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Farmers' adaptation strategies for coping with cyclones effects in Zimbabwe

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Declaration:

I affirm that I am the rightful owner of this research named “Farmers’ adaptation strategies for coping with cyclones effects in Zimbabwe”. All the text in this paper is authentic, and all the sources have been appropriately cited and recognized through references in accordance with the FTA citation rules.

In Prague 18 April 2024

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David Murata.

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Abstract

In recent years, cyclones have been a significant concern within sub-Saharan Africa, particularly along the Zimbabwe-Mozambican belt. The Chikukwa community, located on the Eastern part of Zimbabwe has also been a victim as it also suffers the ravages of these recurring cyclones. The community's vulnerability to these events has also been accentuated by the land characteristics such as rugged and slopy terrain. The main objective of the study was to investigate how the small-holder farmers are coping with the recurring cyclone shocks in Chikukwa community. In addressing these, a quantitative design was adopted, and data were collected using questionnaires through face-to-face interviews. 105 respondents were interviewed from the population database of 150 survivors of March 2019 cyclone Idai. The results indicated a slight difference in the response rate of 51.40% and 48.60% for males and females, respectively. Descriptive statistics showed that 65.70% reported having experienced 1 to 3 cyclones in their lifetime. The destruction of roads has had a significant cyclone impact, with a 100% response rate, while crop field damage and vandalism of houses have 78% and 71%, respectively. Traditional adaptation strategies such as planting vetiver grass and stone terracing have been highly implemented as they were found to fit these mountainous areas firmly. Moreover, mobile phones and radios were reviewed as the primary sources of cyclone information. The main significant recommendation include advocacy by policy makers for more funds to be allocated towards improving already existing traditional adaptation strategies through extension workers and the capacity building of these extension workers in the field of sustainable agriculture.

Key words: Adaptation, cyclones, climate, smallholder, Zimbabwe

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List of abbreviations

AGRITEX	Agricultural, Technical and Extension Services
AEZ	Agroecological Zones
BTS	Base Transceiver Stations
CELUCT	Chikukwa Ecological Land Use Community Trust
ICT	Information And Communication Technology
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organizations
NR	Natural Region
SMS	Short Message Service
SWIO	Southwest Indian Ocean
TC	Tropical Cyclones
TV	Television
ZMD	Zambian Metrological Department

1 INTRODUCTION

Cyclones are highly destructive natural disasters that present significant challenges to communities worldwide, particularly in vulnerable regions like sub-Saharan Africa. Zimbabwe, a landlocked country in southern Africa, frequently experiences the devastating impacts of cyclones, resulting in loss of life, infrastructure damage, and disruptions to livelihoods, especially among rural farming communities bearing the blatant impacts of cyclones, farmers agency in how to adapt and build resilience received little attention in academic literature. Understanding smallholder farmers' adaptation strategies is crucial for enhancing resilience and reducing vulnerability to cyclone impacts (Molua et al. 2020).

Smallholder farmers in Zimbabwe contributes to 70% of the country's food security and forms the bases of rural economy and livelihoods for a significant portion of the population. In Zimbabwe, most of the national workforce is employed within the agricultural sector, with the majority being smallholder subsistence farmers. However, the industry is highly susceptible to the adverse effects of climate change, including the increased frequency and intensity of cyclones. In recent years, Zimbabwe has faced several devastating cyclones, such as Cyclone Idai in 2019 and Cyclone Eloise in 2021, causing widespread destruction and loss of lives, particularly in rural areas (Mavhura 2020).

In rural Chikukwa, Chimanimani, Zimbabwe, smallholder farmers face recurrent challenges posed by cyclone shocks, threatening their livelihoods and food security. Several devastating cyclones have been recorded as having impacted the community, but none of them have caused them to abandon this community. Most of the Indian Ocean cyclones that affected Mozambique have left some memorable negative impacts on the eastern Highlands of Zimbabwe, particularly the remote Chikukwa community. The community and the surrounding areas suffered the brunt of March 2019 Cyclone Idai's impact, as heavy rainfall caused flash floods, landslides, and mudslides that destroyed homes, infrastructure, and agricultural fields. Cyclones are leading to loss of lives, displacement of communities, and severe disruptions to livelihoods, exacerbating the already precarious situation experienced by rural smallholder farmers in the region in trying to sustain their livelihoods. Before Cyclone Idai, the community had also experienced other cyclone disasters, though on a smaller scale.

Cyclone Eline in 2000 and Cyclone Japhet in 2003 caused significant damage to infrastructure and agriculture, emphasizing the region's vulnerability to such extreme weather events (Mavhura 2020). The effects of these cyclone disasters are being worsened by factors such as the region's topography, inadequate infrastructure, limited access to resources, and socio-economic challenges. On the other hand, the steep slopes and narrow valleys make the area susceptible to flooding and landslides, while inadequate road networks hinder emergency response and relief efforts (McAllister & Chikukwa 2021). Moreover, the dependence of local communities on rain-fed agriculture makes them particularly susceptible to the unpredictability of weather.

In the aftermath of Cyclone Idai, initiatives have been undertaken to improve disaster preparedness, adaptation, and resilience in Chikukwa and other cyclone-prone areas. Community-based initiatives, supported by government agencies, non-governmental organizations (NGOs), and international organizations, have prioritized the implementation of early warning systems, disaster risk reduction measures, and livelihood diversification strategies to enhance resilience among vulnerable communities. However, there are still challenges in ensuring effective implementation and sustainable outcomes, considering the complex socio-economic and environmental dynamics (Chingombe & Musarandega 2021).

Against this backdrop, it is essential to understand the historical context and socio-economic dynamics of cyclone disasters in Chikukwa to inform targeted interventions and build adaptive capacity among local communities. By learning from past experiences and utilizing indigenous knowledge systems, stakeholders can collaborate to mitigate the impacts of cyclone shocks and enhance resilience in future disasters (McAllister & Chikukwa 2021). Researchers have only been focusing on Mozambique and have only documented the ones with more significant impact that stretched into the inner communities of Zimbabwe (Munsaka et al. 2021).

However, in response to the escalating threat of cyclones, rural smallholder farmers have developed various adaptation strategies to mitigate the impacts and safeguard their livelihoods. The socio-economic context, available resources, traditional knowledge, and access to external support systems often influence these strategies. Understanding the dynamics of these adaptation strategies is most relevant for developing effective interventions and policies that enhance resilience at the grassroots level (Asare-Nuamah et al. 2022). The study explores the coping strategies adopted by rural smallholder farmers in Zimbabwe in response to cyclone impacts. By examining the diverse range of farmers' techniques, this research sheds light on the impacts being encountered, locally adopted adaptation strategies and how the farmers are getting the early warning information relating to upcoming cyclones.

2 LITERATURE REVIEW

2.1 Climate change

Climate change is a global trend that threatens farmers' livelihood and agricultural farming, particularly in semi-arid areas in Africa (Magesa et al. 2023a). It is one of humans' most dangerous environmental problems and poses profound global and regional impacts. Weather extremes have become more common and more destructive because of climate change, drought, heavy rainfalls, and heat waves (Kikstra et al. 2022). Floods accelerated by heavy rains and abnormal climates have also caused substantial damage to various regions worldwide. More than a billion people are expected to be living in low-lying coastal areas by 2060 (Neumann et al. 2015). Coastal areas with a high intensity of economic activity are mainly at risk of extreme weather events due to climate change. They are vulnerable to cyclones, tsunamis, and other coastal hazards (Reguero et al. 2020). Documented estimates state that the global sea level is rising by 3 to 4 mm per year due to ocean warming and land ice melting and is projected to rise by 0.3 to 2.0 metres by 2100 (Park et al. 2023). Droughts will likely increase and intensify in the 21st century due to reduced precipitation and increased evapotranspiration in Eastern and Southern Africa. In contrast, heavy precipitation events will likely rise in East Africa. In addition to the relatively low rainfall levels in many African countries, the effects of climate change on precipitation patterns, temperature, weed, pest, and disease pressure are likely to make agriculture more challenging (Magesa et al. 2023a)

2.2 Adaptation to Climate Change

Yield levels and productivity of most smallholder farmers in sub-Saharan Africa are generally low and have a declining trend in the region (Thierfelder & Wall 2009). Most small-scale farmers depend entirely or mainly on their cereal production. However, due to low production levels, in many cases, farmers cannot guarantee food security from their harvests, and very few small-scale farmers can sell some surplus to generate income. This dependency makes them highly vulnerable, and, in case of drought, outside assistance in the form of seed, fertilizer, or food aid is required (Marongwe et al. 2011).

In Zimbabwe, farmers often try to compensate for low yields through extensification (increasing cropping areas wherever possible) rather than intensifying to meet the basic household food requirements. This leads to a spreading of already thin resources of labour and production inputs and land degradation because farmers move into marginal and fragile environments, thus compounding the problems (Marongwe et al. 2011).

Due to the excessive dependency of Sub-Saharan Africans on farming, more burden is being exerted on the industry, hence more pressure on the environment as it is also responsible for other ecosystem services. As a result, these multifunctional agricultural landscapes are changing rapidly in response to these demographic pressures, as many people are also migrating from the urban to these farming areas due to other economic factors. Growing demand for food due to population pressure. All these drivers in the context of climate change make it difficult for the systems to adapt. Therefore, there is a need for action throughout the whole food system, and the possible response has been to find ways to use the same farm space effectively and efficiently while considering and developing strong adaptation and resilience strategies when climate change effects such as disasters are in motion (Masikati et al. 2021).

Adaptation has become necessary to reduce climate change's observed and projected impacts and has been found to be crucial in modifying natural or human systems in response to expected or actual climatic stimuli or their effects to moderate harm and exploit beneficial opportunities (Magesa et al. 2023a). There has been growing concern about whether climate change adaptation efforts are mainly positive in achieving Sustainable Development Goals (Denton et al., 2014). Not every adaptation measure to climate change is a good one. Therefore, more researchers are looking for sustainable adaptation measures and strategies that reduce vulnerability to climate change and contribute to social equality and environmental integrity (Brown 2011; Bhatasara & Nyamwanza 2018; Magesa et al. 2023b)

In some cases, what seems to be successful adaptation measures to climate change impacts may undermine sustainable development's economic, social, and environmental objectives hence fail to be considered acceptable by potential beneficiaries (Eriksen et al. 2011). According to Dube et al. (2018), villagers in the Gwanda District, Zimbabwe, use the stream bank cultivation practice as an essential adaptation strategy. This practice eventually contributes to soil erosion, denudation, and siltation of rivers and the local Mnyabezi Dam (Magesa et al. 2023b).

