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The Fountain, established in 2017, is a bi-annual interdisciplinary journal published by the Catholic University of Zimbabwe to share scholarly insights addressing the complex problems facing our world today through thorough, evidence based, and systematic inquiry from a variety of perspectives and disciplines.

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Editorial

This volume of the *Fountain Journal of Interdisciplinary Studies (Volume 9: Issue 1)* carries articles derived from papers presented at a Climate Change conference held in February 2025 in Harare, Zimbabwe. Climate Change continues to inspire new insights and debate that is contributing to the now voluminous body of knowledge on the subject. Articles in this issue focus on Southern Africa in general and Zimbabwe particular, exploring areas of adaptation, policy making, impact on communities and the leveraging of modern mitigatory technologies.

Climate change impacts have become an inherent aspect of contemporary development discourses and trajectories. Technologies related to the Internet of Things (IoT) and Geographic Information Systems (GIS) are potentially tools for the management of smart cities in the Southern African Development Community (SADC) in relation water systems and flood assessments to minimise negative impacts. A robust policy framework tailor made to respond to climate change induced disasters should respond to particular regional contexts as opposed to a one size fits all approach. Research results show that policy decay has led to repeated and worsening vulnerabilities in southern African countries. Participatory approaches, such as community-led GIS mapping, tend to produce more inclusive and context-sensitive outcomes, while top-down deployments often excluded certain population groups. A key negative impact of climate change has been food insecurity. To enhance food security preparedness, innovative farming methods are critical and should include explorations of farming and harvesting edible insects, an age-old practice in the region. Climate-smart agricultural innovations and sustainable land use offer an alternative in sustainable farming and community development, agroecology and biodiversity conservation in the face of increasing macroclimate change risks and shocks.

Human and wildlife conflicts demand intentional management as climate related scarcities appear to have increased unpredictable animal movements in search of food. Cooperative approaches based on community agency and stewardship are arguably preferred for biodiversity conservation. One study explores the relationship between climate change, water scarcity, and human-wildlife conflict (HWC) in the Gache Gache area of Zimbabwe and found an inseparable link between ecological systems and human livelihoods. Climate change is a social fact influencing the daily lives of humans just the same way that it is diverting the environment by challenging the existence of varied types of life. In line with context specific mitigatory responses, certain categories of society need special attention as they are affected differently. For instance, People with autism are likely to exhibit distinctive sensory sensitivity issues by virtue of their insistence on sameness, that could be undermined by climate change effects. Their condition needs to be accommodated in mitigatory policies. A disruptive investigation into climate change deploys what it calls ‘the theory of stupidity’ to unpack the concept of the ‘race to the bottom’ scenario. It argues that stupidity has incentives, and not inherently a mental defect. In the context of Africa’s response to climate change funding crises, ‘the race to ruin’ entails a downward spiral scenario which results in anthropocentric extractivism in poor African countries which undermines mitigatory measures.

This volume of *The Fountain* also carries two articles that focus on animal husbandry and gender in education respectively. An investigation was made of perceptions of communal

farmers in Beitbridge, Zimbabwe, regarding the adoption of artificial insemination (AI) technology in cattle breeding. The results revealed that 99% of the sampled farmers did not regularly utilize AI services due to the absence of locally based AI service providers (97.5%), discontinuation of service between government programs, and insufficient knowledge of AI technology (72%). Uncontrolled breeding systems and poor seasonal nutrition were identified as major challenges by most of the farmers. The majority of farmers (77.5%) preferred using both AI and natural mating where available. As for education, gendered subject selection remains a pressing concern in Zimbabwe's education system. Societal norms, institutional structures, and cultural expectations continue to influence female and male learners' academic choices. Empirical data from Zimbabwean institutions indicated a persistent trend: boys gravitate towards sciences and technical subjects (STEM), while girls dominate Arts and Humanities. These patterns reflect deeply ingrained gender perceptions and socialisation in teachers, parents and learners.

