

Assessing Farmers' Knowledge on Climate Change and Their Adaptation Strategies in Zimbabwe

Beauty Zindi¹

Abstract

Climate change presents a growing threat to agricultural productivity and food security in Zimbabwe, where smallholder farmers depend heavily on rain-fed agriculture and are highly vulnerable to climate variability. This study assesses farmers' knowledge of climate change and examines the extent to which this knowledge influences the adoption of adaptation strategies across selected regions in Zimbabwe. Using a desktop involving case studies from Zimbabwe the article investigates the primary sources of climate information accessible to farmers, the types of adaptation strategies currently employed, and the socio-economic and institutional factors that facilitate or hinder adoption. The findings reveal that while many farmers are aware of climate-related changes such as erratic rainfall, prolonged dry spells, and rising temperatures, their ability to respond effectively is often constrained by limited access to finance, poor extension support, insecure land tenure, and insufficient information. Farmers with greater awareness and access to reliable climate information are more likely to adopt strategies such as conservation agriculture, crop diversification, rainwater harvesting, and drought-tolerant seed varieties. The study concludes that enhancing farmers' knowledge through accessible information, targeted training, and supportive policies is essential to building resilience and promoting sustainable agricultural development in the context of climate change.

Keywords: *Climate Change, Zimbabwe, Conservation Agriculture, Climate Variability.*

Introduction

Climate change poses one of the most significant threats to agricultural productivity, particularly in developing countries like Zimbabwe, where agriculture remains the backbone of the economy and a primary source of livelihood for the majority of the population (Zindi, 2025). Smallholder farmers, who constitute the majority of agricultural producers in Zimbabwe, are especially vulnerable due to limited resources, weak institutional support, and heavy reliance on rain-fed farming systems (Ndlovu & Mjimba, 2021). Assessing farmers' knowledge of climate change and their subsequent adoption of adaptation strategies is crucial for designing responsive policies and support systems that enhance agricultural resilience and food security. Despite increasing climate-related challenges facing the agricultural sector in Zimbabwe, there is limited empirical data on the level of awareness and understanding of climate change among farmers, particularly in rural communities (Nyahunda & Tirivangasi, 2021). The lack of this information hinders the development and implementation of targeted and effective adaptation strategies. Moreover, while various adaptation technologies and practices exist, the rate of their adoption remains low in many regions, raising concerns about the factors influencing uptake (Mavhura, Manyangadze & Aryal, 2022). This study therefore seeks to examine the depth of farmers' knowledge of climate change and assess how this knowledge affects their choice and implementation of adaptation strategies.

Background of Climate Change in Zimbabwe

Zimbabwe has been experiencing increasing climate variability over the past decades, manifested through erratic rainfall patterns, prolonged dry spells, rising average temperatures, and more frequent occurrences of extreme weather events such as droughts, floods, and violent storms (Chingombe & Musarandega, 2021). These climatic shifts have adversely affected agricultural productivity and food

¹ School of Public Management, Governance and Public Policy, College of Business and Economics University of Johannesburg, South Africa, Email: letwinbee@gmail.com

security in the country, particularly among smallholder farmers who rely heavily on rain-fed agriculture. For example, the 2015–2016 El Niño-induced drought led to widespread crop failure and significantly reduced maize yields the country's staple food placing millions at risk of food insecurity (Mujeyi, Mudhara & Mutenje, 2021). Similarly, the Cyclone Idai disaster in 2019 devastated parts of Eastern Zimbabwe, destroying infrastructure, farmland, and livelihoods (Mavhura et al., 2022).

The impacts of climate change are not limited to crop production. Livestock farming has also suffered due to diminished grazing land and water sources, leading to poor animal health and higher mortality rates (Kugedera, Mango & Kokerai, 2020). Additionally, soil fertility has declined in many regions due to both climatic factors and unsustainable land-use practices. Natural resources such as forests and water bodies are also under pressure as communities intensify their reliance on them to cope with the effects of climate stress (Norton & Alwang, 2020).

In response to these mounting challenges, climate change adaptation in agriculture has been declared a national priority. This is reflected in several strategic policy documents, including Zimbabwe's National Climate Policy (2017), the National Adaptation Plan (NAP), and its Nationally Determined Contributions (NDCs) under the Paris Agreement (Parwada, Chipomho & Mandumbu, 2022). These frameworks aim to enhance the resilience of vulnerable communities through improved agricultural practices, institutional support, and investment in climate-smart technologies.

However, the success of these policies largely depends on the knowledge, perception, and adaptive capacity of farmers at the grassroots level. Without a clear understanding of climate change and its impacts, farmers are unlikely to adopt recommended adaptation practices (Ramborun, Facknath & Lalljee, 2020). Studies across sub-Saharan Africa including Kenya, Ethiopia, and Malawi have shown that farmers' perceptions of climate change are closely linked to their willingness and ability to implement adaptive measures. Mavesere and Dzawanda (2022) mention that in Ethiopia, farmers who perceived changes in rainfall patterns were more likely to adopt soil and water conservation techniques. Similarly, in Malawi, access to climate information and agricultural extension services significantly influenced the uptake of drought-tolerant crop varieties (Mujere, 2021).