The current and future impacts of climate change highlight the need for information on the efficiency of farmers' adaptation measures and proper plans for climate change in Africa to enable climate change adaptation planning (Magesa & Pauline 2018). The fifth IPCC Assessment Report also allows for more knowledge and research on responding sustainably to climate change impacts and challenges associated with adaptation projects to sustainable development (Magesa et al. 2023b).

2.3 Climate and weather-related disasters

The detrimental impacts of climate change and natural catastrophes are a widespread concern worldwide, primarily caused by deforestation, escalating temperatures, and the decline of biodiversity. These issues are occurring at an alarming rate, overlapping with the rapid growth of the global human population. In most developing countries, the unanticipated growth rate and expansion of urban centres have created extreme vulnerability for the urban disadvantaged, leading to accentuated impacts during periods of natural disaster occurrence. This vulnerability has increased because most needy people experience physical, social, and economic marginalization, magnified when disasters occur (Williamson et al. 2023).

2.4 Tropical Cyclones

With the intensified global climate change and the integration of economic activities, economic losses from climate and weather-related disasters have increased since 1980 (Zhou & Zhang 2021). Tropical storms are one of the most devastating natural hazards and frequently trigger catastrophes such as storm surges, floods, landslides, and debris flows (Wang et al. 2016). Scientists have found that storm lifetime and intensity have increased since the mid-1970s (Li et al. 2017).

Furthermore, the increase in the population living near the ocean means more people are affected by such disasters(World Bank 2011). Due to the severe damage, they cause tropical cyclones, which are inherently local phenomena, seriously threaten people's lives and assets worldwide. For instance, the super typhoon Hato, which hit the Pearl River Delta of China in 2017, resulted in at least 25 deaths, affected around 740,000 people, and caused over 6500 houses to collapse. Therefore, it is urgent to study how tropical cyclones affect the local economy in coastal areas (Zhou & Zhang 2021). In other sources, tropical cyclones also significantly impact human health, livelihoods, and economic activity. Estimates state that 35% of the world's population is affected by storms and that cyclones affected 466 million people from 1980 to 2009. In addition to the possible immediate impacts on human health, livelihoods, and local economies, severe storms often set back a country's development by several decades (Rakotobe et al. 2016).

The escalation of global warming is projected to increase the proportion of intense tropical cyclones and their peak wind speeds globally. This necessitates a reevaluation and enhancement of existing strategies for risk reduction. The significant hazards caused by tropical cyclones include destructive winds, storm surges, flooding due to heavy rainfall, and landslides. While wind speed is commonly emphasized in tropical cyclones, communication due to technological measuring capabilities, the literature suggests that storm surges and flooding contribute significantly to human casualties and infrastructure damage (Do & Kuleshov 2023).

Cyclones primarily affect coastal regions in South and East Asia, Madagascar, the eastern coasts of North and Central America, and the Caribbean. While fatalities predominantly occur in Asia, economic losses mirror this geographic distribution. Nonetheless, the most substantial economic losses occur in wealthy nations with advanced infrastructure (Doocy et al. 2013). Asian waters are the source of over 90% of cyclone-related fatalities and almost half of all recorded tropical storms. Due to monsoon troughs and easterly waves, cyclones are massive, well-organized storms with distinct cores that form over tropical or subtropical oceans. The ones with an average diameter of 100 to more than 1000 km are characterized by powerful winds and bands of heavy rains that circle the storm's centre and occur every season on average (Doocy et al. 2013).

The high winds, excessive rainfall, and cyclone flooding devastate the national economy and local livelihoods. Cyclones damage infrastructure, threaten food security, flood agricultural areas, destroy crops, injure cattle, and contaminate water supplies, thus increasing the incidence of water-borne diseases and causing human injuries, which would eventually lead to deaths (Rakotobe et al. 2016b)

Cyclones have an impact on all segments of society, but often, the most susceptible groups are those who are underprivileged, marginalized, and lack access to institutional safety measures. Studies from other countries regularly affected by cyclones, such as Bangladesh, India, Mozambique, and Indonesia, have emphasized that smallholder farmers are particularly vulnerable to storms. Smallholder farmers (generally defined as those having less than 2 ha of land) are susceptible to climate shocks, mainly because of their dependence on rain-fed farming. Most of them have limited areas of arable land, leading to food insecurity and high poverty levels. Other issues are lack of access to agricultural and disaster information and limited resources to cope with the impacts of cyclones (Rakotobe et al. 2016a). Therefore, tropical cyclones pose and will continue to be a significant threat to the lives and assets of numerous individuals worldwide. It is crucial to comprehend the economic ramifications of natural disasters to formulate effective disaster policies for mitigation and adaptation to this threat. Identifying the critical sectors most susceptible to direct destruction by these tropical cyclones is essential (Kunze 2021).

In addition, the coping strategies of smallholder farmers to climate shocks and longer-term adaptation plans are often place-specific and adapted to local circumstances. Therefore, gathering comprehensive data on how small-scale farmers in specific regions are now adapting to climate-related disruptions is crucial. This information will help inform the creation of effective strategies and policies to mitigate their vulnerability to such shocks and improve their ability to adapt (Rakotobe et al. 2016b)

2.5 Occurrence of Severe Cyclones at Global Scale

An average total of 84 cyclones have been recorded to be occurring yearly. For the past 50 years, 43 deaths and losses costing $78 million have been recorded as the average damage caused daily. Economic losses from weather, climate, and weather-related disasters can lead to at least one-third of the total deaths and financial losses in the World (WMO 2020).

Within the African and Southern Africa regions, water-related hazards have dominated the list of disasters, affecting human and economic tolls, over the past 50 years. Between 1970 and 2019, water hazards, weather, and climate accounted for 50% of all disasters, 45% of all reported deaths, and 74% of disclosed economic losses globally (Mutasa 2022). Of the top 10 disasters that have occurred during the same period, the hazards that led to human casualties have been droughts (650 000 deaths), storms (577 232 deaths, floods (58 700 deaths), and extreme temperatures (55 736 deaths). In these records, Africa accounted for 15% of weather-related, climate, and water-related disasters, 35% of associated deaths, and 1% of economic losses reported globally (Mutasa 2022).

Southern Africa is considered vulnerable to natural disasters, the majority being hydrometeorological. The most frequent ones are floods, while recurrent droughts affect the most significant number of people and account for the most essential economic losses (Mutasa 2022). Climate extremes, especially precipitation and drought extremes interacting with vulnerability and exposure of humans together with natural systems, can lead to disasters (Liu et al. 2019), resulting in damages that mainly affect the communal farmers who rely on farming. Other significant hydrometeorological hazards affecting southern Africa include landslides, storms, wildfires, and tropical cyclones (TCs), most of which originate from the Indian Ocean (Mutasa, 2022).

The 2018 to 2019 Southwest Indian Ocean (SWIO) cyclone season saw the most significant number of intense Tropical Cyclones (TCs) recorded in a single season based on records from 1980 to date. In this ocean of the 18 tropical cyclones, 11 of them were classified as severe, with wind speeds exceeding 165 km/h (kilometers per hour) (Emerton et al. 2020). The same author also highlighted that the cyclone season typically runs from September to April within the same region, with most systems occurring between December and March. This is also the rainy season when smallholder farming is at its peak. As a result, smallholder rain-fed agriculture in this region is inherently at risk due to frequent droughts and mid-season dry spells. Moreover, land degradation in the form of soil and nutrient erosion is also at its highest rate. Coupled with low rainfall, smallholder farmers practice low-input agriculture, also characterized by low yields averaging about 1 ton per hectare. On the other hand, the high costs of modern irrigation systems within the region also contribute to increased dependency on rain-fed farming by most smallholder farmers for their livelihood and food security. However, climate change and variability come in hand in hindering farmers' reliance on that rainfed agriculture system (Musiyiwa et al. 2017).

2.5.1 Cyclones in Zimbabwe

Zimbabwe has experienced about six or more cyclones events from 1900 to 2013. Inevitably, such events have affected about 14 million people, a more significant fraction being smallholder farmers (Makate & Makate 2019). Moreso, since the millennium, the southern African region has been hit by at least 30 cyclones, with cyclone Eline (2000), Japhet (2003), Dineo (2017), Idai 2019, Chalane (2020), Eloise (2021), all causing considerable damage in Zimbabwe. Most of them have resulted in fatalities and the destruction of infrastructure (Mukwenha et al. 2021). Climate change has been pinpointed as the primary driver of these experiences within the nation, and this indicates that the whole region will remain prone to these disasters, and this is likely to be at an increasing rate for as long as climate change persists, thus threatening the livelihood of people living within (Mukwenha et al. 2021; Munsaka et al. 2021)

Although there have been other cyclones in the past, Cyclone Idai had a more substantial impact than other cyclones, as it damaged water supplies, infrastructure, and crop fields for farmers. This mainly affected the Eastern parts of Chimanimani and Chipinge Districts in Zimbabwe. Moreover, because of road network destruction, stakeholders and rescue teams faced difficulties accessing the areas with the aid, thus increasing the vulnerability of the affected people (Mukwenha et al. 2021; Wynberg 2023). The Zimbabwe Directorate of Civil Protection has made notable strides in documenting and executing Disaster Risk Management (DRM) for adverse weather-related disasters like cyclones. However, the experience of Cyclone Idai proved that a lot still needs to be done to reduce the vulnerability of smallholder farmers living in these prone areas (Mukwenha et al. 2021).

