that there is richness to the information being gathered from the participants.

Table 1: (*Methodology Plan, 2025*)

Stakeholder Group	Interview Participants	FGD Participants	Total Participants
Smallholder Farmers	15	10	25
Government Representatives	2	0	2
Local Experts	2	0	2
Community Leaders	2	0	2
Total	21	10	31

DATA COLLECTION METHODS

Data were collected through interviews, focus group discussions and field observations.

Interviews were conducted with smallholder farmers, government representatives, experts in the field and community leaders. These interviews provided participants with an opportunity to describe their experiences with climate change in their regions and farming areas. The interview questions were prepared in a way that would allow the researcher to ask follow-up questions to elicit more detailed explanations from the interviewees regarding various issues.

One FGD was conducted with 10 smallholder farmers to discuss the effects of climate change within the irrigation scheme. This discussion allowed for interaction among the farmers and provided a means of identifying common challenges and strategies within the community to address these issues.

Field observations were conducted throughout the study to provide an assessment of the irrigation scheme. These observations provided further data to the interview and FGD results to further validate the findings of the study.

DATA ANALYSIS

The qualitative data were analyzed using thematic analysis, a technique that has been used in a variety of studies to extract and interpret the data (Braun and Clarke, 2022). The data analysis process began with the reading of the transcripts of the interviews that were conducted with the participants, the FGD and field observations. During this initial reading of the data, the research became familiar with the experiences of the participants in relation to climate change, livelihoods and food security. Following this initial reading, codes were developed for each of the participants' comments and interview statements to categorise their comments.

Those codes were then reviewed to determine which codes related to the same themes or sub-themes within the data. These themes reflected the relationship between climate change, livelihoods and food security within the Mushandike Irrigation Scheme. Additionally, documentary evidence was reviewed to confirm the findings from the interviews and FGD to ensure the validity of the interpretations of the data. Finally, the themes that emerged from the data and discussions were interpreted through the lens of the

Vulnerability-Resilience-Adaptation Framework to determine the relationship between climate change, the livelihoods of smallholder farmers within the irrigation scheme and food security.

ETHICAL CONSIDERATIONS

In conducting this study, ethical integrity was a primary consideration and demonstrated a commitment to the dignity, rights and welfare of all participants. This study followed the guidelines of accepted ethical principles, in order to ensure that participant autonomy was observed, that the amount of possible harm was minimised and that trustworthiness was maintained throughout the research process. Participants engaged ethically through their provision of informed consent. Consideration of the right to privacy and subsequent confidentiality was a primary concern throughout all aspects of the research process, in order to protect participants from social, psychological or professional harm. During transcription, analysis or reporting, all identifiable participant information was made anonymous, with all participants having a pseudonym assigned for their identity to ensure that identity was not disclosed. All participants were informed before the study began and at every stage thereafter, that they could withdraw their participation at any time and for any reason. This right was first outlined to participants during the consent process and was again reinforced during the entire data collection process to establish that participant's involvement in the research.

DESCRIPTION OF THE STUDY AREA

The location for the implementation and performance of the study was the Mushandike Irrigation Scheme. The scheme is located

approximately 20 km south of the city of Masvingo, within the Masvingo District of Zimbabwe. It was established in 1939 and is one of the largest and most established irrigation schemes within the country covering approximately 847.5 hectares. The irrigation scheme has over 565 farming households distributed across 11 villages within the irrigation scheme. The irrigation scheme utilises the water from the Mushandike Dam.

The Mushandike Irrigation Scheme is established in a semi-arid region of Zimbabwe. In these areas, rainfall is often low and variable, temperatures are high and droughts are common phenomena. Due to these climatic conditions, irrigation is necessary for agricultural production in these regions. Furthermore, the Mushandike Irrigation Scheme has experienced various challenges because of the impact of climate change on the area, such as the decline in available water resources for the irrigation system and damage to the irrigation system itself. These characteristics of the irrigation scheme and area, therefore, make it an appropriate location to investigate the relationship between climate change, the livelihood of its farmers and food security. The study was voluntary and completely free of coercion.

