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The role of indigenous farming knowledge in strengthening climate resilience among smallholder farmers: a case study of rural Zimbabwe

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ABSTRACT

Indigenous farming knowledge remains central to the climate resilience of smallholder agriculture in rural Zimbabwe. This study examined how smallholder farmers in Mutoko and Gweru districts use indigenous knowledge to respond to rainfall variability, prolonged dry spells, rising temperatures and declining water availability. A qualitative method and exploratory design were employed. Purposive sampling was used to select 60 smallholder farmers, comprising 30 participants from each district. Data were collected through in-depth face-to-face interviews, focus group discussions and participant observation, and were analysed thematically. The findings show that farmers rely on crop diversification, crop rotation, drought-tolerant crops, early land preparation, mulching, local seed preservation, water harvesting and riverside-well irrigation to reduce climatic risks and sustain production. Indigenous knowledge was also transmitted through intergenerational learning, farmer networks and community institutions. The study concludes that indigenous farming knowledge is a dynamic resource that should be integrated equitably into agricultural extension, climate adaptation policy and rural development planning frameworks.

INTRODUCTION

Indigenous farming knowledge has been central to the sustainability of agricultural livelihoods across various ecological zones (Malapane et al., 2024). Indigenous farming knowledge is dynamic, adaptive, and continuously refined through experimentation, observation, and intergenerational learning, and not static or outdated (Filho et al., 2022). Recent scholarship has increasingly acknowledged Indigenous Knowledge Systems (IKS) as a useful resource for climate change adaptation, because it offers context-specific understanding of environmental variability, seasonal forecasting, soil and water management, crop selection and risk reduction (Dorji et al., 2024; Sangha et al., 2026). Climate change is threatening food security in Africa through reduced crop production, loss of livestock, pressure on water resources, and increased exposure to extreme events (IPCC, 2022). Smallholder farmers are particularly vulnerable, as they frequently have limited access to irrigation, credit, insurance, extension services, improved infrastructure, and reliable climate information (Kapari et al., 2023; Zenda, 2024). Smallholder agriculture remains at the heart of rural livelihoods and food security throughout Africa, Asia and Latin America (Lowder et al., 2021). Despite working on small plots of land and having limited financial resources, smallholder farmers are important contributors to local and regional food systems.

Indigenous farming knowledge offers practical adaptation strategies to help smallholder farmers cope with climate-related risks. Practices such as intercropping, crop rotation, mixed farming, agroforestry, mulching, and rainwater harvesting, to mention a few, have enhanced the capacity of farming systems to absorb and recover from climatic shocks. Practices like this increase the water-holding capacity of the soil, protect biodiversity, reduce dependence on external inputs, and spread production risks across different crops and livelihood activities (Vernooy, 2022; Kapari et al., 2023; Sangha et al., 2026). Indigenous weather prediction is also important because farmers use indicators like animal behaviour, flowering patterns, wind direction, cloud formation, temperature changes, insects and celestial signs to guide planting, harvesting and resource management decisions (Kom et al., 2023; Zvobgo et al., 2023). Indigenous farming knowledge, while valued, has often been marginalised by modern agricultural policies and the formal research systems and extension services which privilege scientific and commercial models of agricultural development. Globalisation, urbanisation, youth migration, insecure land tenure and the perception of indigenous practices as backward are further threats to the continuity of indigenous farming knowledge (Leal Filho et al., 2025; Sangha et al., 2026). This paper aims to examine the role of indigenous farming knowledge in strengthening climate resilience among smallholder farmers in rural Zimbabwe, with specific reference to Mutoko and Gweru districts. The paper explores how farmers draw on locally developed knowledge and practices to respond to climate-related challenges such as erratic rainfall, prolonged dry spells, rising temperatures and declining water availability. Particular attention is given to practices such as crop diversification, crop rotation, drought-tolerant crop selection, mulching, early land preparation, water harvesting and indigenous irrigation systems.

METHODS

This study adopted a qualitative research approach and an exploratory research design to examine the role of indigenous farming knowledge in strengthening climate resilience among smallholder farmers in rural Zimbabwe. The qualitative approach was appropriate because it enabled the study to obtain detailed accounts of farmers' lived experiences, farming practices, environmental observations and responses to changing climatic conditions. The exploratory design was particularly suitable because it allowed the researcher to investigate how indigenous farming knowledge is understood, transmitted, adapted and applied within specific rural farming contexts.