Table 1: Significant cyclones and severely affected areas in Zimbabwe

Name of Cyclone	**Month and year**	**Local status**	**Total affected population**	**Deaths**	**Areas mostly affected**
Eline	February 2000	Tropical cyclone	2 700 000	106	Chimanimani, Chipinge, Gutu and Mberengwa
Japhet	March 2003	Ex-Tropical cyclone	50 000	8	Chimanimani, Chipinge, Guruve, Masvingo and Muzarabani
Denio	February 2017	Tropical cyclone	3 000	271	Tsholotsho
Idai	March 2019	Tropical cyclone	270 000	634 + 257 missing	Chimanimani, Chipinge
Chalane	December 2020	Tropical storm	More than 600	Not recorded	Chiredzi
Eloise	January 2021	Tropical storm	Not known	3	Not recorded

Source: (Chiimba & Verne 2022)

2.5.1 Farmers Coping Strategies Amid Cyclones.

Cyclones usually leaves footprints, which puts the most marginally located farmers in high vulnerability. Farmers who had stored grains and those with crops still in the fields lose their stored food supplies to the cyclones, thus risking their food security statuses. Drinking water becomes contaminated, and as a result, most water-borne diseases, such as diarrhoea, emerge. Entangled by all these challenges, the communities are developing coping strategies to survive within these harsh conditions since moving out of these fertile marginalized lands would not be an option (McCordic et al. 2022). In other cyclone-prone countries like Madagascar, farmers coped with the food insecurity incidence caused by the cyclone in the form of reducing food consumption, buying additional food, and receiving food aid from neighbours or relatives. Very few of them receive food aid from the government. In addition, more citizens in the country raise funds to send one of their family members abroad so that he/she would be sending remittances, which would support other family members (Rakotobe et al. 2016a).

Moreover, farmers in Madagascar build their homes using light materials such as timber, which they collect from the nearby forests. This helps in such a way that when the cyclones hit, damage to both the property and people would not be too severe, though this could not guarantee safety. The severity of the hurricane would always determine the level of damage to be experienced (Rakotobe et al. 2016a). Apart from this, farmers also identified other strategies, which include building sturdier houses, storing more grains before the cyclone/rain seasons, protecting livestock by relocating them to safer shelters earlier and moving temporarily to another location (Rakotobe et al. 2016a; McCordic et al. 2022)

2.6 Information transmission channels and extension services on a global scale.

Information dissemination can be regarded as a proactive information service designed to educate focused groups of users on economic, social, and educational issues, problems, storage, and information management for its delivery to the intended audience using different communication channels and means (Griffith 2019).

Within the modern-day context, the typical way of receiving information is through social media. This involves social platforms like Facebook, WhatsApp, Instagram, and Twitter. Moreover, within the basket of all these modes, the primary mediums remain television and the internet, with the internet being more questionable because of the lack of centralized management in assessing information quality before dissemination (Griffith 2019).

To facilitate this, more effective extension services must also be developed to address challenges such as meeting the information needs of smallholder farmers in developing countries. In response, agricultural extension experts are tirelessly working towards promoting the widespread use of information and communication technology (ICT) through agricultural extension and other agricultural agents. This can assist in speeding up agricultural technology transfer from research and development institutions to farmers, and at the same time, improving agrarian technology through farmer learning supports, problem-solving techniques and enhancing chances of accessing profitable markets for their produce (Tata & McNamara 2016).

China is also one of the countries that experiences severe natural disasters. Approximately 900 000 people have been killed by these disasters, and about 92% of them might have been avoided if there was an effective pre-warming system employed (Zhang et al. 2016a). Information and knowledge are vital in every community and agricultural setup, and where they are poorly managed, the chances of development of that community and farming sector would be highly impeded (Nicholas-Ere 2017). In the case of China, three main communication models have been reported to be mainly used. These include the probabilistic models (which include SMS, WeChat, TV, and email, among others) the use of loudspeaker vehicles, and passive dissemination (Zhang et al. 2016a). Other possible ways of delivering these messages to the communal farmers include videos, pictures, group meetings, and drama. However, this also depends on the effectiveness, acceptability, and time required for the information to reach the target audience (Nicholas-Ere 2017).

Probabilistic model: This model initially confirms the existing information dissemination rules of different media. This process is done according to the established rules (Zhang et al. 2016a). The model simultaneously discovers the concepts in a domain and the laws and principles that capture relationships between these concepts (Kemp et al. 2010).

Prewarning model: In this case, loudspeaker vehicles are used to disseminate the region's information. Residents are alerted by the loudspeakers' sound and act urgently in the evacuation process in case of emergency (Zhang et al. 2016b).

Passive model: This model defines victims as those who must acquire information through their auditory and visual senses when there is no time to spread the news (Zhang et al. 2016b).

Creating commercialization opportunities for smallholder farmers has become a priority on the agenda of many developing countries. Invariably, most smallholder farmers are less productive than commercial farmers. Apart from the various multifaceted challenges that smallholder farmers face, limited access to extension services is mainly the underlying constraint to their sustainability. Across Africa and Asia, public extension is a fundamental part of converting smallholder farmers because it is their primary source of agricultural information. In these continents, extension continues to be deployed using different evolving approaches. However, weather-related natural disaster occurrence is also part of the information they provide farmers. Still, several disasters like cyclones have been reported occurring while the farmers are unaware (Mapiye et al. 2021).

In some countries like Nigeria, the Ministry of Agriculture developed a portal to enhance agricultural activities. It is a platform that hosts several relevant websites, ensuring users are not shocked by unplanned changes and incidences affecting their services (Nicholas-Ere 2017). These platforms have allowed farmers to access better prices and stay up to date with all the necessary information, thus reducing the need for mediators and, at the same time, improving agricultural productivity and efficiency. The platform also provides weather information to farmers by extrapolating weather from the web, and it also can accept the administrator to feed it the information (Nicholas-Ere 2017).

More so, like other Southern African countries in Zambia, the ZMD (Zambian Metrological Department) focuses on providing weather and climate-related information to the farmers. The focus is to disseminate this information to all the farmers regardless of where they are in the country. However, within and outside Zambia, most smallholder farmers who live within the marginal areas still need to have adequate access to these forecasts due to the methods used (Nanja 2010).

The second Agricultural Policy of Zambia strongly supports sustainable agriculture as it is one of the main pillars that can assist in curbing climate change and its effects. However, despite these efforts, most smallholder farmers still practice agriculture extensification. Within this context, mobile phones are in the leading success race of aiding farmers' access to desired information like weather forecasts, pest attacks, improved cultivation practices, disease management, and input prices. This then guarantees improvement in farmers' knowledge of most issues, particularly farming plans and prudent decision-making, which may improve technical efficiency and awareness (Masikati et al. 2021). Though some regard this as a minor improvement, farmers' access to information has a significant positive change through a persistent and progressive change in mobile phone coverage. With the help of a considerable increase in literacy and rural electrification, they have been incredibly accepted and considered the leading modern medium of communication within the Zambian rural communities. They can potentially narrow down the gap in adopting beneficial information in new farming systems and possible hazards within the farming industry (Mwalupaso et al. 2019).

Among other models used in Zambia are print media, radio, and television. These seem to be effective, but the challenge is that they are usually circulated within the urban areas, which are not even a stronghold for the farming communities, making this information fail or taking time to reach the intended audience, thus increasing the chances for disasters to occur while most rural and marginal farmers are unaware. In the cases where some of the farmers have managed to access the information, they have failed to use it effectively. They do not understand the language that the publishers use. Seasonal climate forecast (SCF) terms such as "Below normal", "Near normal, and "above normal" make it difficult for farmers to depict the meaning without the assistance of an agricultural extension interpreter (Nanja 2010).

2.6.1 Agricultural extension

Agricultural extension refers to the dissemination of agricultural information, knowledge, and technologies to farmers, and normally in rural communities. The primary aim is to enhance agricultural productivity, advocate for sustainable agriculture and enhance the wellbeing of farmers as well. The concept often includes a variety of activities such as training sessions, workshops, and field visits which are facilitated by extension workers (Nehru et al. 2021).

Rural small holder farmers greatly depend on government extension workers' services. They play a massive role in ensuring that farmers receive updated information on their farming systems. The provision of available resources is mainly hindered by poor road networks and lack of proper transportation systems. Delays in the distribution of agricultural inputs to farmers by the stakeholders have been affecting their work to a greater extent as they would be forced to delay the time they disseminate their information, for instance, in cases where they must demonstrate some newly discovered planting practices (Livune 2020.).

However, several approaches are being used to ensure that they effectively provide their services, including the farmer field, participatory, and field approaches. These are mostly regarded as primitive and are being eroded and complemented by the increase in modern methods such as televisions, radios, and phones. Issues such as lack of skills, inefficient use of resources, poor farming structures, and unclear frameworks in using appropriate technologies in information delivery to smallholder farmers have been a great challenge hindering extension success (Somanje et al. 2021). Boyd & Spencer (2022) also stated that farmers need information on inputs, post-harvest management and markets, and exposure to new technologies and recent best practices to improve and sustain farm productivity. Traditional government extension agents have been regarded as the leading brokers responsible for the information flow within the agricultural industry. Still, they have significantly faced criticism due to their limited reach when in need, but all facilitated by the slow adoption of technological changes, a phenomenon common in most third-world nations.

2.6.2 Zimbabwean context in extension services

Effective communication is the critical key to achieving sustainable development, and this can be engineered and subsequently realized. Therefore, the communication process should be regarded as one of the fundamental development tools that must always be prioritized in development programs to realize the expected development goals (Moyo & Salawu 2018).

Uplifting extension services for climate risk management in agriculture can enhance the likely impact of climate-smart innovations on livelihood outcomes. This is because new technologies often come with additional requirements for farmers, and agriculture extension workers help bridge the knowledge gap associated with these new technologies (Makate & Makate 2019). For this to be more effective, regular training is needed to cope with climate and technological challenges.

Like in other developing nations, the Zimbabwean farming system is also one of the nations with a smallholder farming system facilitated by the government extension workers. The public extension system is the largest and most common source of information (Mapiye et al. 2021). Several efforts have been made towards improving agricultural productivity in Zimbabwe. One prominent one is command agriculture, which is manifested through programs like Operation Maguta, where the government tries to guide farmers on the types of crops to grow concerning the food security objectives for that particular year and the process is facilitated by Agricultural, Technical and Extension Services (AGRITEX) (Moyo & Salawu 2018).

Public extension is the primary source of extension services for small-scale farmers in developing countries like Zimbabwe (Mapiye et al. 2021). Zimbabwe's main agricultural extension agency, the Department of AGRITEX, is responsible for public rural agrarian extension. AGRITEX falls under the Ministry of Lands, Agriculture, Fisheries, Water and Rural Resettlement (MLAFWRR) and is represented at the village, ward, district, provincial and national levels (Masere & Worth 2021). As the primary distributors of technologies and information from technology inventors and researchers to farmers, AGRITEX workers are responsible for adopting the technology, which they then disseminate to their clients, who are farmers. Most of these technologies they recommended have not been adopted by the smallholder farmers who have primarily depended on their indigenous knowledge to sustain their farming enterprises and succeed. However, AGRITEX failed to build on this knowledge and practice (Masere & Worth 2021).