Antonio S. Marizane - Chief Editor

A Systematic Review of Digital Strategies for Equitable Climate Adaptation in Southern African Cities

Justice Kasiroori ¹ and Malvern Madamombe²

Abstract

This research examines digital technologies adoption for equitable climate preparedness in Southern African Development Community (SADC) cities. In this review, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology was applied to 23 studies in 11 SADC cities to study smart city technologies (SCTs) as tools of equitable climate adaptation. Results found Internet of Things (IoT) and Geographic Information Systems (GIS) as key smart city tools in SADC cities, aiding equitable water systems and flood assessment respectively. However, most interventions remained limited to short-term absorptive resilience strategies, largely due to systemic barriers such as fragmented governance, financial constraints and limited community engagement, undermining long-term effectiveness and equity. The findings further revealed that participatory approaches, such as community-led GIS mapping, tended to produce more inclusive and context-sensitive outcomes, while top-down deployments often excluded low-income populations. The study identifies four strategic priorities that can strengthen SCT-led climate adaptation. These are, governance reform, innovative financing, community participation and capacity building. These priority areas can be utilised to turn SCT interventions from the current disjointed and mostly donor-dependent initiatives towards more effective and equitable climate adaptation responses. This review advances SADC urban smart technology discourse, supporting equitable climate adaptation planning.

Keywords: smart city technologies, SADC, equitable climate adaptation, inclusive urban planning

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1.0 Introduction

The resilience of cities to environmental change has become one of the more critical aspects in sustainability science (Das et al., 2024). Although climate change presents a challenge to urban sustainability globally, the need to adapt to this challenge is more urgent in African cities (Mengistu et al., 2023). Urban settlements on the continent have become susceptible to extreme weather events such as floods and prolonged droughts (Mengistu et al., 2023). The Southern Africa region, which is also represented by the Southern African Development Community (SADC) economic bloc, is a critical case in the continent. The SADC region is one of the most affected by climate change especially due to climate phenomenon such as El Niño, which has led to increased cyclones, severe drought, floods, extreme temperatures and unpredictable weather (Chang and Ross, 2024). Cities in the SADC region are faced with low institutional capacity, economic vulnerability and weak infrastructural power which has led to poor or sometimes non-existent climate adaptation policies (Gracias et al., 2023). This situation is exacerbated by the process of rapid, often unplanned, urbanisation that is taking place in cities like Harare or mega cities like Johannesburg (Ogwu, 2019; LazaroIU and Roscia, 2018; Echendu and Okafor, 2021).

Against this background of growing difficulties, smart city technologies (SCTs) have been identified as a potential means that can help to improve climate resilience and contribute to sustainable urban planning (Mortaheb and Jankowski, 2023). SCTs are systems that combine automation, real-time data, connectivity and in many cases integrate them with advanced technology to enhance urban activities and enable instant feedback (Gracias et al., 2023). They cover an extensive field of digital technologies such as sensor networks to monitor the environment, predictive analytics using AI and spatial planning using Geographical Information Systems (GIS) platforms (Padmapriya and Sujatha, 2023; Abdulhayan, 2023). Globally, SCTs have been applied to manage domestic water systems, reduce flood risks, various weather hazards and support early warning systems (Jebaraj et al., 2023). In African contexts, successful examples include AI-enabled flood prediction in Nairobi and IoT-based water conservation initiatives in Accra (Daudu et al., 2024; Allarané et al., 2024).

However, despite gaining traction elsewhere, the adoption of SCTs in SADC cities remains limited and inconsistent (Blanco-Montero, 2021). There is a limited research

body and implementation is usually reactive as opposed to strategically oriented, like implementation of post flood sensor networks in Sioma (Zambia) (Siitala and Mbale, 2023) or the attempt at externally funded smart water meters in Harare (Chirisa et al., 2024). These trends question the prospects of scaling SCTs within marginalised SADC cities' landscapes and urban spaces where informal governance and systems tend to overpower service delivery. Unlike some other cities in East or West Africa, where innovation centres and networks have facilitated applied solutions, many SADC cities remain disconnected in their strategy of digital governance systems (Daudu et al., 2024; Allarané et al., 2024; Islamic Development Bank, 2024). The digital infrastructure and policy support needed to get SADC cities like Lusaka and Lilongwe going remains elusive (Siitala and Mbale, 2023). Researchers such as Chirisa et al. (2024) and Siitala and Mbale (2023) have argued that the majority of SCT deployments in SADC cities are limited to donor-led pilots which are disjointed with rest of the urban development plans. Such mismatch between technology innovation and institutional capacity introduces a big limitation (Timothy, 2019; Mwaniki, 2017).