Population and sampling

The study was conducted in Mutoko and Gweru districts of Zimbabwe. The study population comprised smallholder farmers residing and practising agriculture in the selected communities within the two districts. These farmers were considered appropriate participants because of their direct experience of rain-fed agriculture, climate variability and locally developed farming practices. Purposive sampling was used to select participants who possessed relevant knowledge and practical experience of smallholder farming and indigenous agricultural practices. A total of 60 smallholder farmers participated in the study, comprising 30 farmers from Mutoko District and 30 from Gweru District. Purposive selection enabled the researcher to include participants who could provide information-rich accounts of indigenous farming knowledge and its contribution to climate adaptation and agricultural resilience.

Data collection

Data were collected through in-depth face-to-face interviews, focus group discussions and participant observation. The in-depth interviews allowed individual farmers to describe their farming experiences, knowledge of environmental change and adaptation practices in their own words. A semi-structured interview approach was used to provide consistency across interviews while allowing the researcher to ask follow-up questions and explore issues raised by participants in greater detail. Focus group discussions were used to generate collective accounts of indigenous farming practices and climate-related experiences. The discussions enabled participants to compare experiences, clarify shared practices and reflect on areas of agreement or difference. They were particularly useful for understanding how agricultural knowledge is collectively developed, transmitted and validated within rural communities.

Data analysis

Data were analysed using thematic analysis, guided by the six-phase approach developed by Braun and Clarke (2006, 2021). The analysis began with repeated reading of the interview transcripts, focus group discussion records and participant-observation notes to achieve familiarity with the data. Initial codes were then generated to identify meaningful features relevant to the research aim. Related codes were grouped into preliminary themes, which were subsequently reviewed against the coded extracts and the complete dataset. The themes were refined, clearly defined and named before an interpretive account of the findings was developed. This iterative process enabled the researcher to move beyond merely summarising participants' responses and to interpret recurring meanings and patterns across the data. The analysis focused on indigenous farming practices, climate-related challenges, adaptation strategies, knowledge transmission, community-based learning and the integration of indigenous and scientific knowledge.

RESULTS AND DISCUSSION

Indigenous farming knowledge systems: participant perspectives

Participant narratives show that indigenous farming knowledge in rural Zimbabwe is inherited across generations but continually adapted to changing environmental and livelihood conditions. Farmers described these practices as knowledge developed through experience, observation, and interaction with elders, other farmers, and local ecological conditions. Crop rotation was presented as both an inherited practice and a contemporary soil-management strategy. One participant explained: "Crop rotation is one of the methods we employ to keep the land fertile … we have always been practicing crop rotation and our forefathers did it at the instruction of the ancestors. So I can say it's more of an inherited method that has worked for us" (Participant 2, in-depth interview).

This shows that agricultural extension services could be promoting practices that are already deeply embedded in the local farming systems. Farmers do not merely accept crop rotation as an external scientific recommendation, but rather interpret and apply it through knowledge transmitted from previous generations. Diversification of crops was also used to reduce production and market risks. Said a horticulture farmer: "Our major crops include butternut, tomatoes, onions, and green vegetables. These crops are usually grown concurrently to minimize our chances of losses at the marketplace" (Participant 4, in-depth interview). When farmers grow several crops at the same time, they are less likely to lose all of their income if one crop does not do well or if it sells for less in the market. This therefore enhances both ecological and economic resilience. Indigenous water-management systems were especially important where rainfall had become unreliable, and rivers dried up early. Said one participant: "Our main source of irrigation is rivers which dry prematurely. Nevertheless, our indigenous agricultural system has taught us that when the rains go prematurely, we use water from riverside wells to irrigate our plants. The system sustained our forefathers, and it has been passed from one generation to the other" (Participant 5, in-depth interview). This account illustrates how farmers use inherited knowledge of local water sources to maintain crop production during dry periods. Hand-dug riverside wells are therefore not merely emergency responses but established practices transmitted through generations.

Farmers also adjusted land-preparation methods and crop choices to improve soil-moisture retention and cope with declining rainfall. An elderly farmer explained: "We have adopted a system of tilling the land before rain comes so that by the time it comes the soil will be able to hold water for a long time. Also, we are now utilizing crops like millet so that we can get good harvests" (Male farmer, 70 years). This illustrates how early land preparation and drought-resistant crop growing have been meshed by indigenous farmers. These practices help farmers to make the best use of limited rains, while reducing dependence on maize, which is generally more vulnerable to extended dry spells. Knowledge was also shared horizontally through farmer networks, rather than vertically from elders to the younger generations.

One participant explained how farmers learned from one another: "The local rivers such as Nyamuzizi River have dried so early … due to early drying of the river, we now rely on the use of wells and boreholes. We have inspired one another to divert to the use of this system of irrigation" (Male farmer, 54 years, focus-group discussion). This points to the social production and circulation of indigenous agricultural knowledge. Farmers observe good practices in neighbouring farms, exchange information and adapt these practices to their own situations. Such social learning allows locally developed irrigation methods to spread across communities. Indigenous farming knowledge also had cultural and spiritual aspects. As one participant explained: "We consult spirit mediums in many cases because we believe they look after us and they know what we want at any given point" (Male farmer, 35 years, focus-group discussion).