There are also other complementary platforms such as EMkambo, Zimbabwe Farmers' Union (ZFU) bulk SMS and emails, as well as newsletters that have been quite effective in reaching small-scale farmers (SNV 2015). These e-platforms are set to increase efficient and equitable information flow across all actors; farmers, extension agents, researchers, government, and private sector (Mapiye et al. 2021; Masere & Worth 2021)

2.6.3 Challenges Faced and Sources of its extension failures

Zimbabwe's extension workers have faced and continue to face multiple challenges, including poor funding, insufficient remuneration and incentives for extension service workers, lack of in-service training, lack of appropriate technology, inadequate linkages with research and farmers, and poor operational resources like transport to reach all farmers. These challenges have affected the agency's service delivery to small-scale farmers. Furthermore, until recently, AGRITEX failed to invest in building and strengthening endorsing indigenous knowledge to farmers. Moreover, part of the failure of AGRITEX is also found in the extension approaches they have been using, most of which are top-down instead of bottom-up (Masere & Worth 2021).

2.7 Classification of Agroecological Zones in Zimbabwe

The biophysical environment within which the economic men operate often dictates their potential and limits the activities they may do. Environmental parameters such as climate, soil type, natural vegetation, wildlife, water, and other necessary ecosystem resources must be closely studied and known before acting. Knowledge of these parameters enables informed and sustainable long-term planning, particularly in the agricultural sector (Mudzengi et al. 2021). These diverse biophysical variables interact continuously to produce a dynamic platform on which a series of socio-economic activities unfold. A closer analysis of these factors would result in seemingly uniform observable geographical spaces. From an agricultural perspective, these constant land units are termed agroecological zones (AEZs) (Chikodzi et al. 2013).

Apart from the recent Command Agriculture, a strategy adopted by the government to safeguard food security, there has been another strategy: the proper utilization of land. This can be achieved through land use planning to set out the production patterns. As a result, continuous agroecological zoning is based on how the regions are experiencing climate change variability, and change is being widely applied in the design of appropriate agricultural adaptation, land use planning, and reducing vulnerability. These new ecological zones also determine crop and water requirements and long-term frost protection measures (Mugandani et al. 2012.). On the other hand, in the Zimbabwean context, investment in agricultural production is being increasingly directed to agroecological zones where output benefits are expected to peak. This justified the relevance of zone defining and reviews that they are the standard tools for prioritizing agricultural research and investment because they offer relevant, available information regarding environments (Chikodzi et al. 2013).

The agroecological classifications, also known as Natural Regions (NR) categories of Zimbabwe, divided the country into five parts based on mean annual rainfalls, and this was initially done in the 1960s. The one with the best agricultural sustainability was considered Region 1, while the least was Region 5 (Mugandani et al. 2012). Chikodzi et al. (2013) also classified them as land areas representing unique combinations of homogeneous agroclimatic, ecology, soil units, and agricultural activities. However, some weaknesses have been identified. These include having little emphasis on smallholder farming and communal areas and the possibility of boundary changes mainly because of climate change and vulnerability. Moreover, data from a few stations were used to decide whether and zones of the whole nation (Mugandani et al. 2012.)

Table 2: Current agroecological zones of Zimbabwe after reclassification.

AEZ	Area covered (km^2)	Percentage covered (%)	Agricultural production	Description
1	7 000	2	Specified and diversified agriculture	>1000mm rainfall, tea, coffee, plantation farming, macadamia, fruits, intensive livestock production
2	58 600	15	Intensive agriculture	750-1000mm rainfall, intensive crop, and livestock production
3	72 900	19	Semi-intensive agriculture	650-800mm of rainfall. This supports severe mid-summer droughts, but maize, tobacco, cotton, and other cash crops can thrive
4	147 800	38	Semi-extensive agriculture	450-650mm of rainfall. Livestock and drought-resistant crop production
5	104 400	27	Extensive agriculture	<450mm rainfall supports extensive cattle and game protection

Source: (Chikodzi et al. 2013;Sharara et al. 2022)

The number of NRs in Zimbabwe has not changed based on average climate conditions from 1972 to 2006. However, the sizes of the NRs have changed, with NRs 1, 4 and 5 increasing, while NRs 2 and 3 reduced in size by 49% and 13% respectively. These shifts in the size and positions of the could be credited to the impacts of climate variability and change (Mugandani et al. 2012).

2.8 Cyclone Disasters in Chimanimani District

Over the last two decades, the Eastern highlands of Zimbabwe have experienced three cyclones, one ex-tropical cyclone and two tropical storms. The most recognized and devastating was Cyclone Idai, which hit the country in 2019. With a record of 634 people reported dead and 257 still considered missing, it is the deadliest cyclone so far. As a result of landslides, rockfalls and flash floods, an estimated 17 608 households were left homeless, and 12 health facilities and 139 schools were damaged (Chiimba & Verne 2022).

Community-based Disaster preparedness is becoming an increasingly important element of disaster management within the district. Historically, top-down, interventionist approaches have dominated the disaster management field. Initiatives have been characteristically technology-centered and driven by outside experts. However, for the past two decades, increasing emphasis has been placed on the one hand, community-based approaches, and on the other hand, pre-proactive approaches that focus more on the root causes of vulnerability rather than isolated disaster events (Allen 2006)

This recent frequency of cyclones and tropical storms has reached the attention of governments in the region, as it resonates with global concerns about the possible increase in extreme weather events in the future. These are usually accompanied by calls to improve cyclone predictions and early warning systems (Chiimba & Verne 2022). However, though these events are occurring at this high rate and frequency, smallholders still live in these vulnerable areas with less government assistance in ensuring safety and providing disaster preparedness materials. Instead, some new farmers are still moving in from other semi-arid regions like Region IV and V.

Official statements made it clear that even though the country has recently become more aware of the risk posed by cyclones developing in the south-western Indian Ocean, due to weak and unreliable communication infrastructures as well as political instability, which led to economic hardships, effective disaster communication to equip farmers and reduce impact severity remains an issue, particularly in rural areas (Chiimba & Verne 2022).

How people in the Chikukwa community live shows that they have adopted the community-based disaster preparedness approaches. These approaches are intended to strengthen farmers' coping and adaptive capacities locally, where the primary impacts of weather-related hazard events and environmental stresses are experienced (Allen 2006).

However, most research has been focusing more on other critical issues like disaster preparedness, suggesting ways of improving communication among other rural smallholder farmers concerns affecting them during and after these disasters. None of them have been focusing on finding out how these farmers are coping within these vulnerable communities so that these strategies can also be bought and employed in other areas that might have the same experience. This research shall then focus on scrutinizing these farmers' coping strategies and finding ways to improve them so that their crop fields and lives would not be at risk in case of cyclones and other climate-related disasters.

3 AIMS OF THE THESIS

Main objective:

To investigate how smallholder farmers cope with recurring cyclone disaster shocks in the Chikukwa community.

Specific objectives:

i. To identify the environmental effects of cyclones in the Chikukwa community.

ii. To identify measures that the local farmers are implementing to protect their fields.

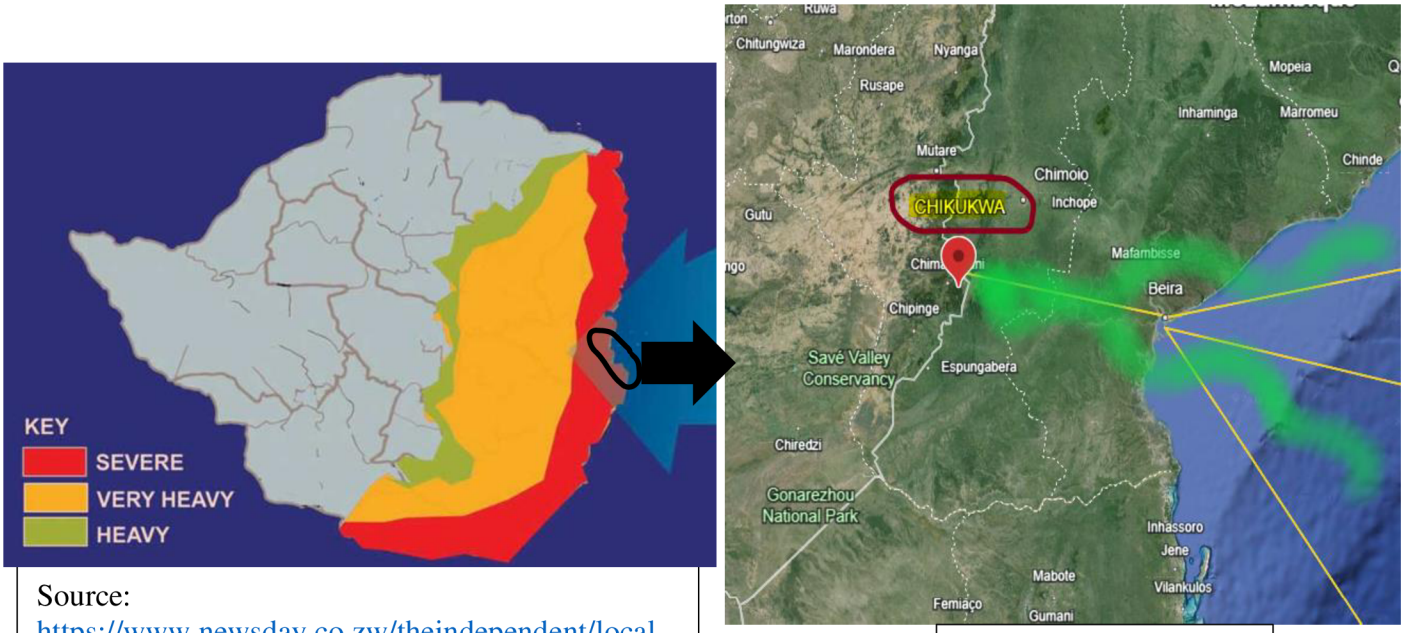
iii. To identify sources of information famers use to receive information about upcoming cyclones.