FINDINGS

The findings presented in this section are based on the data collected from 31 participants which included smallholder farmers, leaders from the Mushandike Irrigation Scheme, local experts and government representatives and. The data was collected through interviews, an FGD and observations of the area. Four major themes were identified through the analysis of this data. Within each of these themes, frequencies and percentages

were calculated in other words, percentages were retained based on coded qualitative response frequencies.

Table 2: Effects of Climate Change on Livelihoods and Food Security (n = 31) (*Field Data, 2025*)

Climate Change Effect	Frequency	Percentage (%)
Decline in crop yield	10	32.3
Livestock productivity loss	8	25.8
Increased food insecurity	7	22.6
Reliance on external food assistance	6	19.3
Total	31	100

CLIMATE STRESS, IRRIGATION CHALLENGES AND DECLINING AGRICULTURAL PRODUCTIVITY

The most frequently reported impact of climate change within the Mushandike Irrigation Scheme was declining agricultural production. This effect was reported by 32.3% of the participants who explained that droughts, erratic rainfall patterns, rising temperatures, dam inflow reductions and irrigation challenges were affecting the ability of farmers within the area to produce the quantity of agricultural goods that they traditionally did.

The irrigation system, established as a means of easing the impact of climate variability in the area, began experiencing water shortages throughout the past several years. As a result, the farmers are unable to continue to produce their typical levels of agricultural goods each year. Furthermore, many of the irrigation canals have eroded over time, resulting in the loss of much of the

irrigation water before it reaches the fields in which the farmers cultivate their crops.

Many participants also reported that agricultural production within the Mushandike Irrigation Scheme has declined substantially over the past two decades. The farmers indicated that the yields that they are able to produce from their fields are not meeting the levels that they are used to producing as a result of the inadequate water supply to their fields and the changing climate within the region.

Regarding the impact of the changing climate upon the ability of the farmers to produce sufficient agricultural goods, one participant stated:

“The biggest challenge we face today is availability of irrigation water. In previous years, irrigation water reached the majority of farmers within the area. Today, however, water is not reliably delivered to the fields owned by farmers in the area and many irrigation efforts fail to complete their irrigation cycles of the fields completely. As a result, crops that are planted within these fields are not able to grow to their full potential and the farmers are unable to deliver as much of the agricultural products as they did prior to the current droughts.”

Another farmer within the area said:

“Within previous years, the rains that fell within the area provided farmers with the water that they needed to irrigate their fields. In addition, there was sufficient rainfall to ensure that the crops that were grown within the region had enough moisture to grow to their full potential. Today, however, the rainfall amounts within the area are not as great as they should be for the region and as a result, the fields are not provided with the water that they require to perform as well as they should.”

A third participant affirmed the following:

“The irrigation system that was established within the Mushandike Irrigation Scheme was constructed decades ago. As a result, the irrigation channels and fields are often not providing the amount of water that the farmers require for the crops within their fields. Furthermore, many of the components of the irrigation system have eroded over time, which results in additional loss of irrigation water before it reaches the crops. As a result of these irrigation challenges, agricultural productivity within the area has declined over time.”

The findings regarding the impact of climate change on the region’s agricultural production are consistent with the impact on the region’s livestock productivity. Thus, each of these findings can be considered as the starting point of the relationship between climate change, livelihoods of the farmers within the area and the food security of those same farmers and their communities. Each of these factors will be explored in the following sections.

LIVELIHOOD STRESS: PRODUCTIVITY LOSSES WITHIN LIVESTOCK

The second most common impact of climate change within the Mushandike Irrigation Scheme is the loss of productivity of the livestock that graze within the region. Climate change has contributed to drought conditions within the area, reducing the availability of pasture for the livestock within the region, contributing to water shortages for the livestock and increasing the temperatures within the region. Each of these factors has led to the livestock within the area becoming weak, dying, or otherwise unable to contribute to herds required to produce income for the farmers within the Scheme.

In addition to the declining productivity of livestock within the area, many of the farmers indicated that their herds have diminished over the past several decades. Each of the farmers provided explanations for such declines. For instance, regarding the declining productivity and numbers of livestock within his herds, one of the smallholder farmers within the area stated averred:

“Our livestock numbers have declined considerably within the past several years. During drought periods, many of our livestock cannot find pasture upon which to graze, or water upon which to drink. Some of the livestock perish as a result of these harsh conditions within the area and some become too weak to contribute to the productivity of our herds.”