This statement reflects the cultural worldview through which some rural communities interpret rainfall, drought and environmental change. Spirit mediums, traditional leaders and ceremonies such as Mafuwe (rainmaking) form part of the institutional and cultural environment within which agricultural decisions are understood. The quotation should be analysed as evidence of participants' cultural interpretation of environmental events rather than as scientific proof of meteorological causation. The participant accounts demonstrate that indigenous farming knowledge systems comprise interconnected practices involving crop rotation, crop diversification, drought-tolerant crops, soil-moisture conservation, local irrigation, social learning and cultural institutions. These systems are not static remnants of the past. They are continuously interpreted, tested and modified as farmers respond to rainfall variability, water scarcity, changing markets and new agricultural technologies.

Climate resilience in smallholder agriculture

Smallholder agricultural climate resilience refers to the ability of farming households to anticipate, absorb, adapt to and recover from climate-related shocks while protecting food production, household livelihoods and the ecological functioning of farming systems. In rural Zimbabwe, resilience is increasingly determined by farmers' ability to deal with unpredictable rainfall, prolonged dry spells, rising temperatures, decreasing water availability and repeated crop failures. The participant narratives highlight how farmers continually adjust their actions to deal with changing climatic conditions, pointing to resilience as an iterative process rather than a static trait. Variability of rainfall has emerged as a major threat to the resilience of smallholder agriculture. Late arrival or early cessation of rainfall often forces farmers to replant, reduce the size of cultivated land, or abandon some fields altogether, they said. One participant said: "If the first crop fails, we are forced to plant again, but sometimes we do not have enough seed. You end up reducing the field because you cannot plant the whole area again." (Participant 8, female, 48 years). This account shows that the capacity to recover from rainfall-related crop failure depends heavily on household access to seed, labour, draught power and financial resources. Better-resourced households may be able to replant, while poorer households are more likely to reduce their cultivated area, thereby increasing their vulnerability to food insecurity.

Mid-season dry spells were also identified as a serious challenge because crops may initially appear healthy but fail during flowering and grain-filling stages. One farmer explained: "The maize can look healthy at first, but when the dry spell comes during flowering, the cobs do not fill properly. At the end you harvest very little. Sometimes the plant remains standing in the field, but when you open the cob there is almost nothing inside" (Participant 16, male, 37 years). The statement illustrates that resilience depends not only on the total amount of rainfall received but also on its timing and distribution throughout the growing season. Even seasons that begin favourably may result in poor harvests where prolonged dry spells occur during critical stages of crop development. Rising temperatures further reduce agricultural resilience by accelerating moisture loss from soils and increasing crop-water stress. Farmers observed that rainfall is no longer as effective as it was previously because intense heat causes the soil to dry soon after rainfall events. A participant noted: "The rain may come, but after a few days the ground becomes dry again because the sun is too hot. The crops start wilting even when we thought the rain was enough." (Participant 4, female, 67 years). This experience shows how increasing temperatures compound rainfall variability.

Higher evaporation rates reduce the amount of moisture available for crop growth, meaning that farmers can experience crop stress even during seasons in which some rainfall is received.

In response, farmers have adopted soil- and water-management practices that help retain moisture and improve the efficiency of limited rainfall. Early land preparation was one such strategy. An elderly farmer explained: "We have adopted a system of tilling the land before rain comes so that by the time it comes the soil will be able to hold water for a long time. Also, we are now utilizing crops like millet so that we can get good harvests." (Male farmer, 70 years). The quotation demonstrates how farmers combine land preparation with the cultivation of drought-tolerant crops. Preparing fields before the onset of rainfall allows soils to absorb and retain water, while crops such as millet reduce dependence on maize, which is more vulnerable to low and poorly distributed rainfall. Water harvesting and indigenous irrigation systems also strengthen resilience by enabling farmers to continue production after rainfall has stopped. One participant stated: "Our indigenous agricultural system has taught us that when the rains go prematurely, we use water from riverside wells to irrigate our plants. The system sustained our forefathers, and it has been passed from one generation to the other." (Participant 5, in-depth interview)

The use of hand-dug riverside wells provides an alternative water source during prolonged dry periods. This practice reduces farmers' dependence on rain-fed production and enables the continued cultivation of vegetables and other crops during periods when ordinary farming activities would otherwise cease.