Nonetheless, there are avenues of entry through alternative means that can be used even in the face of such obstacles. Studies have shown the efficacy of locally developed solutions in climate adaptation or resilience (Burley Farr, 2023). Such stakeholder inclusion has been shown to be effective by Borg et al. (2021) and Cobbinah and Finn (2023) in informal settlements and can become the basis of practically applicable decentralised, low-cost smart technologies for the SADC region. The involvement of local knowledge systems and emphasis on digital inclusion could enable SADC cities to enjoy the many benefits of smart innovations without copying resource-intensive models developed in other regions. This paper fills an important gap in the literature as it undertakes a systematic review of the deployment of smart city technologies to aid climate adaptation in SADC cities. This review, unlike previous studies that concentrate on metropolitan centres that are globally connected, focuses on cities in which there is a less well-developed digital infrastructure, fragmented governance systems and exposure to climate risks. To address gaps that were identified, this study reviews the deployment of SCTs in SADC cities, with particular attention to how these technologies contribute to urban climate adaptation. The review is guided by the following objectives:

1. To map SCT deployments for climate adaptation in SADC cities.
2. To diagnose governance and financial barriers to SCT adoption for climate adaptation.
3. To evaluate how community engagement and local knowledge shape SCT-based climate adaptation outcomes.

Through a synthesis of continent-wide patterns of SCT adoption with a particular emphasis on SADC cities, this systematic review critically examines the broader constraints and enablers of technology-enabled climate adaptation in one of the most climate impacted regions of the continent. The study's results are intended to benefit not only the academic discourse but also the policy making process by providing context-specific information on the possibility of adaptation scaling up in the smart city locally.

1.1 Theoretical Framework

This study adopts a hybrid framework combining Socio-Technical Systems (STS) Theory, Urban Resilience Theory, and the Capability Approach to evaluate the deployment of SCTs for climate adaptation in SADC cities. STS Theory, developed by Trist and Bamforth (1951) at the Tavistock Institute and later extended by Ropohl (1999), forms the foundational lens for this study. It stresses the mutual shaping of technology and society and highlights the linkages and interdependence between technical systems and social structures. According to the STS theory, successful SCTs require more than good technical design as they also rely on governance capacity, institutional coordination and citizen trust. However, STS has been critiqued for assuming alignment between technologies and fragmented social systems, especially in weak governance contexts (Pansera and Fressoli, 2021). In addition to the STS, the study also utilises the Urban Resilience Theory (Meerow et al., 2016; Sharifi and Yamagata, 2018). The theory defines urban resilience as comprising three major capacities which are absorptive, adaptive and transformative. Absorptive capacity involves short-term coping strategies such as ad hoc flood alerts, adaptive capacity refers to medium-term adjustments which maybe be for two to five years, while transformative entails systemic change that is meant to be a permanent part of the climate adaptation process (Meerow et al., 2016). Lastly, the study employs the Capability Approach by Sen (1999), a normative framework which has a strong emphasis on empowerment through the actual freedom that individuals have. The

framework suggests that the existence of technologies like SCTs is not enough as people must be able to use, access and benefit from them. However, while the capability approach exposes equity gaps, it lacks tools for addressing infrastructural or governance deficits (Robeyns, 2021).

Thus, in the framework, the socio-technical systems theory assists in assessing the opportunities and prospects of SCT implementation at the technical and institutional level and the urban resilience theory explains the pathways and typologies of adaptation to climate change. Then the capability approach makes sure that equity, inclusion and human well-being are taken into consideration in any SCT implementation.