In Zimbabwe, several adaptation strategies have been promoted among smallholder farmers, including Conservation Agriculture (CA), agroforestry, mulching, water harvesting technologies (such as infiltration pits and contour ridges), crop diversification, early maturing seed varieties, and the use of organic fertilizers (Mpala & Simatele, 2024; Zindi, 2025). However, adoption rates of these practices remain uneven across regions due to a combination of socio-economic, institutional, and knowledge-related barriers. Many farmers continue to rely on traditional methods and may lack access to timely and accurate climate information, training, or financial resources needed to invest in adaptive technologies (Mujere, 2021).

Despite the growing urgency, there remains a significant knowledge gap regarding the extent of Zimbabwean farmers' understanding of climate change and the specific adaptation strategies they are using or willing to adopt (Chisadza, Mushunje, Nhundu & Phiri, 2020). Most existing studies are localized, outdated, or lack disaggregated data by region, gender, or age, which are all critical in tailoring effective interventions (Bhatasara, 2017). This study therefore seeks to bridge this gap by providing empirical insights into the knowledge levels of farmers across selected districts in Zimbabwe and by documenting the adaptation mechanisms they employ. The findings will inform policymakers, development practitioners, and extension services on how best to support farmer-driven climate adaptation in a sustainable and inclusive manner. It is against this background that the study seeks to achieve the following objectives:

- To assess the level of awareness and understanding of climate change among farmers in selected regions of Zimbabwe.
- To identify the key sources of climate change information available to farmers in Zimbabwe.
- To examine the types of adaptation strategies currently employed by farmers in response to climate change impacts in Zimbabwe .
- To determine the relationship between farmers' knowledge of climate change and the adoption of specific adaptation strategies in Zimbabwe.

Key Sources of Climate Change Information Available to Farmers

In Zimbabwe, farmers rely on a variety of sources for climate change information, ranging from formal institutional channels to informal community-based systems. One of the most critical sources is the Agricultural Technical and Extension Services (AGRITEX), which operates under the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development (Chanza & Gundu-Jakarasi, 2020). The Extension officers provide vital, localized information on climate-smart agricultural practices, such as conservation agriculture, drought-resistant crop varieties, and land-use planning. According to Nciizah, Nciizah, Mubekaphi & Nciizah (2022) in districts like Chiredzi and Mutoko, AGRITEX officers regularly hold field days and community workshops where farmers are taught how to interpret seasonal forecasts and adopt appropriate planting calendars.

Another key source is the Zimbabwe Meteorological Services Department (MSD), which provides scientific weather and climate data to the public. The MSD disseminates seasonal forecasts, early warning alerts, and daily weather updates through multiple platforms including radio, newspapers, and SMS services (Kugedera, Mandumbu & Nyamadzawo, 2022). Farmers in regions like Masvingo and Matabeleland South often rely on MSD bulletins to plan their agricultural activities, such as determining the optimal time for planting or harvesting to avoid crop losses due to adverse weather events (Nyahunda & Tirivangasi, 2021).

The Radio and television broadcasts are also significant channels for climate change information, especially in rural areas where literacy levels and access to digital tools may be limited (Norton & Alwang, 2020). Stations like *Radio Zimbabwe* and *National FM* air agricultural programs such as *Murimi Wanhasi* (Today's Farmer), which cover topics on weather patterns, drought preparedness, and farming techniques in indigenous languages (Muthelo, Owusu-Sekyere & Ogundeji, 2019). These platforms are widely accessible and have proven effective in reaching remote farming communities.

In recent years, mobile and digital platforms have emerged as innovative tools for information dissemination. Mobile services such as EcoFarmer, a product by Econet Wireless, provide daily weather forecasts, farming advice, and even crop insurance tips via SMS to 56 registered users (Nyoni, Bruelle, Chikowo & Andrieu, 2024). Another platform, eMkambo, operated by Knowledge Transfer Africa, integrates climate and market information, helping farmers make better decisions about planting, harvesting, and selling their produce (Mavesere & Dzawanda, 2022). These services are particularly useful in areas with high mobile penetration but limited physical infrastructure.

The Non-Governmental Organizations (NGOs) and donor-funded projects also play a crucial role in delivering climate change information. Organizations like Practical Action, CARE International, and the Zimbabwe Resilience Building Fund (ZRBF) have worked extensively in districts such as Chipinge, Buhera, and Chimanimani conducting farmer training sessions, participatory scenario planning workshops, and distributing simplified weather bulletins (Mujere, 2021; Chisadza, Gwate & Musinguzi, 2024). These programs aim to build farmers' capacity to understand and respond to changing climate conditions.

Farmers also benefit from informal sources such as peer learning through farmer-to-farmer networks and community groups. In many rural settings, farmers gather during community meetings, cooperative group sessions, or informal discussions to share experiences and indigenous knowledge about climate patterns and adaptation techniques (Mpala & Simatele, 2024). For example, in Mwenezi and Nyanga, community-based farmer groups have adopted collective decision-making approaches, using both traditional weather indicators and modern forecasts to guide their farming activities (Norton & Alwang, 2020).