Crop diversification constitutes another important dimension of climate resilience. Instead of depending on a single crop, farmers cultivate several crops with different water requirements, maturation periods and market opportunities. A horticulture farmer explained: "Our major crops include butternut, tomatoes, onions, and green vegetables. These crops are usually grown concurrently to minimize our chances of losses at the marketplace." (Participant 4, in-depth interview). Diversification spreads both climatic and economic risk. Where one crop fails because of drought, pests or unsuitable temperatures, another may survive. Likewise, when the market price of one crop declines, income from other crops may help sustain the household. Crop diversification therefore strengthens production, livelihood and income resilience simultaneously. Social learning and farmer-to-farmer knowledge exchange also support resilience.

Farmers reported that successful irrigation and farming methods spread through observation, interaction and community networks. One participant observed: "Due to early drying of the river, we now rely on the use of wells and boreholes. We have inspired one another to divert to the use of this system of irrigation" (Male farmer, 54 years, focus-group discussion). This account indicates that climate adaptation is not only an individual household process. Knowledge is exchanged through social relationships, allowing farmers to observe successful practices, evaluate their usefulness, and adapt them to their own farms. These networks strengthen collective adaptive capacity by accelerating the spread of locally appropriate solutions.

Integration of indigenous and scientific knowledge

The findings show that smallholder farmers in rural Zimbabwe do not necessarily view indigenous and scientific knowledge as mutually exclusive. Instead, they mix inherited farming practices with advice from agricultural extension officers, modern irrigation technologies, and modern climate information. This interaction generates hybrid adaptation strategies that are still culturally and environmentally grounded, but at the same time benefit from scientific and technological advances. Crop rotation is a good example of this type of integration. Although agricultural extension officers championed crop rotation as a scientific soil management practice, farmers explained that it was practiced in their communities long before it was integrated into formal extension advice. One participant said: "Crop rotation is one of the methods we employ to keep the land fertile. We have always been told by agriculture extension officers and other experts that we don't have to plant the same crops again and again on the same piece of land. The method seems to be working, but it's actually not new because we have always been practicing crop rotation and our forefathers did it at the instruction of the ancestors." (Participant 2, in-depth interview). This account demonstrates that scientific agricultural advice may reinforce rather than introduce certain farming practices.

The participant recognised the contribution of extension officers while simultaneously locating crop rotation within inherited community knowledge. Integration therefore occurs when scientific explanations and technical guidance strengthen practices that farmers already understand and use. A similar form of integration is evident in irrigation. Farmers traditionally relied on riverside wells and hand-dug waterholes when rainfall ended prematurely. However, some farmers have incorporated boreholes, solar-powered pumps and submersible irrigation equipment into these established water-management systems. One participant explained: "The local rivers such as Nyamuzizi River have dried so early. In previous years the river used to go up to October with water flowing. However, due to early drying of the river, we now rely on the use of wells and boreholes. We have inspired one another to divert to the use of this system of irrigation" (Male farmer, 54 years, focus-group discussion). Wells and boreholes are not merely externally imposed technologies, but are integrated into local strategies for coping with water scarcity. Another example of hybrid farming systems development is solar-powered irrigation. In Mutoko, some farmers use submersible solar pumps which they place in boreholes, riverside wells or river waterholes to extract water for horticultural production.

This combination proves that integration is not just a substitution of traditional methods with modern machinery. Rather, farmers adapt new technologies to knowledge systems they already possess. Solar pumps increase the efficiency of water extraction, and local ecological knowledge informs the choice, location and management of water sources. The resulting system is locally relevant and technologically enhanced. This is reflected also in the choice of crops and the preparation of the land. Farmers have inherited knowledge of drought-tolerant crops, soil properties and seasonal conditions, and they also receive advice from extension workers on better varieties, planting dates and soil management. One farmer said: "We have adopted a system of tilling the land before rain comes so that by the time it comes the soil will be able to hold water for a long time. Also, we are now utilizing crops like millet so that we can get good harvests" (Male farmer, 70 years). Early land preparation is practical knowledge of farmers on rainfall and soil-moisture conservation; the cultivation of millet is in line with scientific recommendations of promoting drought-tolerant crops in water-stressed areas. Thus, the two systems of knowledge meet at the practical goal of reducing crop failure. Farmer-to-farmer learning is an important mechanism for the spread of integrated practices. Farmers observe the technologies and farming methods that others use, assess how well they work, and adapt them to their own circumstances. The approach of social learning connects indigenous knowledge transmission and contemporary agricultural innovation. It also shows that farmers are not passive recipients of technologies introduced by researchers, extension officers or development agencies. They actively assess, re-interpret and adapt external knowledge.