2.0 Material and methods

This research utilises the systematic literature review (SLR) methodology, with adherence to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. PRISMA guidelines were chosen due to their transparent method of record identification and screening of studies which contributes to the replicability of research and methodological transparency (Sarkis-Onofre et al., 2021). To identify the literature on SCTs for climate adaptation in SADC cities, a structured search strategy was designed. First, the review period (2010-2024) corresponds to the emergence of SCTs into discourse on climate and wider regional strategies such as the Agenda 2063 (African Union, 2015) and SADCs Climate Adaptation Strategy (SADC, 2011). Following definition of the review period, the search was done in various databases, such as Scopus and Web of Science, JSTOR and SpringerLink, and African databases, including AJOL and Sabinet, among other relevant databases. Grey literature produced by reputable organisations such as UN-Habitat, the World Bank, AfDB, and the local governments was included. Cross-validation of such reports occurred with peer-reviewed studies when available. Backward and forward reference searches were carried out to locate other relevant sources of information through citation tracking. The role of this multi-step approach was to provide an inclusive and contextually informed evidence-base through which SCTs are to be evaluated in the SADC cities resilience.

The research compiled a list of keywords based on the research question and objectives. These keywords included “Smart City Technologies”, “Climate Adaptation,”

“Smart Urban Resilience,” “Southern African Development Community Climate”, “Community-Based Climate Approaches,” “Climate Equity,” “Climate Governance,” “Climate Funding Constraints,” and “Climate Community Engagement.” Synonyms and related terms were incorporated to broaden the search, such as “Smart Cities” OR “Urban Technologies,” “Climate Change Mitigation” OR “Climate Resilience,” “Sustainable Urban Development” OR “Resilient Cities,” “Southern Africa” OR “Sub-Saharan Africa,” “Local Participation” OR “Community Involvement,” and “Environmental Sustainability” OR “Eco-Friendly Solutions.” The keywords were combined using Boolean operators, resulting in search strings like (“Smart City Technologies” OR “Urban Technologies”) AND (“Climate Adaptation” OR “Climate Resilience”) AND (“SADC” OR “Southern Africa”). To retrieve the most relevant studies, we employed the use of Boolean searches and truncation in our search strategy. Key search terms included smart cities, climate adaptation and SADC region with the aim of balancing breadth and precision. The results were narrowed down by subject topic and language (English) to concentrate on work that is both empirical and policy related. The PRISMA flow diagram in Figure 1 demonstrates the steps that were used in the identification and selection of the studies that were review in this study.