Lastly, research institutions and universities contribute by generating and sharing localized climate and agricultural research. Institutions such as the University of Zimbabwe and the Crop Breeding Institute collaborate with farming communities to introduce climate-resilient crops and conduct workshops on sustainable farming practices (Gram, Roobroeck, Pypers, Six, Merckx & Vanlauwe, 2020). These academic institutions often work in partnership with NGOs and government departments to ensure their research reaches end-users effectively.

Methodology Used

The study used various case studies to collect data from various farmers who are using various strategies to adopt climate change in Zimbabwe. The review encompassed both grey and academic literature that examined the use of climate change adaptation strategies and agriculture in Africa. The

selected case studies were widely published on climate change, climate change awareness and adaptation strategies, climate smart agriculture, and climate change agriculture. This entailed doing content validation and scrutinising the origins of documents to evaluate their accuracy, dependability, authenticity, and importance (Kumar, 2019). In addition, the researcher utilised content analysis and theme categorisation methodologies to examine the gathered data, thus enhancing her comprehension of the topic and making a valuable contribution to the discussion on climate change adaptation strategies in Zimbabwe.

Climate Adaptation Strategies Currently Employed by Farmers in Zimbabwe

Zimbabwean smallholders employ a mosaic of climate-smart responses that reflect the country's varied agro-ecological zones, farm sizes and resource levels. Below is an examination of the main adaptation strategies in use, with concrete examples of where and how farmers are putting them into practice.

Conservation Agriculture (CA) “Pfumvudza/Intwasa” and allied practices

Conservation Agriculture (CA) has emerged as a key pillar in Zimbabwe's climate change adaptation strategy, with the Pfumvudza/Intwasa programme serving as the flagship model for its implementation (Zindi, 2025). CA is based on three core principles that is minimum soil disturbance, permanent soil cover using organic mulch, and crop rotation. These principles aim to improve soil structure, conserve moisture, and enhance resilience to climate stressors such as drought and heatwaves. Madamombe, Ng'ang'a, Oborn, Nyamadzawo, Chirinda, Kihara and Nkurunziza (2024) added that Pfumvudza/Intwasa has been widely promoted by the Zimbabwean government in collaboration with development partners as a low-cost, scalable solution for smallholder farmers.

The implementation of Pfumvudza has seen remarkable uptake across various districts, especially in drought-prone areas like Chiredzi, where over 40,000 communal farmers adopted the model in the 2022/2023 agricultural season (Madamombe et al., 2024). Farmers prepared standardized micro-plots measuring 39 x 16 meters (0.06 hectares), applied organic mulch, and planted early-maturing varieties of maize and sorghum. Remarkably, many of these farmers reported successful harvests despite experiencing a severe heatwave in November, a feat rarely achieved under traditional tillage systems, which are more vulnerable to moisture loss and soil degradation (Chanza, & Gundu-Jakarasi, 2020).

The success of Pfumvudza is not limited to manual farming methods. In Shamva, for example, mechanisation of CA has added efficiency and scale (Mavhura et al., 2022). Local service providers rent out two-wheel tractors equipped with basin diggers, enabling farmers to create uniform planting basins quickly and at lower labour costs. This mechanised approach reduces the time required to prepare Pfumvudza plots by up to 90%, making it feasible for larger plots and for elderly or labour-constrained households to participate effectively (Norton & Alwang, 2020).

Furthermore, in Makoni District, CA has also been integrated with agroforestry, where farmers plant nitrogen-fixing trees such as *Faidherbia albida* along their Pfumvudza plots (Chisadza, Gwate & Musinguzi, 2024). These trees provide shade, enrich the soil with organic matter, and enhance moisture retention, further strengthening the resilience of the cropping system. Meanwhile, in Buhera and Gutu, some farmers have combined CA with water harvesting techniques such as tied ridges and infiltration pits around the Pfumvudza plots to maximize water retention during dry spells (Mavesere & Dzawanda, 2022).

Moreover, women and youth groups have been central to the success of Pfumvudza in many districts. Mujere (2021) observed that in Mutoko, for example, women's farming cooperatives have adopted Pfumvudza on communal plots, producing surplus grain for sale while contributing to household food security. Youths involved in the programme have also been trained as CA champions, helping to mobilize community participation and share knowledge about proper plot preparation, spacing, mulching, and rotation techniques (Ndlovu & Mjimba, 2021; Mpala & Simatele, 2024). However, the success of the Pfumvudza/Intwasa programme is not without challenges. Some farmers face constraints such as limited access to mulching, inadequate training, or delays in distribution input. Nonetheless, where properly supported, Pfumvudza has proven to be a practical and effective adaptation strategy that boosts yields, conserves soil moisture, and reduces vulnerability to climate variability (Nyoni et al., 2024).