Another farmer stated:

“Within the past few decades, many of our livestock have perished as a result of drought conditions within the region. Those animals that remain within our herds are often too weak to contribute to the herds overall, which were once some of the richest in the area.”

A community leader within the area explained the following:

“Within our community, livestock are often one of the assets that the farmers utilise to endure difficult years within the economy. However, each drought within the past few decades has forced the farmers to sell their livestock in order to provide for their families. Thus, many of the farmers within our community no longer possess the same amount [number] of livestock that they once did.”

Regarding the impact of climate change upon the livestock of the farmers within the Mushandike Irrigation Scheme, a local expert within the area maintained that:

“The loss of livestock within the community is one of the main challenges that farmers of the Mushandike Irrigation Scheme face as a result of the impact of climate change upon the region. The livestock are vital to both the income and survival of the farmers and their

families within the region. Should the farmers lose their livestock, they will no longer be able to endure the challenges of drought, famine and economic difficulties that may arise within the future.”

These findings help to indicate that the loss of productivity of the livestock within the area is one of the factors that contribute to the vulnerability of the livelihood systems of farmers and the growing food insecurity within the area.

FOOD INSECURITY AS A RESULT OF CLIMATE CHANGE

The third most common impact that the climate change has had on the Mushandike Irrigation Scheme is food insecurity. Food insecurity within the area is the result of the declining agricultural productivity of the region. Farmers within the area that are unable to produce crops are unable to provide for their own diets. Food insecurity is also caused by the declining livestock productivity within the region, as well as the resulting declining incomes of those farmers.

Another impact of food insecurity is that the diet of the individuals within the Mushandike Irrigation Scheme has changed over the past decades. Many of the farmers stated that they consume fewer types of foods than they used to during previous decades. Furthermore, many of the foods consumed by the farmers are mainly staple foods, such as *sadza*. Foods that were once commonly consumed within the diets of the area’s farmers, such as vegetables, fruits, meat and dairy products, are no longer frequently available as a result of the declining agricultural and livestock productivity within the region.

One female farmer within the irrigation scheme explained:

“There was a time when the granaries within our homesteads were always filled with the foods that we grew within the fields. We grew enough maize, vegetables and other foods to provide for our families. Today, however, our food supplies are often depleted within a few months of harvest, which forces many of us to purchase food within the market, or from others within the community or nation for survival.”

Another participant within the area stated:

“The variety of food that we consume within our homesteads and communities has declined recently. Today, we rely upon *sadza* and a few other food products to sustain our diets. As a result of the decline within our ability to produce food, as well as the decline in the income that we are able to earn, we can no longer provide the same variety of food to our diets as we could within previous decades.”

A representative from the government responded to the topic of food insecurity thus:

“Food insecurity within the Mushandike Irrigation Scheme is a growing challenge that has emerged within recent years. Many of the farmers within the area are unable to produce the amount of food that their children require to survive and many of them have to rely upon external assistance to survive famines and droughts. The reduction in the ability of farmers within the area to produce food has contributed to the food insecurity within the region.”

The local expert in the area added:

“The relationship between food insecurity within the area, declining livestock and declining income for the farmers is evident within the irrigation scheme. The decline in the ability of farmers to provide for their livestock results in the farmers’ incomes decreasing. With less income, those farmers are unable to purchase the foods that the farmers require to provide for their own diets. As a result of these factors, smallholder farmers become food insecure within the area.”

These findings help to reveal that food insecurity is another of the elements that contributes to food insecurity within the region and is, therefore, another of the elements that establishes the

relationship between climate change, livelihood systems and food security.

IMPACT OF CLIMATE CHANGE: EXTERNAL ASSISTANCE

The fourth most common effect that climate change within the Mushandike Irrigation Scheme has had upon the region's inhabitants is reliance on external assistance to survive droughts and famines that have occurred within the area. In the past few decades, the area has become unable to provide for its inhabitants through agriculture and livestock production. Thus, those who would traditionally have been self-sufficient within their communities are forced to rely upon external assistance to ensure their survival.