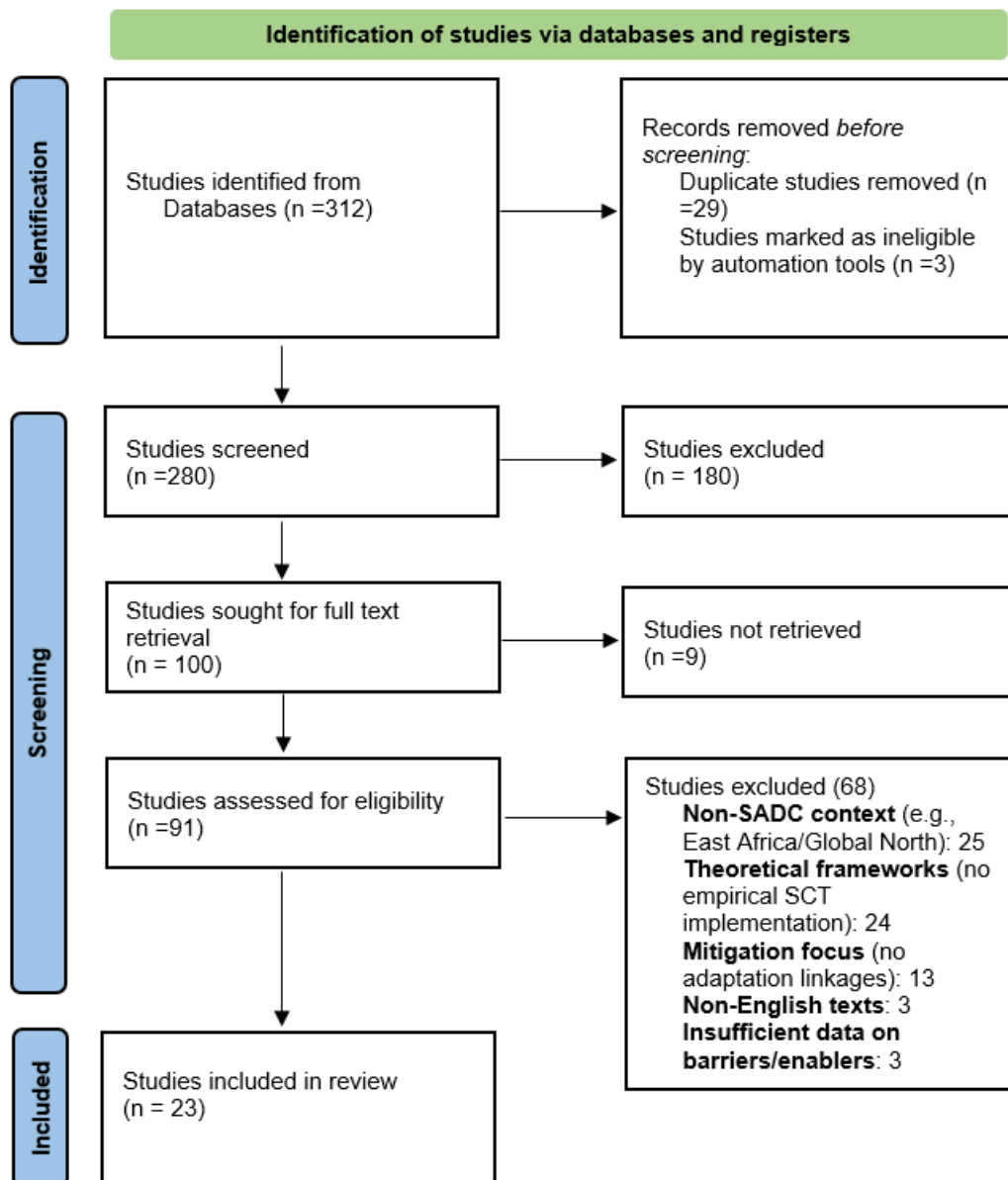


Figure 1. PRISMA flow chart

For the inclusion criteria we limited the sources to publications that studied SCTs in the context of SADC cities and addressed climate adaptation issues such as governance, policy, or socio-technical aspects in the whole implementation process. Additionally, only peer-reviewed articles, conference papers and high-quality institutional reports published between 2010 and 2024 were selected. The exclusion criteria included research carried out for cities outside SADC. However, exceptions were made for studies that provided comparative or generic experiences that could be applied to SADC. Furthermore, non-peer reviewed publications such as opinion articles, blog posts or publications were excluded in order to achieve methodological rigour.

After that we conducted full-text screening on the studies that met the inclusion criteria to make sure that they were relevant to the research objectives. The methodology made the approach to the review sound and replicable, reflecting the theme of intersection of technology, governance and climate resilience. The study design strikes a balance between depth theory and empirical inferences, forming a basis of interpretation of the role of SCTs in climate adaptation in highly urbanising and climate-sensitive regions.

In the first step, 312 records were selected through academic databases. Upon initially eliminating 29 duplicate and 3 studies that did not meet the criteria marked by the automation tools, 280 records were put through the screening process. During title and abstract screening, 180 studies were excluded because they were potentially not relevant to SADC cities, did not include SCTs or did not focus on climate adaptation. A total of 100 studies were accessed at the full texts level, but only 91 of these studies were successfully retrieved. In the eligibility checks, 68 studies were excluded for different reasons. The grounds for exclusion included 25 studies whose geographic focus was outside of SADC, 24 were only theoretical works without an empirical SCT implementation, 13 studies which focused solely on climate mitigation with no elements of adaptation connection. An additional three (3) studies were excluded as they were non-English publications, followed by a further three (3) studies which lacked details on enablers or barriers to SCT implementation. In total, 23 studies matched all inclusion criteria. Following the screening process, priority was given to literature that was directly relevant to SADC-specific SCT-based climate adaptation projects. This procedure guaranteed consistency with the regional scope and the objectives of the review. The systematic selection minimised bias and maximised transparency, which is crucial so the review adds value to discourses on smart cities and equitable climate adaptation in the Global South.