4 METHODOLOGY

4.1 Study area.

Chikukwa community is in the Chimanimani district of eastern Zimbabwe and is known for its rugged terrain, abundant vegetation, and primarily agricultural economy. It is along the Mozambique-Zimbabwe mountainous border, which was once a plantation belt during the colonial era. The community lies along the mountainous terrains of the Zimbabwe-Mozambique border. It is mainly dominated by Agricultural Region I and II Zimbabwean zones, which receive more rainfall than other zones. This makes it more attractive for farmers to live in the region as it comprises fertile soils. However, this picturesque landscape is being identified as prone to natural disasters, especially cyclones that emerge from the Indian Ocean via Mozambique, which have historically caused significant damage to the local communities. That combination of steep terrain and high rainfalls makes it prone to landslides and high erosion, exacerbated by these recurring cyclones. (McAllister & Chikukwa 2021).

Chimanimani District in Manicaland was severely affected by the recent most devastating cyclones that mainly affected Mozambique and part of Zimbabwe. The ones that left severe footprints include Cyclone Idai and Eline. Considering the visible landslide marks and the steep terrain, the area looks very risky for human habitation, but the population of people living there is increasing. Due to these factors, the area proved to be more appropriate for the research. In addition, the researcher's great understanding of the area's state, laws, and customs aided in reinforcing why it would be worthwhile to conduct the study there.



Source: https://www.newsday.co.zw/theindependent/local-news/article/200008792/cyclone-freddy-soaks-

Source: google earth

Figure 1: Study area indicating the areas where cyclones have an impact and enlargement of the study area.

4.2 Survey Sampling and procedure.

The selection of participants was done using the snow bow purposive sampling method. The first step was to provide a database of the recently encountered cyclone Idai survivor beneficiaries, and then try to reach them using the above-mentioned method. The CELUCT community-based organization provided the beneficiary database. There were 150 survivors of Cyclone Idai, and 105 were then selected from the list. This method was used to avoid choosing people who might not have experienced the first-hand impacts of cyclones. More so, in the absence of another farmer, a replacement was instantly made from the sampling frame until the target of the response rate was achieved. The rationale for selecting this target group was mainly based on significant considerations such as (age, the respondents or household member must have been in Chikukwa before 2019, and existence in the Cyclone Idai Relief Aid database of 2019-20).

There are 6 villages in Chikukwa (Ward 10). In allocating questionnaires to each village, the distribution process was undertaken based on the severity of observed and experience negative impacts per each village, with the most severe getting the highest number of questionnaires while the least severe getting the least number as well. The allocation per village was as follows Rujeko, (25), Chitekete (24) Munaka (21), Kubatana (17), Mabasa (10) and Kwaedza (8).

4.3 Data collection process

The research was undertaken from 23 August to 13 September 2023. The quantitative technique approach was used in the research after thoroughly considering the characteristics of the variables being studied. In conducting data collection, the researcher was directly involved into the research and also got the help from 5 *(3 women and 2 men)* trained enumerators. The selection process was an expert technique. This was based on the fact that they are undertaking a Diploma in Agroecology, which makes them more knowledgeable on the subject under study, and that made it easier to clarify some questions to the respondents. A questionnaire with 3 sections was used. It comprised of the experiences of farmers, how they received information, and the major impacts of cyclones felt within the study area.

On the first day of the interviews a pilot test was done to assess the relevance of the questionnaire in relation to the study objectives. 6 randomly selected farmers from the Chikukwa community participated in the process. To bridge gaps related to the falsification of information in the cases where some of the farmers are given the chance to fill out the forms on their own, this process was done together with all the involved researchers. This also could identify possible outliers to be adjusted to suit the usual distribution trend of the available secondary data and farmers' responses. The study objectives guided the procedure of choosing the variables that were utilized to create the scenarios.

Face-to-face interviews, which used questionnaires and observation were undertaken during the collection process. Each questionnaire was mainly directed per person separately to give room for informed different opinions from each farmer. Most questions were multiple selection types, closed questions, and one Likert scale type. The process consisted of pen-and-paper questionnaire interviews with face-to-face interaction with farmers.

The questions used were developed based on the study objectives with the help of findings from the secondary data during proposal development. These served as the primary tools in collecting, which fit within the scope of the rural community of Chikukwa, as other options for using mobile phones and recording devices were excluded due to the lack of technological equipment for all enumerators.

4.3.1 In-depth interviews

To get a deeper and more in-depth understanding of the study, the researcher also interviewed the key informant stakeholders, who provided more insight into the experiences of the farmers. For this activity, 4 participants were selected to express their views on a particular topic defined by the researcher. This approach was chosen based on the criteria that the respondents are all farmers with firsthand knowledge of the adaptation mechanisms and cyclone experiences within the area under research. These participants have been living in the community since birth, while some came through marriages but have been in the community for more than 20 years. Key informant participants such as the village heads and ward councillors were also among the 4 selected participants. As the group facilitator, helped by the local Agroecology graduates, the researcher posed questions to the participants and took their notes. Using the responses provided, the researcher identified other factors that were added to the responses as written text within the discussion.

4.3.2 Secondary data

The secondary data was mainly collected from scientific databases such as Science Direct, Research Gate and Willey, World Bank and FAO. Other secondary data also included were from CELUCT databases, files, published reports, and the recorded information from the Village heads. All these helped provide valuable information in mapping the paper from the background until achieving the desired results.

4.4 Data analysis

The obtained data was coded, sorted, and processed using a Microsoft Excel spreadsheet, which was used to sort data and analyze the frequencies, percentages, and all graphs. In addition, the SPSS (Statistical Package for Social Sciences) version 29.0 was used to calculate mean, minimum, maximum, and standard deviation of continuous variables. Most of the data were firstly analysed by SPSS and further processed in Excel spreadsheets.

5 RESULTS AND DISCUSSIONS

5.1 Descriptive Analysis

The results in Table 4 show that of the 105 interviewed respondents, with an average age of 43 years. The minimum age of participants was 18 years, while the oldest respondent was 78 years. They have an average household size of 4 members. The minimum household size was 1, with a maximum size of 13 family members.

Table 3: Continuous Variables

Variable	Description	Mean	SD	Min	Max
Age	Years	43.30	16.16	18	78
Household size	Members	4.75	2.22	1	13

Categorical variables

The majority were female respondents, 51.4%, while male respondents were 48.6%, as represented by Table 5 below. More than half of them (52.4%) have a farm size of less than 1 hectare of farmland, while only 1.9% have farmlands greater than 5 hectares. 35.2% and 10.5% of the respondents have land sizes of (1 to 2 hectares) and (3 to 4 hectares) ranges, respectively. In terms of experiencing tropical cyclones, nearly two-thirds indicated that they had experienced at least 1 to 3 cyclones (65.7%) in their entire life. 31.4% were the survivors of at least 4 cyclones, while only 2.9%, particularly the aged ones, indicated to have experienced more than 7 cyclones. Most of these respondents proved to have stayed in the community for more than 20 years as represented by 73.3% rate of response. Most of them were born and raised in Chikukwa, while some migrated into the community looking for fertile farmlands or came through employment. Some of the respondents mentioned that they experienced fewer cyclones while they had been living in the area for more than 20 years. This might have been because they were out of the community for those periods when the cyclones were experienced.

The location of farms is somehow evenly distributed in low-lying areas, steep slopes, along riverbanks, and around homesteads, with respective percentage response rates of 24.4%, 29.7, 17.4 and 28.5 as shown in a table below.

Table 4: Categorical variables

Variables	Description	Frequency	% of total
Gender	Male=1	51	48.60
	Female=2	54	51.40
Number of cyclones experienced.	1-3=1	69	65.70
	4-6=2	33	31.40
	7<=3	3	2.90
Number of years stayed in Chikukwa	1-5=1	9	8.60
	6-10=2	7	6.70
	11-15=3	3	2.90
	16-20=4	9	8.60
	20<=5	77	73.30
Farm size (hectares)	<1ha=1	55	52.40
	1-2ha=2	37	35.20
	3-4ha=3	11	10.50
	5ha<=4	2	1.90

5.2 The environmental impacts of cyclones within the Chikukwa community.

Respondents emphasized the negative impacts of cyclones, identified as road destruction, crop fields, vandalism of houses, schools, and other buildings, and ecological disturbances, as indicated in Figure 2 above. All the respondents (100%) reported the destruction of roads as a significant impact on their agricultural activity. This was followed by the destruction of crop fields and damage of homesteads, which have response rates of 78% and 71%, respectively. Though the respondents proved to have suffered from the other adverse effects, injuries and deaths of people were reported to be at a lower rate of 38%.

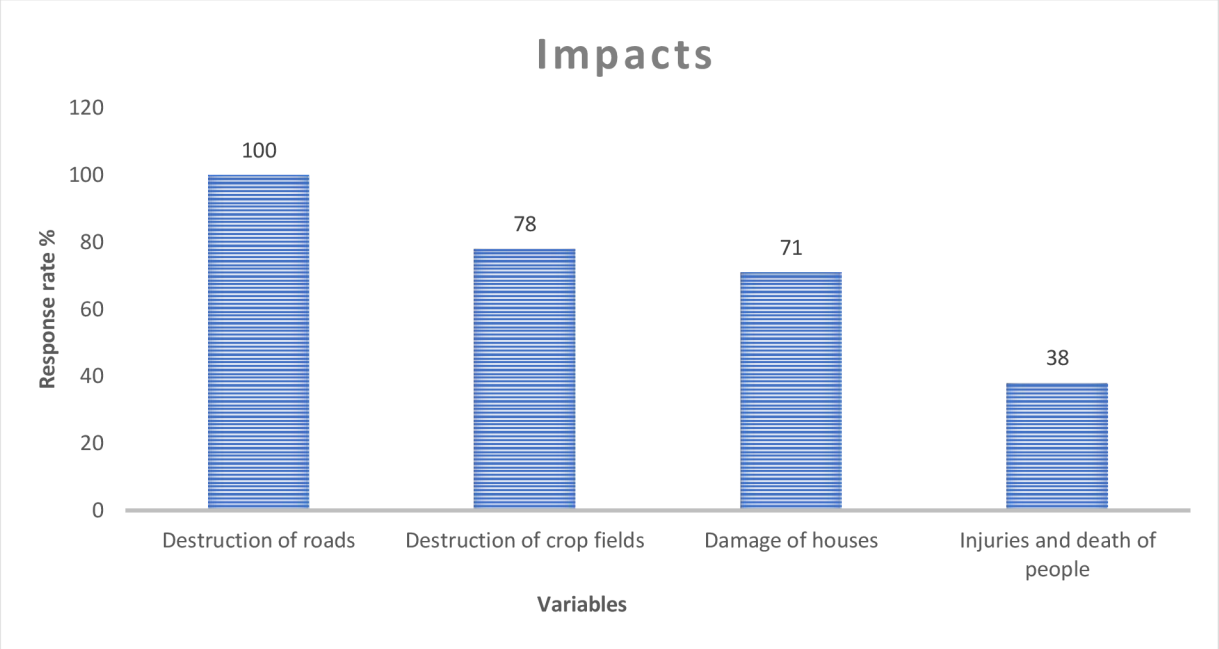


Figure 2: Major Identified negative impacts.