Crop Diversification and Uptake of Drought-Tolerant Germplasm

Crop diversification and the use of drought-tolerant germplasm have become critical adaptation strategies for smallholder farmers in Zimbabwe as they face increasingly erratic rainfall patterns and extended dry periods (Phiri, Nhliziyo, Madzivire, Sithole & Nyathi, 2021). Traditionally, many households depended almost exclusively on maize as their staple crop. However, the impacts of climate change such as mid-season dry spells, delayed onset of rains, and shorter growing seasons have made maize cultivation increasingly risky, particularly in agro-ecological regions IV and V where rainfall is unreliable (Norton & Alwang, 2020).

In response, farmers are gradually shifting from mono-cropping systems toward a diversified cropping portfolio that includes drought-resilient staples and high-value crops (Chingombe & Musarandega, 2021). In Rushinga District, for example, many households that previously relied on maize have transitioned to growing pearl millet and sorghum. The small grains are well-suited to low rainfall conditions, requiring 30–40% less water than maize and performing better in nutrient-poor soils. According to Mpala and Simatele (2024) through a partnership with the World Food Programme (WFP) and the Ministry of Agriculture, farmersED in Rushinga have received support in the form of drought-resistant seed varieties, training, and threshing equipment, which has reduced post-harvest losses and improved market readiness. Some communities have also accessed formal markets and school feeding programs, which purchase small grains for nutritional and food security purposes.

In addition to staple crops, farmers are exploring high-value cash crops that require less water and have better market returns. In Chiredzi, for instance, chilli farming has become a popular alternative to maize. Farmers grow bird's eye chilli and habanero varieties, which are drought-tolerant and require less irrigation (Newsham, Naess, Mutabazi, Shonhe, Boniface & Bvute, 2023). A single harvest can yield earnings of up to US \$400, offering farmers both income security and a pathway out of climate vulnerability (Norton & Alwang, 2020). Several contract farming arrangements facilitated by private buyers and NGOs have also helped link these chilli farmers to export markets, particularly in Asia and Europe.

Other regions have embraced the cultivation of leguminous crops such as cowpeas, ground nuts, and bambara nuts, which not only tolerate dry conditions but also fix nitrogen in the soil, improving fertility for future planting (Mujere, 2021). In Buhera and Bikita, cowpeas have become a strategic crop due to their short growing period and compatibility with intercropping systems (Mpala & Simatele, 2024). Farmers in these districts often plant cowpeas alongside sorghum or millet, ensuring food availability even in seasons with limited rainfall.

Furthermore, the uptake of early-maturing and drought-tolerant maize varieties has also gained momentum. Varieties such as ZM521, ZAP61, and SC403, promoted through the Seed Co and government extension programmes, have been introduced in areas like Gokwe South and Mangwe (Ndlovu & Mjimba, 2021). These varieties are bred to mature within 90–100 days, making them ideal for regions with short rainy seasons. Farmers using these varieties have reported stable yields even during sub-optimal rainfall years. Another noteworthy initiative is the promotion of indigenous and underutilized crops. In parts of Matabeleland South, farmers are reviving traditional crops such as amaranth (mowa), pumpkins, and watermelons, which have high nutritional value and are well-adapted to local climatic conditions (Mavesere & Dzawanda, 2022). These crops, often grown using minimal external inputs, contribute to both household food security and dietary diversity.

Rainwater Harvesting and In-field Moisture Conservation

In the semi-arid south-west of Zimbabwe, farmers are reviving and modernising traditional soil and water conservation practices to cope with climate variability. A key strategy has been the upgrading of old contour ridge systems by adding cross ties (tied ridges) and infiltration pits (Chisadza et al., 2020). These practices help create small reservoirs along the contour that hold water long enough for it to seep into the soil. Complementary techniques such as potholing and micro basins, popular in Masvingo, further enhance infiltration and cut evaporative losses, with some farmers reporting a 10 % yield rise over five years despite erratic rains (Nyoni et al., 2024). These modifications slow down surface runoff, trap rainwater, and improve water infiltration into the soil profile.

In addition, zai pits (planting basins), common in communal areas of Matabeleland, are being reintroduced with modern adjustments such as the incorporation of compost or manure to boost soil fertility while retaining water around crop roots (Chanza & Gundu-Jakarasi, 2020). Farmers also combine mulching with tied ridges to further reduce evaporation and protect the soil surface. In drought-

prone wards of Gwanda, households are experimenting with stone bunds and grass strips across slopes, which help to stabilise soils while enhancing groundwater recharge (Newsham, Naess, Mutabazi, Shonhe, Boniface, & Bvute, 2023). The adoption of these in-field moisture conservation measures has contributed to improved crop stand, especially for small grains such as sorghum and millet, which are more resilient to water stress. Studies by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) show that integrating rainwater harvesting with drought-tolerant seed varieties can increase water use efficiency by up to 30 % (Mavesere & Dzawanda, 2022). Farmers also benefit from reduced soil erosion and better soil structure, making their fields more productive in the long term.

Beyond individual fields, community-level initiatives such as rehabilitating small earth dams and constructing run-off harvesting structures channel excess rainwater into shared reservoirs for supplementary irrigation of vegetables and livestock watering (Mujere, 2021). These combined approaches reflect a growing trend toward climate-smart agriculture, where traditional knowledge is adapted with new techniques to enhance resilience in fragile dryland farming systems.