2.1 Ethical Considerations in the Systematic Review

Ethical rigour was obtained through a transparent, objective and replicable review process as described in the preceding section. The inclusion and exclusion criteria were clearly stated and regularly used based on the PRISMA framework. To counter any possible biases in grey literature, the sources were triangulated with peer-reviewed publications and in the case where primary data are available or regional publications triangulated with these as well. Potentially conflicting studies, including

industry-sponsored promotion of SCTs, were critically appraised to reduce undue influence. The ethical consideration was also applied to fair representation in the SADC region; whereby high-profile projects should not take the centre stage at the expense of low- resources contexts that are underreported. Furthermore, ethical implications of SCT implementation at the costs of SCT deployment (including the risk of digital exclusion and data privacy issues) were addressed during synthesis. Collectively, these protective measures improved the validity and equity of the overview, which future researchers can recreate or expand to support it.

3.0 Results

This systematic review integrates evidence from 23 peer-reviewed empirical studies on the implementation of smart city technologies (SCTs) for climate change adaptation in Southern African cities. The cities emerged inductively from the geographic focus of the literature. As such, the analysis covers 11 cities, namely: Cape Town, eThekweni, Harare, Windhoek, Lusaka, Maputo, Mzuzu, Johannesburg, Gaborone, Lilongwe, and Blantyre. These cases were synthesised to identify patterns across three interdependent dimensions, socio-technical dynamics, resilience capacities, and equity outcomes. Each of these dimensions was shaped by contextual factors such as governance limitations, infrastructural gaps and socio-economic vulnerabilities and mapped to the theoretical framework.

3.1 Smart City Technology Interventions

The review found that SCT interventions in SADC cities were primarily driven by IoT and GIS which accounted for 60.87% ($n=14$) of the studies (Table 1). IoT applications were reported in 8 of the 23 studies (34.8%), mainly focused on water conservation and waste management, for example, smart water metering in Harare. GIS was used in 6 studies (26.1%) for flood risk mapping and urban zoning, such as in Cape Town's informal settlements. Transformative technologies such as blockchain and AI were reported much less often, occurring in 4 (17.4%) and 3 (13.0%) papers respectively. They are still largely conceptual or pilot, held back by infrastructural gaps and low institutional capability (Blanco-Montero, 2021). Thus, the review shows that there is little adoption of transformational technologies for climate adaptation in SADC cities.

Table 1. Smart City Technology interventions

SCT Type	Primary Adaptation Focus	Representative Case Studies
IoT	Water conservation, waste management	Gambe (2015); Ripunda and Booyesen (2021); Holmes (2019); Blanco-Montero (2021)
GIS	Flood risk mapping, zoning	Musungu et al. (2011)
Blockchain	Water governance, secure payments	Adeola et al. (2024)
AI	Climate adaptation, predictive analytics	Holmes (2019); Akoh et al. (2011)
Other (3D printing, automation)	Urban infrastructure readiness, skills development	Holmes (2019)

Figure 1 illustrates the frequency of each SCT type, visually reinforcing the predominance of IoT and GIS over blockchain and AI.