In the past, the Mushandike Irrigation Scheme was one of the most productive irrigation systems in Masvingo Province. However, climate change within the region has contributed to the decline of the productivity of the area, forcing the population to rely on external assistance in order to survive within the region.

One of the participants indicated that their community had become dependent on external assistance for survival:

"In the past, each of the homesteads within the irrigation scheme were able to produce enough food within the region to provide for their own families. Today, however, many of those same families are struggling to meet their food requirements. As a result, they are upon external assistance to survive within their communities."

Another farmer within the area stated:

"External assistance for farmers is provided dependent in the form of food aid from external organisations and the government. These external forces are necessary to supplement the food that is provided by the farmers that are unable to produce enough food for their own

populations. However, as these populations become more food insecure, the reliance upon external assistance increases for those populations within the area.”

Another community leader within the area said:

“The irrigation system was created to provide for the livelihoods and food security of the farmers that live within the irrigation system. Today, however, the farmers are experiencing declining water availability within the irrigation dams, leading to declining agricultural productivity. As a result, those farmers that were once self-sufficient within their communities are beginning to rely on external assistance during drought periods, as they were not required to do so within previous decades of the existence of the irrigation system.”

The local expert within the area commented on the need for external assistance:

“The increasing dependence on external assistance is another result of the impact of climate change upon the irrigation system. The impacts of climate change upon the region include the reduction of agricultural productivity within the region, the decline of the livelihoods of the farmers and the increase in food insecurity within the area.”

These findings help to further indicate that external assistance is yet another element of the relationship between climate change, the area’s livelihood systems and food security within the Mushandike Irrigation Scheme.

UNDERSTANDING THE CLIMATE CHANGE-LIVELIHOODS-FOOD SECURITY NEXUS

The findings of this study demonstrate that there is a relationship between climate change, the livelihood and the food security of the region. Climate change has impacted the area in that droughts, water shortages and declining productivity of the irrigation system have led to declining agricultural production within the

region. The decline in agricultural productivity within the region has led to declining livestock productivity, as well as the decline in the income of the farmers that depend on those livestock for both survival and income. The decline of the income and livelihood systems of the farmers has led to food insecurity of those farmers and their communities.

Thus, each of the factors that were discussed contribute to another of the factors within the area. For instance, climate change has contributed to irrigation system challenges and declining agricultural production. Such declining agricultural production has contributed to the erosion of the livelihoods of the farmers within the region. Those vulnerable livelihood systems have contributed to food insecurity within the area, as well as the dependency of those farmers on external assistance to survive famines and droughts.

These findings are consistent with the Vulnerability-Resilience-Adaptation Framework regarding the impact of climate variables upon the livelihood and food security systems within the area. Furthermore, these findings help to indicate that intervention strategies can be developed within the Mushandike Irrigation Scheme can address the issues related to food insecurity within the area. Such interventions may include addressing irrigation system challenges, increasing the food productivity within the system, improving the livelihood systems of the area and increasing the climate adaptation strategies of the farmers.

DISCUSSION

The findings of this study demonstrate that there is a relationship between climate change, the livelihood systems and the food

security of the farmers within the Mushandike Irrigation System . The major climate challenges facing the farmers and their environment include droughts, erratic rainfall amounts, increasing temperatures within the area and the resulting challenges of the availability of water for the irrigation system and its fields.

Each of these factors has contributed to the findings of the study as to the impact that each can have on other systems within the area. For instance, each of the factors related to climate change have contributed to the findings of the impact that climate change can have on the irrigation system of the Mushandike Irrigation Scheme. Additionally, the findings of the impact of climate change on the irrigation system are consistent with those of other studies that have been performed within other parts of Africa regarding the impacts of climate change on smallholder farmers.