Small-scale Irrigation Powered by the Sun

In Zimbabwe small scale farmers have started using irrigation powered by the sun. These systems provide a reliable and affordable alternative to diesel-powered pumps, reducing fuel costs and minimising carbon emissions. Chingombe and Musarandega (2021) pointed out that the Kushinga women's garden in Shurugwi supports 32 households with year-round access to fresh produce and generates incomes of about US \$10 per member per day through tomato and leafy green sales. Beyond household food security, this has enabled families to pay school fees and diversify their livelihoods. Similar solarised schemes in Zvimba (Mashonaland West) and Chivi (Masvingo) are earmarked for centre pivot irrigation covering up to 150 hectares, significantly expanding the scale of production and opening up opportunities for local markets and small agro-enterprises (Nyahunda & Tirivangasi, 2021). In Gwanda North, where water scarcity is acute, communities are combining sand water abstraction with solar pumping technologies to tap into shallow aquifers beneath riverbeds (Norton, & Alwang, 2020). This approach now services around 250 communal farmers cultivating one-hectare plots, transforming drylands into productive gardens.

Solar irrigation is also being linked with climate-smart cropping systems, such as integrating drip irrigation with high-value horticulture (onions, tomatoes, paprika) and small grains (Parwada et al., 2022). This ensures efficient water use, with drip systems reducing water loss by up to 60 % compared to traditional flood irrigation. Moreover, women and youth have become central beneficiaries, as these systems reduce the labour burden of fetching water manually while enabling them to engage in commercial agriculture. The NGOs such as Practical Action together with government-backed programs like the Zimbabwe Smallholder Irrigation Revitalisation Programme (SIRP), are scaling up such initiatives, offering training on system maintenance, cooperative management, and market access (Mavesere & Dzawanda, 2022). In areas like Mwenezi, farmer groups are piloting solar-powered cold storage facilities, allowing perishable vegetables to last longer and fetch higher prices in urban markets. Overall, solar-powered irrigation is reshaping the smallholder farming landscape in Zimbabwe. It not only improves food and nutrition security but also enhances resilience against climate shocks, diversifies income sources, and contributes to broader rural development goals.

Integrated Crop–Livestock Strategies and Fodder Innovation

Norton and Alwang (2020) affirm that livestock keepers in Zimbabwe's drylands are responding to feed shortages and erratic rains by adopting integrated crop livestock strategies that enhance resilience, reduce costs, and generate new income streams. A key innovation has been the establishment of on-farm fodder banks and the use of low-cost feed processing technologies. The Vusanani Group in Umzingwane, supported by the Matabeleland Enhanced Livelihoods and Nutrition Adaptation (MELANA) project, processes bush meal feed using tree pods (such as acacia and marula) mixed with crop stover (Chiturike, Nyamadzawo, Gotosa, Mandumbu, Nyakudya, Kubiku, & Kugedera, 2022). With a hammer mill acquired through a 70 % grant, the group is able to lower the cost of supplementary feed while selling surplus to neighbouring farmers, thus creating a community-level input market.

In Lupane, hay baling clubs emerge as collaborative enterprises where groups cultivate velvet bean (*Mucuna pruriens*) and lablab, both high-protein legumes, for dry season feeding (Makate, Makate, Mango & Siziba, 2019). These fodder crops not only improve livestock nutrition but also fix nitrogen, enriching soil fertility for subsequent cropping. In Garanyemba, a livestock drought mitigation

centre demonstrates the power of integration by pairing a solar-driven 30 000L water tank with a drip-irrigated horticulture plot (Norton & Alwang, 2020). This dual system provides both green fodder and vegetables, ensuring continuous income and feed availability even in peak drought months.

In addition, farmers report healthier animals with shorter recovery times after drought, improving their ability to sustain draft power for land preparation and transportation. To cushion weather-related income shocks, smallholders in Matabeleland South are increasingly enrolling in the Farmer's Basket index insurance product, paying roughly US \$24 per hectare (Mpala & Simatele, 2024). Unlike traditional indemnity-based schemes, payouts are triggered automatically by satellite-monitored rainfall or temperature thresholds, bypassing long disputes and bureaucratic delays. In Bulilima District, early payouts after the 2022/23 drought allowed farmers to restock small ruminants, purchase fodder, and maintain household food security (Mavesere & Dzawanda, 2022). These strategies show how crops and livestock integration goes beyond subsistence to create circular systems of resource use crop residues feed animals, manure enriches soils, fodder crops support livestock, and livestock incomes buffer farming households.

Farmers' Knowledge of Climate Change and the Adoption of Specific Strategies.