The destruction of roads has been a major concern as it has hindered the transport system, particularly for the aid workers and disaster risk reduction teams who needed to assist the survivors. As a result, farmers were marooned for a longer period as the country lacks enough emergency equipment to respond to these catastrophes quickly. This also affects the respondents in other livelihood services as they could not travel to work or access other basic public services outside their vicinity. On the other hand, the death rate report was recorded as low.

This might be because most farmers have already started practicing land protection measures such as agroforestry and terracing within their homesteads.

According to Rakotobe et al. (2016) cyclones cause substantial infrastructure damage in Madagascar. Their research also mentioned that over 80% of farmers experience damage to their residences, including collapsed or damaged roofs, broken walls, and destruction of houses, as reported by 18% of farmers. Dwellings that suffered the most damage from the cyclones were those constructed with mud and situated on steep slopes or near waterways. Cyclones also cause substantial harm to public infrastructure, resulting in the closure of numerous local schools, churches, and markets for one or more weeks for restoration. The immediate consequences on cattle and harm to individuals were deemed less severe. In addition, the cyclone also impacted the accessibility of non-timber forest products, such as wild yams and honey, which farmers typically obtain from forests. This was due to the destruction of vegetation caused by the cyclone, making it challenging for farmers to access the forests ecosystem services. The result of their research revealed that the effects of Cyclone Giovanna on agricultural production and family food security were predominantly detrimental. Nearly 90% of farmers reported that the hurricane affected their rice fields.

Supporting the above-highlighted facts, another study from Chapungu (2020) showed that the community's infrastructure, including residential buildings, roadways, and bridges, has not undergone measures to ensure its resilience to climate-related challenges. Occasionally, some houses were built out of poles and dagga without sturdy foundations. In certain cases, houses were situated inappropriately without considering critical environmental factors. For instance, many displaced households reported being relocated to low-lying areas that directed floodwater, destroying their homes. Thus, farm location in this study was examined as it determines its severity and susceptibility to devastation by the cyclone.

5.2.1 Farm locations and their relationship with encountered effects

Figure 3 shows that severe impacts have been significantly felt along the riverbanks, where the wetland fields are located. This has been represented by 81.12%. 13.59%, 3.81% and 1.48% reported the severity in riverbanks as high, moderate, and low. None of the respondents indicated any negative impacts in this location after cyclones.

According to the local laws of the community, farmers are supposed to keep a distance of 30 metres from the riverbank from where they start their farming. However, most do not follow this rule, leading to high siltation and flooding during cyclones or heavy rains. This led to a very high severity of impact along riverbanks.

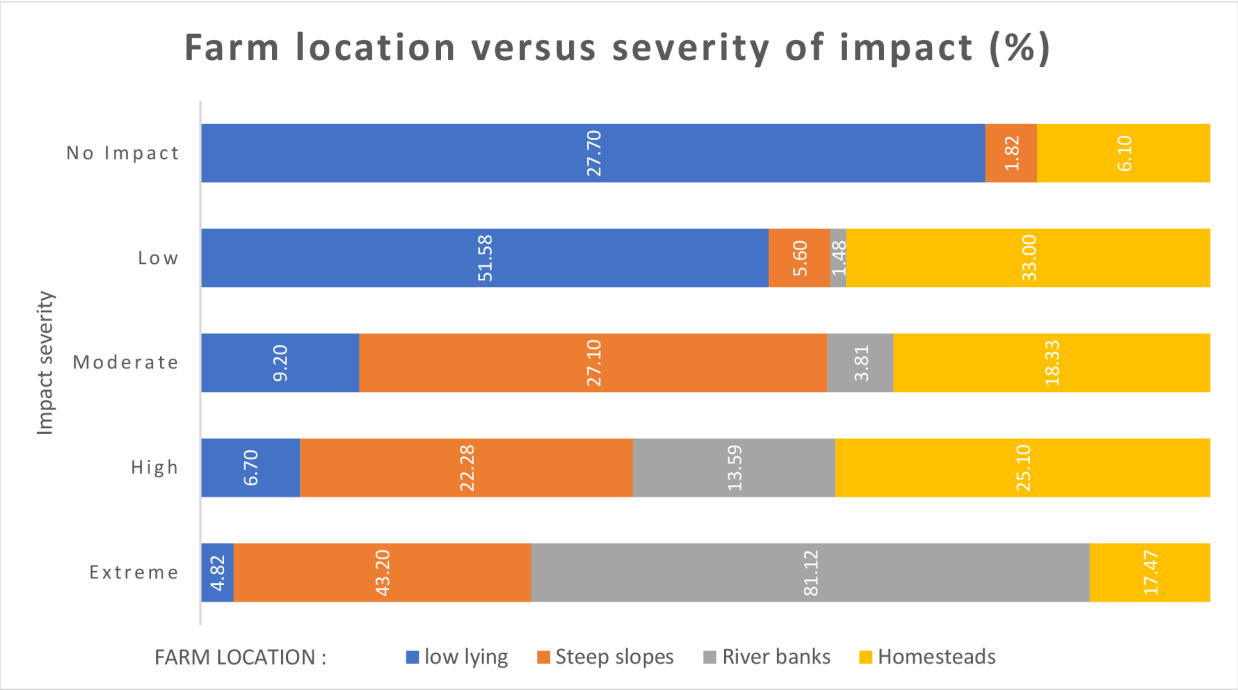


Figure 3: Severity and farm location relationship.

Steep slopes have received second from the highest response rate in terms of severity. 43.20% rated the impact as extremely high, while 22.28%, 27.10%, 5.60% and 1.82% indicated that the rates were high, moderate, low and no effect, respectively. This was also accelerated by erosion and landslides shared on these steep slopes. Most of the areas that are usually destroyed are bare while most of those covered by vegetation remain intact. Moreover, around the homesteads, the most significant number of respondents emphasized that the impact was low, with an impact rate of 33.00%. In comparison, 25.10%, 18.33, 17.47% and 6.10% highlighted the rating as low, high, moderate, extreme and no impact, respectively. Farms in low-lying areas far from the riverbanks are the only ones that received a high response rate of low and no impact ratings compared to other farm locations.

They both received a response rate of 51.58% and 27.70% respectively. Other responses were also indicated as moderate (9.20%), high (6.70%) and extreme (4.82%). These last three results were supported by the fact that primarily those who lived in low-lying areas along the gullies were highly affected by cyclones through running water. At the same time, those in open spaces or very close to the trees also incurred the impacts through wind destruction. However, the adaptation strategies to be used were also mainly influenced by the location of the farmland.

The Chikukwa farmers are always vulnerable to cyclone shocks because they lack external support, mainly from the government. High unemployment made most of them depend only on subsistence agriculture without any hope for change in their livelihood strategies. According to Mavhura et al. (2013), in the study of Muzarabani floods, farmers who live close to the riverbanks are more prone to experience severe impacts of water-related hazards. The authors also emphasized that farmers do not necessarily adopt all the strategies. Instead, they assess their location and capability and implement the best techniques.

5.3 Adaptation measures being practically implemented by local farmers to protect their crop fields.

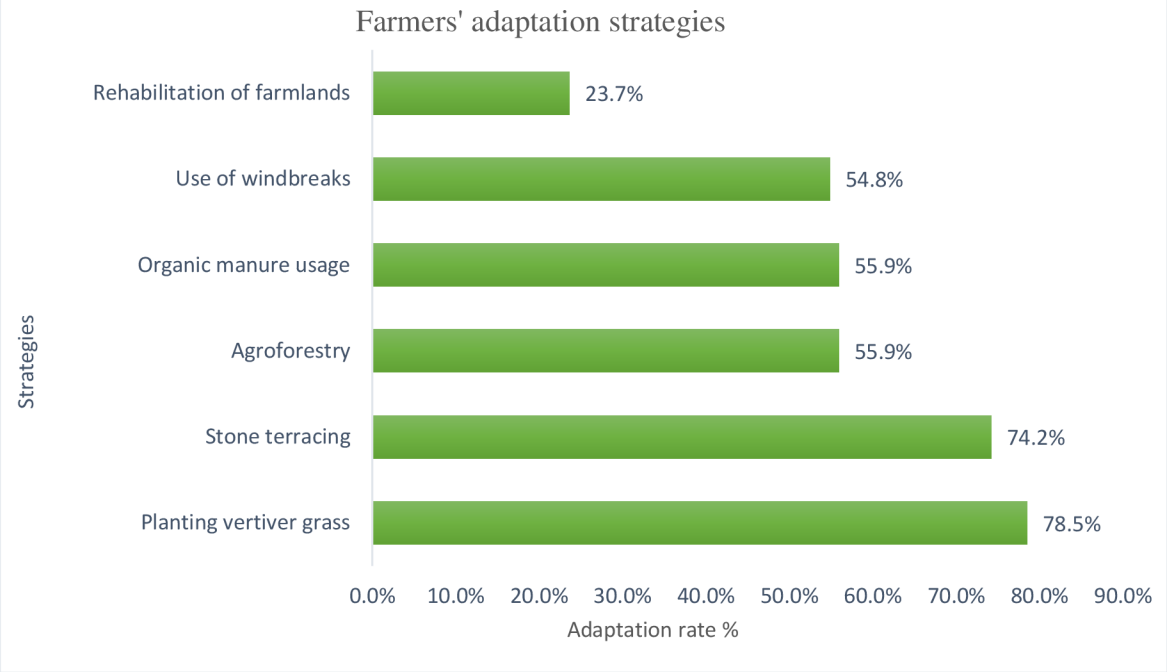


Figure 4: Major practical adaptation strategies.