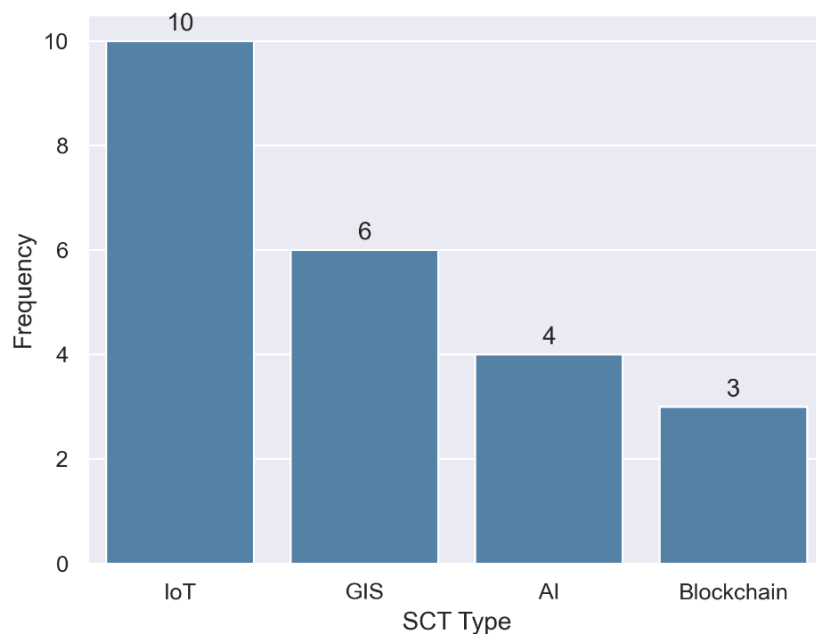


Figure 1. Count of SCT Types

3.2 Resilience Capacities

The review classified resilience strategies into absorptive, adaptive, and transformative capacities as shown in Table 2. The majority ($n=9$) focus on absorptive capacities that emphasise short-term risk mitigation. For instance, IoT-driven water rationing in Harare achieved significant water savings but excluded informal settlements due to affordability issues. Adaptive strategies ($n=7$) include participatory decision-making, as seen in Windhoek (Vhumbunu and Adetiba, 2023) and community-led planning in Maputo (van Berchum et al., 2020), though these efforts are often limited by institutional inertia. The data shows that transformative SCT strategies in SADC cities are rare with a notable example of the blockchain-enabled water governance model, which, despite its transparency, faces scalability challenges and high costs (Adeola et al., 2024). The predominance of absorptive approaches suggests a systemic short-termism that may hinder broader transformative impacts.

Drawing on the urban resilience framework, the study categorised resilience strategies into the absorbent, adaptive and transformational capacities (Table 2). The most common strategy was absorptive, mentioned in 9 of the 23 studies (39.13%), which targeted short-term coping strategies like decentralised alert systems or temporary rationing of water resources. An example is that drainage network monitoring prevented localised flooding in Lusaka (Nyimbili et al., 2024). Adaptive strategies (7 studies, 30.43%) entailed institutional learning and adaptive governance instruments like climate dashboards and zone-responsive governance. For example, real-time weather information was used in the decision-making of municipal level in Windhoek (Vhumbunu and Adetiba, 2023). This allocation signifies a disproportionate emphasis on the short-term containment occupation, and a limited thrust to progress structural resilience or long-term capacity.

Table 2. Resilience Capacities and Outcomes

Resilience Capacity	Definition	Key Outcomes and Examples	Equity Implications
Absorptive	Short-term risk mitigation	IoT water metering reduces losses (Gambe, 2015); rapid waste management (Blanco-Montero, 2021)	Often excludes low-income households

Adaptive	Medium-term systemic adjustments	Participatory decision-making (Scott and Taylor, 2023); community-led planning (Kareem et al., 2020)	Partial inclusion; institutional barriers persist
Transformative	Long-term systemic change	Governance realignment (Holmes, 2019); blockchain-enabled water governance	High costs and skills gaps limit scalability
Mixed	Combination of strategies	Integrated stormwater harvesting (Mukome, 2024); urban agriculture (Jagganath, 2021)	Outcomes depend on local conditions and investment

3.3 Socio-Technical Dynamics and Governance Barriers

Based on the review, two important patterns come into light concerning socio-technical dynamics. First, there is a constant mismatch between SCT interventions and local socio-political conditions. Although various studies report technically successful SCT implementations, many fail to account for local economic realities, informal settlement dynamics or community attitudes. For instance, in Mzuzu, Malawi, predictive flood modelling overlooked informal housing patterns and struggled with adoption in low-income areas due to affordability constraints and mistrust in data collection (Gumindoga et al., 2024). Such a mismatch compromises sustainability and inclusivity aspects of SCT projects over the long-term. Data-driven projects which focus purely on efficiency and do not consider either affordability or trust often lead to low-income populations being left out. In the same sense, government flood modelling remains a technological tool that often fails to capture community knowledge or informal ways of the city, which reduces its usefulness in climate adaptation.