Some of the major findings of the study are that one of the most common impacts of climate change for farmers within the area is a decrease in the productivity of their crops. The major reasons for the decline include the impact of unreliable supplies of water for irrigation, as well as the changes in the climate that impact the growth of those crops. These findings are consistent with those of Chisadza *et al.* (2025), who found that the rising temperatures and decreasing rainfall within areas like Zimbabwe have had major impacts on the productivity of smallholder farmers' agricultural systems. Additionally, these findings are also supportive of Macheka *et al.* (2023) who indicate that declining agricultural production can threaten the availability of food for those farmers and lead to food insecurity within the region.

Another finding of the study was that the productivity of livestock within the area has declined as a result of climate change. The decline in the available pastures for those livestock, the lack of available water resources within the area and the impact of the climate on the health of the livestock has contributed to these findings. These findings are again supported by Akinkuolie *et al.* (2025), who pronounced that droughts and the related losses of livestock within regions of Africa are one of the main reasons that the livelihoods of those farmers are vulnerable to climatic conditions. Additionally, Moyo *et al.* (2023) are also supportive of these conclusions regarding the impacts of climate change on the livelihoods of the farmers within the irrigation system.

Another important finding of the study was that many of the farmers within the Scheme have experienced an erosion of their livelihoods as a result of climate change. The reasons for these findings are primarily related to the findings of declining agricultural production within the area, as those farmers are forced to sell assets to provide food for their households. These findings are again supportive of Moyo *et al.* (*ibid.*), who observed that smallholder farmers within vulnerable areas to climate change are forced to liquidate their assets as a means of surviving the period of climate stress. However, the study indicates that these strategies lead to increased vulnerability of those farmers to climate change.

In addition to these findings related to livestock and livelihoods, the study also found that many of the individuals within the irrigation system were experiencing an increase in food insecurity and a decrease in dietary diversity. These findings are again related to the declining agricultural production within the area.

Chitsungo (2023) are supportive of these conclusions regarding the relationship between agricultural productivity and food availability. Additionally, Gebeyehu *et al.* (2025) found that climate change and its impact on agricultural production is one of the main causes of food insecurity within Africa.

In addition to these findings related to food availability, the study also found that many of the individuals within the irrigation system have had to increase their dependence on external food assistance.. Mutengwa *et al.* (2023) are supportive of the findings of the Mushandike Irrigation Scheme study in that they also found that many individuals within climate vulnerable areas of Africa are forced to rely on external food assistance to survive drought conditions and lack of agricultural production. However, the findings of the present study are unique in that the study was performed within an area established as a means of reducing the climate vulnerability of those farmers.

These findings can be explained in the context of the Vulnerability-Resilience-Adaptation Framework used in the study. The framework indicates that the impacts of climate change are recognised as vulnerabilities of the area, as the droughts, lack of rainfall and rising temperatures within the area impact the land systems of the region. These impacts lead to vulnerability within the area's livelihood systems. Additionally, the framework also recognises the importance of resilience and adaptations of those areas as a means of reducing the vulnerability of the climate change impacts on the area's agriculture and food security.

Furthermore, the findings of the study indicate that there is a relationship between climate change, smallholder farmers'

livelihoods and food security within the area. The vulnerabilities within the climate system of the region lead to challenges to the agricultural systems of the area, which impact the livelihood and food security of the farmers that rely on the production of those crops for their survival.

Overall, this study helps to contribute to the existing literature regarding the relationship between climate change, smallholder farmers' livelihoods and food security. Unlike many existing studies that focus on the impacts of climate change on agriculture alone, it is able to examine the impacts of climate change on the entire system of smallholder farmers within the Mushandike Irrigation Scheme. Furthermore, the findings help to highlight the need for interventions within those factors to provide for the creation of sustainable livelihoods and food security systems within these areas.

CONCLUSION

As discussed above, this study performed an investigation into the relationship between climate change, smallholder farmers' livelihoods and food security within the Mushandike Irrigation Scheme. Through reviewing the existing literature on the topic and through performing the investigation itself, it becomes apparent that climate change has had an impact on the ability of the irrigation system to provide for the smallholder farmers that utilise its resources. Furthermore, the declining agricultural production of those farmers has had an impact on their livelihood systems, food security and the ability of their communities to remain resilient in the face of climate change impacts.