The relationship between farmers' knowledge of climate change and the adoption of specific adaptation strategies is both direct and significant. In Zimbabwe, farmers who possess a clear understanding of climate change on causes, impacts, and expected patterns are more likely to adopt proactive and effective adaptation strategies (Chisadza et al., 2024). Knowledge acts as a foundational driver that shapes farmers' perceptions, attitudes, and decision-making processes in the face of climate risks. When farmers are aware of changes in rainfall patterns, increasing temperatures, and frequent droughts, they are more inclined to adjust their farming practices accordingly (Bhatasara, 2017). For instance, in districts such as Mutoko and Guruve, farmers who have received training through Agricultural Extension Services (AGRITEX) or NGO-led programs have shown a higher likelihood of adopting Conservation Agriculture (CA) practices, including minimum tillage, mulching, and crop rotation (Chanza & Gundu-Jakarasi, 2020). These farmers are often aware of the benefits of CA in conserving soil moisture and increasing yields under dry conditions. In contrast, those with limited understanding of climate change tend to stick to traditional farming methods, which may not be sustainable in the current climate (Chingombe & Musarandega, 2021).

Similarly, knowledge of seasonal forecasts and climate projections enables farmers to make informed decisions about crop selection and planting times. In Masvingo Province, farmers with access to weather information through mobile platforms like EcoFarmer or radio programs like Murimi Wanhasi have adopted early-maturing or drought-tolerant crop varieties such as sorghum, millet, and cowpeas (Mujere, 2021). These farmers demonstrate an understanding of the risks posed by shorter growing seasons and erratic rainfall, and they adjust their cropping calendars accordingly. In contrast, farmers without access to this knowledge often miss critical planting windows, resulting in poor yields or total crop failure (Mpala & Simatele, 2024)

Furthermore, farmers with greater awareness of climate change impacts are more likely to invest in water harvesting and small-scale irrigation systems. In Chivi and Gwanda districts, farmers who have been part of climate adaptation workshops initiated by organizations such as Practical Action have constructed infiltration pits, tied ridges, and solar-powered irrigation systems to cope with declining rainfall (Nyoni et al., 2024). This shows that knowledge transfer and training significantly influence the adoption of technologies that enhance resilience. It is also evident that peer learning and community knowledge-sharing platforms amplify the relationship between knowledge and adaptation. In communities where farmers discuss climate experiences and share solutions such as farmer field schools or cooperative groups in Nyanga and Chipinge there is a higher rate of adoption of practices like agroforestry, intercropping, and crop diversification (Mavesere & Dzawanda, 2024). Farmers in these areas not only apply what they learn from institutions but also integrate indigenous knowledge, enhancing their adaptive capacity.

Challenges Hinder Farmers from Effectively Adopting Climate Change Practices in Zimbabwe

Farmers in Zimbabwe face a range of challenges and barriers that limit their ability to effectively adopt climate change adaptation practices. These barriers are rooted in socio-economic, institutional, infrastructural, and informational constraints, which collectively undermine resilience in the face of worsening climate variability.

One of the most significant challenges is limited access to financial resources and credit facilities. Many smallholder farmers lack the capital to invest in climate-resilient technologies such as solar-powered irrigation, improved seed varieties, or water harvesting infrastructure (Chisadza et al., 2024). For example, in drought-prone areas like Buhera and Gokwe North, farmers who wish to implement tied ridges or construct infiltration pits often cannot afford the necessary tools or hire labour (Norton & Alwang, 2020). Similarly, the cost of purchasing drought-tolerant seeds or fertilizers is often out of reach, especially in the absence of subsidy programs or affordable credit schemes.

Lack of adequate climate information and extension services is another major constraint. While institutions like the Zimbabwe Meteorological Services Department and AGRITEX provide weather forecasts and technical support, the coverage is uneven and often limited in remote rural areas (Chanza & Gundu-Jakarasi, 2020). In districts such as Binga and Lupane, farmers frequently report receiving late or insufficient information on seasonal forecasts, which hampers timely planting and decision-making (Chingombe & Musarandega, 2021). Moreover, the technical language used in forecasts is often not easily understood by farmers, especially those with lower literacy levels.

Low levels of education and awareness about climate change also hinder adaptation efforts. In some communities, farmers do not fully understand the scientific causes and long-term implications of climate change, leading to limited appreciation of the value of adaptation strategies (Nyahunda & Tirivangasi, 2021). In places like Mwenezi and Chiredzi, some farmers still attribute changing weather patterns to traditional beliefs rather than environmental shifts, and as a result, they may resist adopting new practices like conservation agriculture or crop diversification (Ndlovu & Mjimba, 2021).

Insecure land tenure and small landholdings further complicate adaptation. In many communal areas, farmers do not have title deeds or secure rights to the land they cultivate, discouraging them from making long-term investments in soil conservation or agroforestry (Mujere, 2021). For instance, in parts of Mashonaland Central, farmers are hesitant to plant trees or construct permanent irrigation systems because of fears that their land could be reallocated by local authorities or traditional leaders (Chanza & Gundu-Jakarasi, 2020). Notably, gender-related barriers also affect adaptation efforts. Women, who constitute the majority of smallholder farmers in Zimbabwe, often have less access to land, credit, and information compared to men. In provinces like Manicaland and Matabeleland North, female farmers struggle to attend training sessions or access mobile-based climate information due to cultural restrictions, time burdens, and lower ownership of mobile phones (Newsham et al., 2023).