The findings indicated that planting vetiver grass and stone terracing are the most adopted measures, with 78.49% and 74.19%, respectively. This suggests that the respondents were well exposed to these measures. The observations and further probing show that farmers have traditionally adopted these measures long ago because of the mountainous terrain. This has stabilized the soils to reduce erosion since many crop fields are also located on slopy lands. These practices might have been adopted in the 1980s during the period of forced extension services. The extension workers forced all farmers on slopy lands to plant vetiver and build terraces within their farmlands and homesteads. However, this is being reinforced again because of the recurring cyclones.

Agroforestry, organic manure, and planting trees as windbreaks are the moderately adopted rates, with windbreaks having a rate of 54.84% and in comparison, using organic manure and planting trees in the form of agroforestry account for 55.91% of the total. However, there has been a shallow adaptation rate on rehabilitation of the damaged farmlands, indicated by the low adoption rate of 23.66%, which differs more than 3 times from the most adopted measures. Rehabilitation of destroyed areas and infrastructure, such as roads and other ecosystems, requires technological and monetary resources. In this case, most community members cannot afford them. There is a lower assistance rate from the government and the local NGOs, thus leading to a lower adoption rate for farm rehabilitation.

Altieri & Nicholls (2017), in their study on adaptations and mitigation potential of traditional agriculture mentioned that during water-related disasters, slopy lands with natural forests are more prone to erosion as compared to those with properly planned forestry systems to save specific purposes such as windbreaking or agroforestry within the cropping fields. In addition to the above study, the addition of manure has been a more effective strategy in hurricane-prone areas as it enhances infiltration, drainage, biological activity, and aeration in soils with top fertile soils that have been washed away (Aryal et al. 2020). The author also believes that diversifying crops in the form of agroforestry also serves the same purpose of adding manure through leaf foliage while holding the soil during cyclones. However, both methods are regarded as too traditional.

On the other study of Cyclone Idai in 2019, 7 survivors expressed that there were adaptation measures to handle a tragedy of such immense scale. However, they admitted that sufficient awareness regarding climate change and the necessary actions to adapt to it are available. Most of the 351 sampled respondents, namely over 70%, admitted to being unaware of climate change and the necessity for adaptation. Instead, they failed to establish a correlation between climate change and extreme weather events. Some attributed the cyclone to spiritual forces, which were believed to be punishing their communities for social faults and other misdeeds. The absence of understanding of climate change and the corresponding beliefs resulted in action and incapacity to undertake measures to alleviate potential climate-related catastrophes (Chapungu 2020). There has also been a relationship between the impact's adaptation strategies and flow of information before, during and after cyclones and these are mainly affected by the sources used.

5.4 Sources of information used by farmers to receive information about upcoming cyclones.

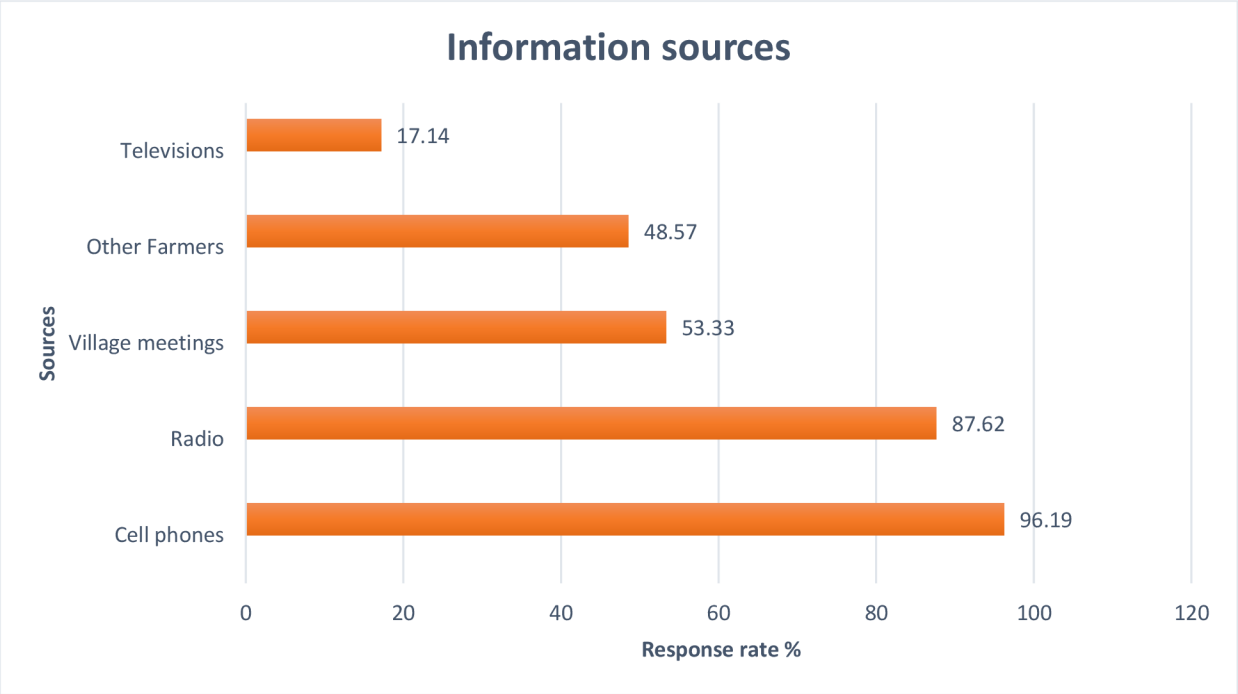


Figure 5: Major information sources used by farmers.

Cell phones (social media and SMSs) and radio have proved to be the most used sources of information patterning cyclone disasters. Among all the selections, 96.19% and 87.62% of the responses reviewed said they received their information through their cell phones and radio. Meanwhile, village meetings, with 53.3%, and farmer-to-farmer information sharing, with 48.8%, also have moderately higher percentages. Televisions do not play a huge role, with the lowest usage rate of 17.1% of the responses. Moreover, NGOs and agricultural extension agents also play a small contributing role, with 31.4% and 39% of their total responses, as indicated above in Figure 4.

Within the study area, almost everyone owns a cell phone, and the household owns radios. It is a tradition for household heads to buy radios for their families. Some even use the radios within their cell phones. When there are upcoming weather-related hazards, the government sends notification messages to all the registered sim cards while reporting on the radio during news times. That might be why most respondents indicated using these two as major sources. Farmers in this study area rely more on subsistence and have less to sell. Due to this, most cannot afford televisions and electrification of their households for easy functioning of these gadgets, thus decreasing the usage of televisions.

According to Mubofu et al. (2020), in their study on agricultural information sources, 82.2% of the respondents reviewed radio as the primary source for disseminating information concerning this study's results. This article proved a high preference attributed to its ability to raise awareness and provide adequate details regardless of an individual's literacy level since the local language is used for broadcasting. Village meetings, with 63.3%, were also regarded as the crucial role players together with farmer-to-farmer exhibitions that also have a response rate of 30%, and these also reviewed similar results, which are in line with the results of this Chikukwa study. The author also emphasized the use of extension workers and non-governmental organizations among the Iringa farmers in Tanzania.

Another study that supports this research's findings was from Tripathi (2009), which focused on assessing the use of mobile phones in information dissemination. Being easily accessible and providing customized content were the main benefits, so most respondents regarded it as a crucial information disseminator. Other sources, such as farmer-to-farmer, radio and television, have also been regarded as necessary and ranked in descending order. The main identified differences in this study were that extension agencies were rated higher than televisions, which is the opposite of Chikukwa Chimanimani.

5.4.1 Farmers views on need for improvement.

After probing into farmers, they were asked whether there is a need for improvement in the communication modes that they are currently using. 73.3% highlighted a gap in disaster information dissemination, while only 26.7% indicated satisfaction with the status quo. This shows that farmers do not trust the current measures, leading them to suggest possible improvements to strengthen the system.

5.4.2 Farmers suggestions towards improving the already available communication strategies

The graph in Figure 5 indicates that more than 82% of respondents are requesting assistance, mainly with establishing new alternative mobile network systems such as the Base Transceiver Stations (BTSs). This has been mainly because there is only one unreliable network provider station in the area, which can sometimes provide poor network services. However, because there is no competition from other providers, they do not intend to improve the quality of their services. Respondents also suggested that using all the channels mentioned above also aids in ensuring that all farmers receive disaster information on time. This has been represented by 76.32%. Using the local language on disaster indicator ratings and other warning posters and installing metrological centres in disaster-prone areas are the moderately and least suggested communication measures, with 68.42% and 53.95%, respectively.

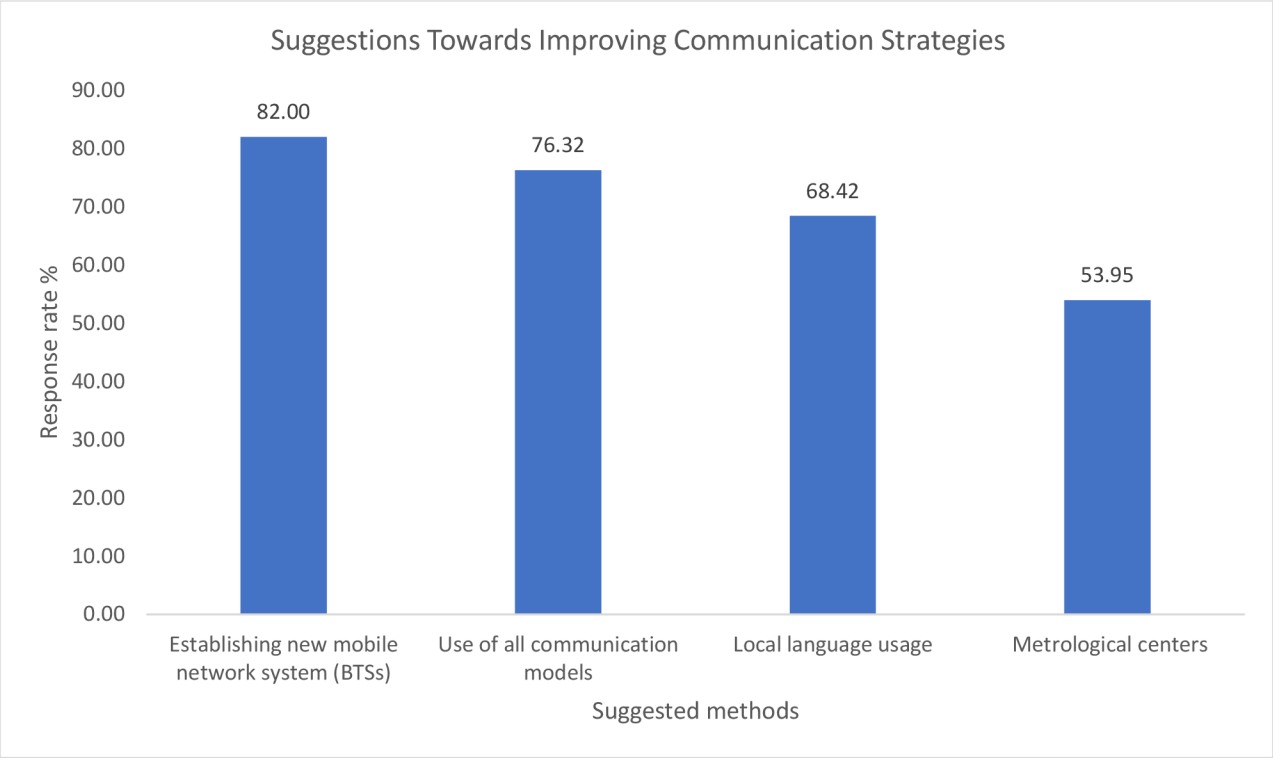


Figure 6: Suggested improvements in communication strategies.