These findings help to support the Vulnerability-Resilience-Adaptation Framework that was established within the article to help explain the relationship between climate change, smallholder farmers' livelihoods and food security. Climate change acts as the main vulnerability of the region, contributing to droughts, lack of rainfall and increasing temperatures. Each of these factors has an impact upon the land systems of the region, contributing to vulnerabilities within the livelihood systems of smallholder farmers within the area. The framework also explains the importance of the resilience systems within the area as a means of combating those vulnerabilities of the climate change impacts on the smallholder farmers of the region.

Overall, therefore, this study helps to contribute to the existing literature on the topic of climate change, smallholder farmers' livelihoods and food security. The study determined that there is a relationship between these three variables. More specifically, the findings indicate that climate change contributes to vulnerability within the area, which negatively impacts the livelihood and food security of the smallholder farmers in the Mushandike Irrigation Scheme. Therefore, improvements to food security within the irrigation system will require the implementation of interventions related to each of these discussed variables.

POLICY RECOMMENDATIONS

One of the first departments that can be targeted for policy changes to address the findings of this study is the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development of Zimbabwe. Within this ministry is the Department of Agricultural Education and Extension (AGRITEX). AGRITEX can implement training systems that teach smallholder farmers various methods

of increasing climate resilience of their agricultural systems. Such training can focus on methods of conservation of the land systems within the area, introduction of drought tolerant crops and other programmes that increase the ability of the farmers to produce food despite the impacts of climate change.

Additionally, the Government Irrigation Department can work to rehabilitate the irrigation systems utilised by the farmers within the irrigation system. Many interventions that could be done include the desiltation and clearing of irrigation channels, the rehabilitation of canals, the replacement of damaged components of those irrigation systems and the implementation of technologies that increase the efficiency of the irrigation systems. Additionally, the use of solar systems to irrigate the fields during extended periods of drought could be developed and implemented into the irrigation system.

Also, the government's Meteorological Services Department (MSD) can implement systems that provide weather forecasts to the smallholder farmers within the irrigation system of the Mushandike Irrigation Scheme. By allowing the farmers to understand the weather conditions that will develop within the area over the coming days or weeks, the MSD can allow the farmers to adjust their agricultural practices to minimise the potential risks of droughts or rainfall that might develop within the area.

Another target can be the local irrigation management institutions. These institutions can work to establish better systems within the irrigation system for managing the water allocated to each of the smallholder farmers. For instance, management institutions can

implement improvements to the irrigation system to ensure that water is distributed equally to each smallholder farmer, whether those farmers are located at the head-end or tail-end of the irrigation system. Additionally, implementing management institutions that provide oversight of the irrigation system will lead to the reduction of conflicts between farmers for access to the system's resources.

Another group that can be targeted for policy changes is the traditional leaders and structures within the area. These individuals can begin to implement initiatives that focus on the conservation of the natural resources that exist within the irrigation system. Such initiatives could target the land systems, the water systems and even the implementation of afforestation programmes that aim to increase the number of trees within the area and provide benefits to the climate system of the region.

Finally, the last group that can be targeted for policy change are the development partners and non-governmental organisations that work within the irrigation system. These groups can begin to implement programmes and initiatives that increase the resilience of the smallholder farmers of the irrigation system. Such programmes may focus on increasing the diversity of livelihoods of those farmers, increasing their access to natural resources, or even implementing financial inclusion programmes for those smallholder farmers.

LIMITATIONS OF THE STUDY

Despite thorough research that was performed in an attempt to analyze the relationship between climate change, smallholder farmers' livelihood systems and food security within the

Mushandike Irrigation Scheme, there are some limitations to the study. The study was limited to only one irrigation system within one region of Zimbabwe. Thus, the findings of the study may not be generalisable to other irrigation systems. Additionally, as a qualitative study, the research used methods that collected narratives from the farmers, rather than performing surveys that would allow estimation of outcomes through statistical analyses. Also, the study relied upon experiences of the farmers as to the relationship between climate change and their livelihoods and food systems. Thus, while the study used various methods to review the experiences and knowledge of these smallholder farmers, there is a potential bias to their findings.