Indigenous farming systems result from long-term community–environment interactions (Mekonnen et al., 2021; Vijayan et al., 2022). Indigenous farming systems, unlike externally imposed agricultural models that often emphasise uniformity, mechanisation and high external inputs, are usually place-based, flexible and responsive to local ecological conditions (Apraku et al., 2021; Rankoana, 2022). As such, they are not static traditions but dynamic systems of knowledge that change through experimentation, observation and adaptation to shifting environmental realities (Schlingmann et al., 2021; Sangha et al., 2026). Recent research shows that indigenous and local knowledge remains relevant for climate adaptation, especially where formal climate information, extension services and modern technologies are scarce or unequally accessible (Apraku et al., 2021; Mekonnen et al., 2021). A hallmark of indigenous farming knowledge is its holistic understanding of the relationship between soil, water, crops, livestock, forests, climate, people and spiritual life (Vijayan et al., 2022).

For indigenous systems, agriculture is not a stand-alone economic activity but part of a wider socio-ecological system (Mekonnen et al., 2021). This systems-based approach supports sustainability by linking production choices to ecological balance, cultural identity and communal responsibility (Schlingmann et al., 2021). For example, many indigenous farming communities protect natural resources while maintaining productivity through crop rotation, mixed cropping, intercropping, polyculture, livestock integration, water harvesting and seasonal farming practices (Rankoana, 2022). A recent study on indigenous agricultural methods such as crop rotation, polyculture, intercropping, livestock farming, ploughing rituals, water harvesting and seasonal agriculture in the Vhavenda community in Musina, South Africa, found that these practices contributed to sustainable environmental management and rural livelihoods (Malapane et al., 2024).

Crop diversity is a key component of indigenous farming knowledge systems. Smallholder farmers often plant several crops in the same field or on different plots to spread the risk of total crop failure (Labeyrie et al., 2021; Nkonya et al., 2023). Farmers can diversify climatic and economic risks by intercropping cereals and legumes, mixing drought-tolerant crops with shorter-season crops, and maintaining diverse household gardens (Gashure, 2024). Crop diversification also enhances dietary diversity, assists in preserving soil fertility, and reduces vulnerability to pests and diseases (Nkonya et al., 2023). Vernooy (2022) asserts that crop diversification can enhance resilience to climate change by decreasing the likelihood of total crop failure and increasing the diversity of smallholder diets.

Similarly, traditional farming systems, as studied by Sangha et al. (2026), show that Indigenous Peoples and local communities have detailed knowledge of crop and animal varieties, allowing them to sustain diversified agroecological systems with minimal dependence on agrochemicals. Another important feature of many indigenous farming systems is agroforestry. The integration of trees, crops and livestock has multiple ecological and livelihood benefits, such as shade, fodder, fruits, fuelwood, improved soil fertility, reduced erosion and enhanced carbon storage (Taillandier et al., 2023; Gashure, 2024). Trees in drought-prone areas can help alleviate heat stress, conserve soil moisture and shield crops from strong winds. Agroforestry provides benefits for both climate adaptation and mitigation by increasing farm-level resilience, maintaining biodiversity and supporting carbon sequestration (Taillandier et al., 2023). Recent studies affirm that agroforestry practices have gained increasing importance in enhancing the adaptability of smallholder farmers to climate threats, especially in areas where rainfall is unreliable and land degradation is increasing (Zeratsion et al., 2024; Abebaw et al., 2025; Gashure, 2024).

Indigenous farming knowledge includes local weather and seasonal forecasting systems. Farmers often seek environmental cues such as animal behaviour, bird migration, flowering, sprouting of leaves, wind direction, cloud formation, temperature changes and celestial patterns to forecast rainfall, drought or seasonal change (Guye et al., 2022; Alemayehu et al., 2023). These forecasts guide decisions on land preparation, planting dates, crop selection, harvesting and livestock movement (Guye et al., 2022). Zvobgo et al. (2023) reported that many smallholder farmers in Chiredzi, Zimbabwe, used indigenous and local knowledge forecasts based on observations of cuckoo birds, the sprouting of Mopane tree leaves, high summer temperatures and Nimbus clouds. The study also found that farmers who used indigenous and local forecasts adopted more adaptation measures than farmers who did not. Similarly, Kom et al. (2023) showed that farmers in South Africa rely on indigenous weather indicators to make climate-adaptation decisions. Seed selection, preservation and exchange are equally central to indigenous farming knowledge systems. Indigenous farmers typically cultivate local seed varieties adapted to particular soils, rainfall conditions, pests and cultural food preferences (Ayenan et al., 2021; Ncube et al., 2023). These seed systems are important for conserving agrobiodiversity and promoting resilience under uncertain climatic conditions. Local seed varieties may not always produce the highest yields under optimal conditions, but they are often valued for their reliability, drought tolerance, taste, storage qualities and cultural importance (Ncube et al., 2023). Thus, farmer-managed seed systems and community seed banks play an important role in conserving crop genetic diversity and supporting climate adaptation (Ayenan et al., 2021; Ncube et al., 2023). Recent research on seed systems in Africa shows that crop diversity, variety type and seed sources are important elements of farmers' strategies for coping with climate variability and shocks (Vernooy, 2021; Makate, 2025).