There has been a challenge that the nation at large has never used the local languages as the first language when writing official documents. They have always been using English, which makes it challenging to transition and start using the local languages just because of these catastrophes, which are only occurring in a small fraction of the country. On the aspect of metrological centres, farmers believe that establishing metrological centres is capital-demanding, which might be a constraint for them unless other donors are willing to finance these initiatives.

Sources from Chiimba & Verne (2022) revealed that the perceptions of the people in Chimanimani about vulnerability to disasters dramatically changed. According to Chiimba & Verne (2022) Cyclone Idai proved that disaster communications may evolve in a form in which the official information may not be fulfilled. However, there should be several ways of disseminating information, mainly using all possible sources so that no one would be surprised. This information corresponds with the study findings, as indicated by the 76.32% response rate above.

Studies from Chapungu (2020) conducted in Chimanimani indicated the results that, there is a lack of efficient communication between weather specialists and communities regarding weather and climate information. Consequently, local populations are mainly uninformed and, therefore, unprepared. Once distributed, the data is encoded using language and technical jargon, as reported by over 55% of the participants. This establishes obstacles that increase their vulnerability, as the intended recipients would not adequately receive the information. Furthermore, the literature also indicated that the spread of erroneous information had engendered a lack of confidence within the groups intended to receive assistance. As an illustration, farmers once invested in drought-tolerant maize varieties based on meteorological reports, only to encounter a season with abundant rainfall. Communities began disregarding weather warnings, increasing their vulnerability (Chapungu 2020).

6 CONCLUSION AND RECOMMENDATIONS

As indicated by the first objective which focused on identifying the environmental impacts of cyclones, the destruction of roads, crop fields and damage to houses have all been reviewed as major negative impacts of cyclones within the study area. There was a 100% response rate on road destruction, which was found to be a major concern for the whole community as the area became accessible during these incidents. Therefore, it is recommended that the government construct strong tarred roads to address this issue as the dust roads could quickly develop gullies during heavy rains. Moreover, there are only two alternative routes to access this community, and constructing more alternative roads might help to make the area easily accessible.

The second objective focused on examining the preparedness measures that the local farmers are practically implementing to protect their crop fields. Although more than half of the respondents proved to have adopted most of the strategies, there is a great need for improvement in farm rehabilitation. That very low response rate indicated that farmers have no capacity; hence, the government needs intervention. The first recommendation would be for the local government to assist with small earth-moving machinery that can help farmers remove huge stones that have been deposited by cyclones in their fields, closing the gullies opened during heavy rains as well as reinforcing other already adopted measures like stone terracing which are not easy to implement manually. Another recommendation would be for policy makers to advocate for more government funds to be allocated on capacitating the extension workers in the field of sustainable farming systems. As a result, they can also aid in reinforcing the adoption rate of other strategies, such as the use of windbreaks, agroforestry, and organic manure, which have already been partially adopted. These measures aim to stabilize soil, reduce erosion, and enhance resilience to cyclones.

The third objective focused more on identifying the sources of information that farmers use to receive information about upcoming cyclones. Key findings show a high reliance on mobile phones and radios for obtaining information. However, as indicated by most respondents, there is a clear need for improvement in communication strategies to facilitate the use of the variables mentioned above. The need for new mobile network provider systems like BTSs has been a major concern, especially because of the poor network quality provided by the available BTS.

Respondents believed that provided they had a good network system, they could receive the warning information in a timely manner and thus undertake the preparedness measures which would eventually reduce impacts like deaths and injuries. In addressing this case, the government could subsidize other private network providers so that they would also have the incentive to install their private BTSs in rural areas, which are mainly not lucrative for them because of low population rates, which might lengthen their payback period.

Eventually, there is need for a strong collaboration between researchers and policy makers in enhancing the effectiveness of these results towards community resilience to cyclone disasters.

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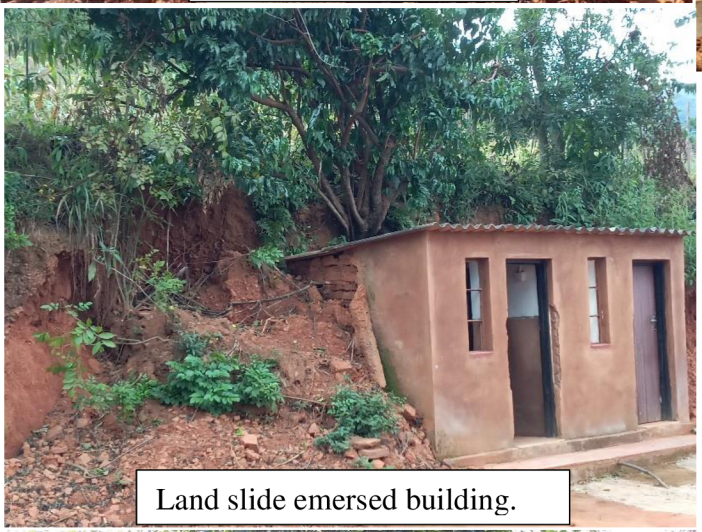
8 APPENDIX

8.1 Field photos showing impacts of cyclones.

Houses and destructed

Eroded riverbanks



Land slide emersed building.

Bridge closed by flood debris.

Community members strategizing a possible way forward after cyclone.

Muddy dust road in Chikukwa after cyclone

House destructed by cyclone.

Disaster response team (Red Cross)

Crop field and road destroyed

8.2 Questionnaire

Verbal consent ☐ Date: ……. /……../…….

(Tick or write details in the given spaces)

Name of interviewer

Demographic and Farm information

1 (a) Age: ***(years)***:……**(b)Household size**:……

(b) Sex:

Male	*Female*	*Other*

2 (a)Location (ward, village)

Ward:	*Village:*

3. Do you belong to any community social group(s)? Yes……. No…….

*If yes, can you name it/them*_____

4. How long have you been staying in Chikukwa community?

1 to 5 years	6 to 10 years	11 to 15 years	16 to 20 years	20 years +

5. Farm size:

Less than 1 ha	1 to 2 ha	3 to 4 ha	5+

6. Where is your farm located?

Low lying areas		Other:	
On slopy areas			

Along the riverbanks			
Around my homestead			

7. Rate the severity of impact of cyclones on the areas where your farm(s) is located:

	Extreme	High	Moderate	No Impact
Low lying areas				
On slopy areas				
Along the riverbanks				
Around my homestead				

8. What percentage of your farm is arable?

25%	50%	75%	100%

Cyclone information

1. **How may cyclones have you experienced while you are in Chikukwa from 2000 to date**?

0	1 to 3	4 to 6	7 to 9	10+

2. **On the ones listed below, which ones did you experience?**

Eline	Japhet	Denio	Idai	Chalane	Eloise

3. **Which one has been the most devastating/caused more damage? Rate according to severity from 1 to 6** ***(1 being the least severe and 6 being the most severe). NB****: Only rate the ones you experienced.*

Eline	Japhet	Denio	Idai	Chalane	Eloise

4. **Which social measures have you put in place in protecting yourself and your community during cyclones?**

Creating strong social groups		Developed safer evacuation centers	
Trained and ready DRR team		Other;	
Good communication networks			

5. **Since these areas are experiencing cyclones regularly, why are you still living in these vulnerable areas and not moving to safer places.**

The areas are fertile	
Lack of jobs forcing us to all venture into farming	
Safer places are far and inhabitable	
The need to stay close to their ancestors' graves (Cultural reasons)	
Others:	

6. **With your experience of these cyclones taking place, which measures have you taken in protecting your crop fields?**

Planting vetiver grass	
Agroforestry	
Stone terracing	
Avoid stream bank cultivation	
Rehabilitation of farmlands	
Use of manure to enhance infiltration	
Use of windbreaks	
Other:	

7. **To what extent did these measures protect your fields from other cyclones that occurred after implementation?**

Greater:	*Lesser:*	*No Change:*

8. **When your farming has been halted, what other surviving strategies do you have apart from crop farming?**

Receiving remittances from family members abroad	
Part time jobs	
Full time job at a company	
Receiving food aids	
Other:	

9. **What are the major impacts that you and your community have faced during and soon after cyclones?**

Destruction of houses	
Deaths and injuries	
Destruction and closure of main roads	
Destruction of crop fields	
Other:	

Sources of Information

1. **How do get information about the upcoming cyclones?**

Radio		Extension agents	
Televisions		NGOs	
Newspapers		Other:	
Other farmers			
Village meetings			

2. **Do you agree that these sources are reliable?**

Agree	Strongly agree	Neutral	Disagree	Strongly disagree

3. **Do you always receive information about cyclones on time? Yes**…… **No**……

4. **To what extent have these sources helped you in getting prepared for the catastrophe?**

Greater:	*Lesser:*	*No Change:*

5. **Are you satisfied with how this information is being disseminated?**

Yes:	*Neutral:*	*No:*

6. **Should there be improvements in how this is done? Yes**…… **No**……

7. **If yes. What are your suggestions?**

Improvements on the network system (BTS)		Use of all communication models to make sure that everyone receives the information *(Including traditional village messengers)*	
Installation of metrological centers in prone areas		Other:	
Use of local languages in Disaster Risk indicator ratings			

Thank you for your participation!