FUTURE RESEARCH

Future research should employ methods of comparing findings of the study with other irrigation systems across the country of Zimbabwe. Thus, implementing studies that compare the vulnerability of various irrigation systems to climate change impacts will enable researchers to determine whether the findings of the study can be applied beyond the Mushandike Irrigation System.

Furthermore, other future researches can focus on determining the effectiveness of various interventions that were discussed within this article. For instance, studies can investigate methods of improving the irrigation systems within the area to determine if such improvements can lead to an increase in the resilience of the smallholder farmers within Zimbabwe. Additionally, other future research can focus on the impacts of climate change upon other aspects of smallholder farmers' livelihood systems, such as their livestock systems or income systems.

REFERENCES

- Akinkuolie, T. A., Ogunbode, T. O. and Adekiya, A. O. (2025). Resilience to Climate-induced Food Insecurity in Nigeria: A Systematic Review of the Role of Adaptation Strategies in Flood and Drought Mitigation. *Frontiers in Sustainable Food Systems*, 8, 1490133.
- Awazi, N. P., & Tume, S. J. P. (2025). Impacts, vulnerability, resilience, and nature-based adaptation to climate variability and change in rural communities in the Bamenda Highlands of Cameroon. In G. J. Nagy & D. Y. Ayal (Eds.), *Handbook of nature-based solutions to mitigation and adaptation to climate change* (pp. 875–895). Springer. https://doi.org/10.1007/978-3-031-34967-6_148
- Azine, P. C. *et al.*-b (2025). Assessing Smallholder Farmers' Vulnerability to Climate Change and Coping Strategies in South Kivu Province, Eastern Democratic Republic of Congo. *Environmental Systems Research*, 14(1), 2. <https://doi.org/10.1186/s40068-025-00393-8>
- Bitrus, M. A., & Obidi, A. J. (2025). Climate change, crises, and food security in Africa. *University of Jos Journal of Political Science*, 2(2), 97–107
- Braun, V. and Clarke, V. (2022). *Thematic Analysis: A Practical Guide*. Thousand Oaks, CA: Sage.
- Chanza, N. and Musakwa, W. (2022). Ecological and Hydrological Indicators of Climate Change Observed by Dryland Communities of Malipati in Chiredzi, Zimbabwe. *Diversity*, 14(7), 541.
- Chisadza, B. *et al.* (2025). Resilient Agriculture in Semi-arid Zimbabwe: Adaptation Strategies and Influencers among Smallholder Farmers. *Discover Agriculture*, 3(1), 76. <https://doi.org/10.1007/s44279-025-00234-3>

- Chitsungo, B. (2023). Effects of Irrigation Investment on Agricultural Productivity, Food Security and Poverty: Case of Masvingo District, Zimbabwe. *Economia Aziendale Online*, 14(4), 1183-1200.
- D'Adamo, I. *et al.* (2022). An Analysis of Sustainable Development Goals in Italian Cities: Performance Measurements and Policy Implications. *Land Use Policy*, 120, 106278. <https://doi.org/10.1016/j.landusepol.2022.106278>
- Dzvimbo, M. A., Manyeruke, C., Chitiga-Mabugu, M. R., & Zvimba, T. (2022). Exploring climate change impacts on smallholder farmers in Mhondoro-Ngezi District, Zimbabwe. In W. Leal Filho *et al.* (Eds.), *Handbook of climate change across the food supply chain* (pp. 381–402). Springer. https://doi.org/10.1007/978-3-030-87934-1_22
- Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4.
- Feliciano, D. *et al.* (2022). Assessment of Agricultural Emissions, Climate Change Mitigation and Adaptation Practices in Ethiopia. *Climate Policy*, 22(4), 427-444.
- Gebeyehu, L., Gemechu, A. and Bedemo, A. (2025). Effects of Climate Change on Food Security in Africa: Meta-analysis. *Journal of Agriculture and Food Research*, 23, 102214. <https://doi.org/10.1016/j.jafr.2025.102214>
- Guest, G., Namey, E. and Chen, M. (2020). A Simple Method to Assess and Report Thematic Saturation in Qualitative Research. *PloS ONE*, 15(5), e0232076.