Climate resilience in smallholder agriculture is the ability of agricultural systems and farming households to anticipate, withstand, adapt to and recover from climate-related shocks while ensuring food production, livelihoods and ecological sustainability (Aschinger et al., 2023). Resilience for smallholder farmers is not only about bouncing back from droughts, floods or heatwaves, but also the capacity to adapt farming practices, diversify livelihoods, protect natural resources and maintain household food security in the face of changing climatic conditions (Lamichhane et al., 2022). This is especially relevant in sub-Saharan Africa, where many smallholder farmers rely on rain-fed agriculture and remain highly vulnerable to rainfall variability, extended dry spells, decreasing soil fertility, pest outbreaks and extreme weather events (IPCC, 2022; Kapari et al., 2023; Mpala & Simatele, 2024).

Research in rural Zimbabwe confirms that dependence on rain-fed production, limited financial resources and inadequate access to agricultural equipment and inputs increase farmers' exposure to drought and water scarcity (Mpala & Simatele, 2024). The IPCC states that climate change is already negatively affecting food security in Africa through reductions in crop production, livestock productivity, fisheries, rangelands and access to food. Smallholder agriculture remains the backbone of global and regional food systems (Lamichhane et al., 2022). Although small farms often have limited land, capital and infrastructure, they make a significant contribution to food production and rural livelihoods. Lowder et al. (2021) estimate that farms smaller than two hectares produce approximately 35% of the world's food, while family farms produce about 80% of food in value terms. Thus, building smallholder resilience is critical for household survival as well as broader food security, rural development and poverty reduction (Aschinger et al., 2023). Smallholder farmers often face a series of overlapping vulnerabilities, such as limited access to credit, irrigation, markets, extension services, climate information, mechanisation and secure land tenure (Lowder et al., 2021; Lamichhane et al., 2022; Shilomboleni, 2024). Economic, technological, informational, environmental and institutional barriers can substantially restrict farmers' adoption of climate-adaptation measures.

CONCLUSION

Indigenous knowledge on farming is an important resource to respond to challenges caused by climate change in smallholder agriculture. It is very valuable because of the focus on sustainability, adaptability, and local relevance. The paper showed that traditional practices enhance climate resilience through diversification, conservation, and community-based approaches. These practices provide practical solutions to address environmental risks. Further resilience can be achieved by integration with scientific knowledge. Collaborative approaches enable the development of innovative and effective strategies. Documentation, education, and policy support are vital to ensure its continuity. Supporting smallholder farmers is key to building resilient agricultural systems. Inclusive development includes their knowledge and experiences. The climate change situation calls for urgent, whole-of-system responses. Indigenous knowledge provides a basis for sustainable adaptation strategies.

REFERENCES

Abebaw, S. E., Yeshiwas, E. M., & Feleke, T. G. (2025). A systematic review on the role of agroforestry practices in climate change mitigation and adaptation. *Climate Resilience and Sustainability, 4*(2), e70018.

Alemayehu, A., Behaylu, A., Agumass, G., & Dejen, A. (2023). Farmers' traditional knowledge on climate change and weather forecast: The case of Menze Gera Midir district, Ethiopia. *Environmental Development, 47*, 100908.

Apraku, A., Morton, J. F., & Apraku Gyampoh, B. (2021). Climate change and small-scale agriculture in Africa: Does indigenous knowledge matter? Insights from Kenya and South Africa. *Scientific African, 12*, e00821.

Aschinger, R., Boillat, S., & Ifejika Speranza, C. (2023). Smallholder livelihood resilience to climate variability in South-Eastern Kenya, 2012–2015. *Frontiers in Sustainable Food Systems, 7*, 1070083.

Ayenan, M. A. T., Aglinglo, L. A., Zohoungbogbo, H. P. F., N'Danikou, S., Honfoga, J., Dinssa, F. F., Hanson, P., & Afari-Sefa, V. (2021). Seed systems of traditional African vegetables in Eastern Africa: A systematic review. *Frontiers in Sustainable Food Systems, 5*, 689909.

Bezner Kerr, R., Postigo, J. C., Smith, P., Cowie, A., Singh, P. K., Rivera-Ferre, M., Tirado-von der Pahlen, M. C., Campbell, D., & Neufeldt, H. (2023). Agroecology as a transformative approach to tackle climatic, food, and ecosystemic crises. *Current Opinion in Environmental Sustainability, 62*, 101275.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in reflexive thematic analysis? *Qualitative Research in Psychology, 18*(3), 328–352.

Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum, 41*(5), 545–547.

Dagunga, G., Ayamga, M., Laube, W., Ansah, I. G. K., Kornher, L., & Kotu, B. H. (2023). Agroecology and resilience of smallholder food security: A systematic review. *Frontiers in Sustainable Food Systems, 7*, 1267630.

Dorji, T., Rinchen, K., Morrison-Saunders, A., Blake, D., Banham, V., & Pelden, S. (2024). Understanding how Indigenous knowledge contributes to climate change adaptation and resilience: A systematic literature review. *Environmental Management, 74*(6), 1101–1123.

Gashure, S. (2024). Adaptation strategies of smallholder farmers to climate variability and change in Konso, Ethiopia. *Scientific Reports, 14*, 19203.

Gumucio, T. (2024, January). *Women's land tenure security as a pathway to climate change mitigation and adaptation: Evidence scan*. Landesa.

Guye, M., Legesse, A., & Mohammed, Y. (2022). Indigenous weather forecasting among Gujii pastoralists in southern Ethiopia: Towards monitoring drought. *Pastoralism, 12*, Article 43.

Ijatuyi, E. J., Lamm, A., Yessoufou, K., Suinyuy, T., & Patrick, H. O. (2025). Integration of indigenous knowledge with scientific knowledge: A systematic review. *Environmental Science & Policy, 170*, 104119.

Intergovernmental Panel on Climate Change. (2019). *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. https://www.ipcc.ch/srccl/

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability: Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama, Eds.). Cambridge University Press.

Kapari, M., Hlophe-Ginindza, S. N., Nhamo, L., & Mpandeli, S. (2023). Contribution of smallholder farmers to food security and opportunities for resilient farming systems. *Frontiers in Sustainable Food Systems, 7*, 1149854. https://doi.org/10.3389/fsufs.2023.1149854

Katiyatiya, C. L. F., & Ncanywa, T. (2026). A review of climate-smart agricultural extension services as a catalyst for sustainable farming in South Africa. *Africa's Public Service Delivery & Performance Review, 14*(1), a1005.

Kom, Z., Nethengwe, N. S., Mpandeli, S., & Chikoore, H. (2023). Indigenous knowledge indicators employed by farmers for adaptation to climate change in rural South Africa. *Journal of Environmental Planning and Management, 66*(13), 2778–2793.

Labeyrie, V., Renard, D., Aumeeruddy-Thomas, Y., Benyei, P., Caillon, S., Calvet-Mir, L., Carrière, S. M., Demongeot, M., Descamps, E., Junqueira, A. B., Li, X., Locqueville, J., Mattalia, G., Miñarro, S., Morel, A., Porcuna-Ferrer, A., Schlingmann, A., Vieira da Cunha Avila, J., & Reyes-García, V. (2021). The role of crop diversity in climate change adaptation: Insights from local observations to inform decision making in agriculture. *Current Opinion in Environmental Sustainability, 51*, 15–23.

Lamichhane, P., Hadjikakou, M., Miller, K. K., & Bryan, B. A. (2022). Climate change adaptation in smallholder agriculture: Adoption, barriers, determinants, and policy implications. *Mitigation and Adaptation Strategies for Global Change, 27*, Article 32.

Leal Filho, W., Barbir, J., Gwenzi, J., Ayal, D., Simpson, N. P., Adeleke, L., Tilahun, B., Chirisa, I., Gbedemah, S. F., Nzengya, D. M., Sharifi, A., Theodory, T., & Yaffa, S. (2022). The role of Indigenous knowledge in climate change adaptation in Africa. *Environmental Science & Policy, 136*, 250–260.

Leal Filho, W., Lütz, J. M., Totin, E., Ayal, D., & Mendy, E. (2025). Obstacles to implementing Indigenous knowledge in climate change adaptation in Africa. *Journal of Environmental Management, 373*, 123678.

Lowder, S. K., Sánchez, M. V., & Bertini, R. (2021). Which farms feed the world and has farmland become more concentrated? *World Development, 142*, 105455.

Makate, C., Angelsen, A., Mulesa, T. H., & Westengen, O. T. (2025). The dynamics of crop diversity and seed use in the context of recurrent climate shocks and poverty: Seasonal panel data evidence from rural Uganda. *World Development Perspectives, 39*, 100698.

Malapane, O. L., Musakwa, W., & Chanza, N. (2024). Indigenous agricultural practices employed by the Vhavenda community in the Musina Local Municipality to promote sustainable environmental management. *Heliyon, 10*(13), e33713.