Additionally, market access and infrastructure deficits prevent farmers from fully benefiting from adaptation (Norton & Alwang, 2020). Even when farmers adopt climate-smart practices like growing drought-tolerant crops or raising small livestock, they may struggle to transport or sell their produce due to poor road networks or lack of storage facilities. This is evident in regions like Chimanimani, where farmers growing high-value crops such as chilli or groundnuts often face post-harvest losses due to delayed access to markets after climate-related disruptions (Mpala & Simatele, 2024).

Conclusion

The assessment of farmers' knowledge of climate change and their adaptation strategies in Zimbabwe highlights both the resilience and constraints faced by smallholder communities. Findings suggest that most farmers are aware of the shifting climate patterns, often describing them in terms of delayed rains, prolonged dry spells, rising temperatures, and increased frequency of droughts. This experiential knowledge has informed the adoption of various adaptation strategies, including rainwater harvesting, in-field moisture conservation, crop diversification, and the uptake of drought-tolerant seed varieties. Such measures not only strengthen household food security but also enhance dietary diversity and income stability.

However, challenges such as limited access to inputs, inadequate extension services, poor infrastructure, and lack of financial resources continue to hinder the scaling up of these practices. Moreover, while indigenous knowledge remains central to local adaptation, it needs to be complemented by scientific innovations and supportive policies that promote climate-smart agriculture.

Therefore, the study concludes that empowering farmers through capacity building, access to climate information, credit facilities, and technology transfer is essential to strengthen their adaptive capacity. Ultimately, sustainable agricultural adaptation in Zimbabwe requires a multi-stakeholder approach, where farmers, government, research institutions, and development partners collaborate to ensure that climate-resilient strategies are effectively implemented and scaled up.

References

- [1] Bhatasara, S. (2017). Rethinking climate change research in Zimbabwe. *Journal of Environmental Studies and Sciences*, 7, 39–52.
- [2] Chanza, N., & Gundu-Jakarasi, V. (2020). Deciphering the climate change conundrum in Zimbabwe: An Exposition. In John P Tiefenbacher (Ed.), *Global warming and climate change* (pp. 1–25). IntechOpen. <https://doi.org/10.5772/intechopen.84443>
- [3] Chingombe, W., & Musarandega, H. (2021). Understanding the logic of climate change adaptation: Unpacking barriers to climate change adaptation by smallholder farmers in Chimanimani District, Zimbabwe. *Sustainability*, 13, 3773. <https://doi.org/10.3390/su13073773>
- [4] Chisadza, B., Gwate, O. & Musinguzi, S. P. (2024). Assessing land degradation neutrality in semi-arid dryland agroecosystems of the Matabeleland North province of Zimbabwe. *Earth Sci Inform.* <https://doi.org/10.1007/s12145-024-01384-6>.
- [5] Chisadza, B., Mushunje, A., Nhundu, K. & Phiri, E. E. (2020). Opportunities and challenges for seasonal climate forecasts to more effectively assist smallholder farming decisions. *South African Journal Science.* <https://doi.org/10.17159/sajs.2020/4649>.
- [6] Chiturike, P., Nyamadzawo, G., Gotosa, J., Mandumbu, R., Nyakudya, I. W., Kubiku, F. N. M., & Kugedera, A. T. (2022). Evaluation of different rainwater harvesting techniques for improved maize productivity in semi-arid regions of Zimbabwe with sandy soils. *Journal of Sustainable Agriculture and Environment*, <https://doi.org/10.1002/sae2.12033>
- [7] Gram, G., Roobroeck, D., Pypers, P., Six, J., Merckx, R., & Vanlauwe, B. (2020). Combining organic and mineral fertilizers as a climate-smart integrated soil fertility management practice in sub-Saharan Africa: A meta-analysis. *PLoS One*, 15(9), e239552. [10.1371/journal.pone.0239552](https://doi.org/10.1371/journal.pone.0239552)
- [8] Kugedera, A. T., Mandumbu, R., & Nyamadzawo, G. (2022). Rainwater harvesting and *Leucaena leucocephala* biomass rates effects on soil moisture, water use efficiency and *Sorghum bicolor* [(L.) Moench] productivity in a semi-arid area in Zimbabwe. *Journal of the Science of Food and Agriculture*, 102, 6443–6453. <https://doi.org/10.1002/jsfa.12011>
- [9] Kugedera, A. T., Mango, L., & Kokerai, L. (2020). Evaluating the effects of integrated nutrient management and insitu rainwater harvesting on maize production in dry regions of Zimbabwe. *International Journal of Agriculture, Environment and Food Sciences*, 303–310. <https://doi.org/10.31015/jaefs.2020.3.9>
- [10] Madamombe, S. M., Ng'ang'a, S. K., Öborn, I., Nyamadzawo, G., Chirinda, N., Kihara, J., & Nkurunziza, L. (2024). Climate change awareness and adaptation strategies by smallholder farmers in semi-arid areas of Zimbabwe. *International Journal of Agricultural Sustainability*, 22(1). <https://doi.org/10.1080/14735903.2023.2293588>
- [11] Makate, C., Makate, M., Mango, N., & Siziba, S. (2019). Increasing resilience of smallholder farmers to climate change through multiple adoption of proven climate-smart agriculture innovations. Lessons from Southern Africa. *Journal of Environmental Management*, 231, 858–868. <https://doi.org/10.1016/j.jenvman.2018.10.069>
- [12] Mavesere, F. & Dzawanda, B. (2022). Effectiveness of Pfumvudza as a resilient strategy against drought impacts in rural communities of Zimbabwe. *Geo Journal*. 88(3):3455. <https://doi.org/10.1007/S10708-022-10812-3>.
- [13] Mavhura, E., Manyangadze, T., & Aryal, K. R. (2022). Perceived impacts of climate variability and change: An exploration of farmers' adaptation strategies in Zimbabwe's intensive farming region. *GeoJournal*, 87, 3669–3684. <https://doi.org/10.1007/s10708-021-10451-0>
- [14] Mpala, T. A & Simatele, M.D. (2024). Climate-smart agricultural practices among rural farmers in Masvingo district of Zimbabwe: perspectives on the mitigation strategies to drought and water scarcity for improved crop production. *Front Sustain Food System*, 7:1298908. <https://doi.org/10.3389/fsufs.2023.1298908>.
- [15] Mujere, N. (2021). Assessing the potential contribution of Pfumvudza towards climate smart agriculture Zimbabwe: a review. Preprints. <https://doi.org/10.20944/PREPRINTS202101.0619.V1>.
- [16] Mujeyi, A., Mudhara, M., & Mutenje, M. (2021). The impact of climate smart agriculture on household welfare in smallholder integrated crop–livestock farming systems: Evidence from Zimbabwe. *Agriculture & Food Security*, 10, 4. <https://doi.org/10.1186/s40066-020-00277-3>
- [17] Muthelo, D, Owusu-Sekyere, E. & Ogundeji, A. A. (2019). Smallholder farmers' adaptation to drought: identifying effective adaptive strategies and measures. *Water*, 11(10):2069. <https://doi.org/10.3390/w11102069>
- [18] Nciizah, T., Nciizah, E., Mubekaphi, C., & Nciizah, A. D. (2022). Smallholder farmers' adaptation strategies and food security: Experiences from Zimbabwe. In H. A. Mupambwa, A. D. Nciizah, P. Nyambo, B. Muchara, & N. N. Gabriel (Eds.), *Food security for African smallholder farmers, sustainability sciences in Asia and Africa* (pp. 267–280). Springer Nature Singapore.
- [19] Ndlovu, T. & Mjimba, V. (2021). Drought risk-reduction and gender dynamics in communal cattle farming in Southern Zimbabwe. *International Journal of Disaster Risk Reduction*, 58: 102203. <https://doi.org/10.1016/J.IJDRR.2021.102203>.