- Intergovernmental Panel on Climate Change (2022). Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security and Greenhouse Gas Fluxes in Terrestrial Ecosystems. Cambridge University Press. <https://doi.org/10.1017/9781009157988>
- Macheka, L. *et al.* (2023). Use and Influence of Food and Nutrition Security Vulnerability Assessment and Analysis Reports in Zimbabwe. *North African Journal of Food and Nutrition Research*, 7(16), 68-84.
- Makate, C. *et al.* (2016). Crop Diversification and Livelihoods of Smallholder Farmers in Zimbabwe: Adaptive Management for Environmental Change. *Springerplus*, 5(1), 1135. <https://doi.org/10.1186/s40064-016-2802-4>
- Malanco, J. A., Makurira, H., Kaseke, E., & Gumindoga, W. (2018). Water management challenges at Mushandike irrigation scheme in Runde catchment, Zimbabwe. *Proceedings of the International Association of Hydrological Sciences*, 378, 73-78. <https://doi.org/10.5194/piahs-378-73-2018>
- Mekonnen, A. *et al.* (2021). Climate Change Impacts on Household Food Security and Farmers Adaptation Strategies. *Journal of Agriculture and Food Research*, 6, 100197. <https://doi.org/10.1016/j.jafr.2021.100197>
- Morales-Muñoz, H. *et al.* (2020). Exploring Connections: Environmental Change, Food Security and Violence as Drivers of Migration—A Critical Review of Research. *Sustainability*, 12(14), 5702.
- Moyo, E. *et al.* (2023). Health Effects of Climate Change in Africa: A Call for an Improved Implementation of Prevention Measures. *Eco-Environment and Health*, 2(2), 74-78.

- Mureri, A. *et al.* (2024). Unpacking Success: Key Attributes of Effective Small-scale Communal Irrigated Agriculture in Zimbabwe. *Agricultural Research Journal*, 61(5).
- Mutengwa, C. S., Mnkeni, P. and Kondwakwenda, A. (2023). Climate-Smart Agriculture and Food Security in Southern Africa: A Review of the Vulnerability of Smallholder Agriculture and Food Security to Climate Change. *Sustainability*, 15(4), 2882.
- Mwadzingeni, L., Mugandani, R. and Mafongoya, P. L. (2021). Assessing Vulnerability to Climate Change in Smallholder Irrigation Schemes of Zimbabwe. *Sustainability*, 13(18), 10023.
- Ogwu, M. C., Izah, S. C. and Ntuli, N. R. (Eds.). (2024). *Food Safety and Quality in the Global South*. Singapore: Springer Nature. <https://doi.org/10.1007/978-981-97-2428-4>
- Palinkas, L. A. *et al.* (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533-544.
- Rehman, A. *et al.* (2024). Climate Change and Food Security in South Asia: The Importance of Renewable Energy and Agricultural Credit. *Humanities and Social Sciences Communications*, 11(1), 342. <https://doi.org/10.1057/s41599-024-02847-3>
- Saccone, D. and Vallino, E. (2025). Global Food Security in a Turbulent World: Reviewing the Impacts of the Pandemic, the War and Climate Change. *Agricultural and Food Economics*, 13(1), 47. <https://doi.org/10.1186/s40100-025-00388-0>
- Saunders, M., Lewis, P. and Thornhill, A. (2022). *Research Methods for Business Students* (9th Ed.). Harlow, England: Pearson.

- Touch, V., *et al.* (2025). Bridging Extreme Climate Risks, Financial Precarity and Adaptation Gaps: Advancing Inclusive Adaptation in Rain-fed Agricultural Systems. *Global Environmental Change*, 95, 103073. <https://doi.org/10.1016/j.gloenvcha.2025.103073>
- Worakamol, W. (2023). Climate Change and Its Effect on Agriculture. *International Journal of Agricultural Sciences and Veterinary Medicine*, 11(4), 1-8.
- Zvokuomba, K. and Batisai, K. (2023). From 'Hydrology of Hope' to 'Hydrology of Despair': A Feminist Review of Mushandike Small-scale Irrigation Scheme in the Semi-arid Region of Southern Zimbabwe. *South African Geographical Journal*, 105(1), 99-114.