Mekonnen, Z., Kidemu, M., Abebe, H., Semere, M., Gebreyesus, M., Worku, A., Tesfaye, M., & Chernet, A. (2021). Traditional knowledge and institutions for sustainable climate change adaptation in Ethiopia. *Current Research in Environmental Sustainability, 3*, 100080.

Mollel, M., Quiroz, L. F., Varley, C., Firestine, A., McLoughlin, M.-E., Kafunah, J., Kharkar, S., O'Farrell, J., Ndlovu, N., Johnston, A., McKeown, P. C., Brychkova, G., Murray, U., Leiva, S., & Spillane, C. (2025). Digital technologies to accelerate the impact of climate smart agriculture by next-generation farmers in Africa. *Frontiers in Sustainable Food Systems, 9*, 1462328.

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. *Frontiers in Sustainable Food Systems, 7*, 1298908.

Ncube, B. L., Wynberg, R., & McGuire, S. (2023). Comparing the contribution of formal and local seed systems to household seed security in eastern Zimbabwe. *Frontiers in Sustainable Food Systems, 7*, 1243722.

Nkonya, E., Kato, E., Msimanga, M., & Nyathi, N. (2023). Climate shock response and resilience of smallholder farmers in the drylands of south-eastern Zimbabwe. *Frontiers in Climate, 5*, 890465.

Nocezo, Y.-I., Manyike, J. Z., Zhou, L., & Ngarava, S. (2024). The impact of access to climate services on smallholder farmers' cropping decisions and household food security in Elundini Municipality, Eastern Cape Province. *Frontiers in Climate, 6*, 1458999.

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 Services, 34*, 100450.

Pierri, F. M., Anseeuw, W., & Campolina, A. (2025). Land tenure for resilient and inclusive rural transformation. *Global Food Security, 44*, 100835.

Rankoana, S. A. (2022). Indigenous knowledge and innovative practices to cope with impacts of climate change on small-scale farming in Limpopo Province, South Africa. *International Journal of Climate Change Strategies and Management, 14*(2), 180–190.

Sangha, K. K., Leyton-Flor, S. A., Kassa, G., Ahammad, R., & Dendup, S. (2026). Key lessons from Indigenous Peoples and Local Communities' farming systems: Insights from a global review. *Frontiers in Sustainable Food Systems, 10*, 1743959.

Schlingmann, A., Graham, S., Benyei, P., Corbera, E., Martinez Sanesteban, I., Marelle, A., Soleymani-Fard, R., & Reyes-García, V. (2021). Global patterns of adaptation to climate change by Indigenous Peoples and local communities: A systematic review. *Current Opinion in Environmental Sustainability, 51*, 55–64.

Shilomboleni, H., Epstein, G., & Mansingh, A. (2024). Building resilience in Africa's smallholder farming systems: Contributions from agricultural development interventions—A scoping review. *Ecology and Society, 29*(3), Article 22.

Taillandier, C., Cörvers, R., & Stringer, L. C. (2023). Growing resilient futures: Agroforestry as a pathway towards climate resilient development for smallholder farmers. *Frontiers in Sustainable Food Systems, 7*, 1260291.

Vernooy, R. (2022). Does crop diversification lead to climate-related resilience? Improving the theory through insights on practice. *Agroecology and Sustainable Food Systems, 46*(6), 877–901.

Vernooy, R., Adokorach, J., Coulibaly, H., Fadda, C., Jeko, M., Kakeeto, R., Kasasa, P., Sikitu Kazungu, J., Mapanda, S., Mollel, M., Wasswa Mulumba, J., Mushita, A., Nyamongo, D., Otieno, G., Recha, T., Sidibe, A., Simiu, G., Wanjala, B., Wahome, P., & L'Équipe de l'Institut des Sciences Agronomiques du Burundi. (2021). *Mobilizing crop diversity for climate change adaptation and resilience: Field experiences from Africa* (ISSD Africa Working Paper 2021-03). ISSD Africa.

Vijayan, D., Ludwig, D., Rybak, C., Kaechele, H., Hoffmann, H., Schönfeldt, H. C., Mbwana, H. A., Vacaflores Rivero, C., & Löhr, K. (2022). Indigenous knowledge in food system transformations. *Communications Earth & Environment, 3*, Article 213.

Zeratsion, B. T., Manaye, A., Gufi, Y., Tesfaye, M., Werku, A., & Anjulo, A. (2024). Agroforestry practices for climate change adaptation and livelihood resilience in drylands of Ethiopia. *Forest Science and Technology, 20*(1), 47–57.

Zvobgo, L., Johnston, P., Olagbegi, O. M., Simpson, N. P., & Trisos, C. H. (2023). Role of Indigenous and local knowledge in seasonal forecasts and climate adaptation: A case study of smallholder farmers in Chiredzi, Zimbabwe. *Environmental Science & Policy, 145*, 13–28.