- [20] Newsham, A., Naess, L. O., Mutabazi, K., Shonhe, T., Boniface, G., & Bvute, T. (2023). Precarious prospects? Exploring climate resilience of agricultural commercialization pathways in Tanzania and Zimbabwe. *Climatic Development*, 1–15. <https://doi.org/10.1080/17565529.2023.2229775>
- [21] Norton, G. W., & Alwang, J. (2020). Changes in agricultural extension and implications for farmer adoption of new practices. *Applied Economic Perspectives and Policy*, 42, 8–20. <https://doi.org/10.1002/aep.13008>
- [22] Nyahunda, L., & Tirivangasi, H. M. (2021). Barriers to effective climate change management in Zimbabwe's rural communities. In N. Oguge, D. Ayal, L. Adeleke, & I. da Silva (Eds.), *African handbook of climate change adaptation* (pp. 2405–2431), Springer International Publishing. https://doi.org/10.1007/978-3-030-45106-6_251
- [23] Nyoni, R.S, Bruelle, G, Chikowo, R. & Andrieu, N. (2024). Targeting smallholder farmers for climate information services adoption in Africa: a systematic literature review. *Climate Service*, 34: 100450. <https://doi.org/10.1016/j.cliser.2024.100450>.
- [24] Parwada, C., Chipomho, J., & Mandumbu, R. (2022). Building resilience to climate change by adopting conservation agriculture in the smallholder farming systems. In H. A. Mupambwa, A. D. Nciizah, P. Nyambo, B. Muchara, & N. N. Gabriel (Eds.), *Food security for African smallholder farmers* (pp. 281–294), Springer Nature Singapore. https://doi.org/10.1007/978-981-16-6771-8_17
- [25] Phiri, K., Nhliziyo, M., Madzivire, S. I., Sithole, M. & Nyathi, D. (2021). Understanding climate smart agriculture and the resilience of smallholder farmers in Umguza district, Zimbabwe. *Cogent Social Science*. <https://doi.org/10.1080/23311886.2021.1970425>
- [26] Ramborun, V., Facknath, S., & Lalljee, B. (2020). Moving toward sustainable agriculture through a better understanding of farmer perceptions and attitudes to cope with climate change. *Journal of Agricultural Education and Extension*, 26, 37–57. <https://doi.org/10.1080/1389224X.2019.1690012>
- [27] Zindi, B. (2025). Climate Change and Food Nexus in Africa. *IAHRW International Journal of Social Sciences Review*, 13(3), 577-584.