Second, the barriers based on issues of governance are a common trend. The fragmented policy frameworks, weak institutional coordination and siloed departmental mandates have not supported the integration and scaled-up deployment of SCTs in various SADC cities (African Development Fund, 2022). There is evidence of how fragmented governance structures constrain cross-sectoral collaboration and tends to marginalise community-led efforts. Although comparative lessons have been brought forth by areas that are not under SADC, the review establishes the possibility of a moderately centralised system of governance that extends both coordinated decision-making and stakeholder inclusion (African Development Fund, 2022).

This relationship is visualised in Figure 2, which maps SCT efficacy against levels of governance centralisation using data extracted from the 23 reviewed studies. The figure synthesises empirical patterns across the sample, showing how varying degrees of centralisation correlated with reported implementation outcomes. Studies were categorised by governance structure (fragmented, moderately centralised, or highly centralised) and SCT outcomes were assessed in terms of scale, inclusivity, and sustainability.

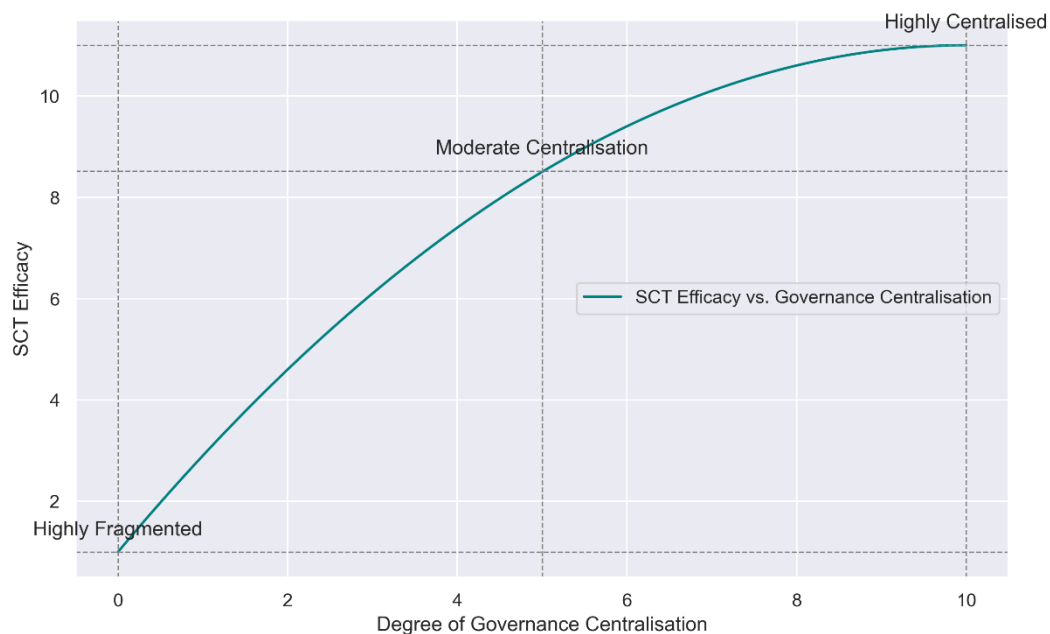


Figure 2. SCT Efficacy vs. Governance Centralisation

3.4 Equity Outcomes and the Capability Approach

The findings showed that SCT deployment showed mixed results in terms of equitable distribution of the solutions. For instance, participatory GIS projects in Cape Town have in certain instances facilitated the ability of informal settlement communities to make direct contributions to flood-risk maps, which targets location-related vulnerabilities (Musungu et al., 2011). Notwithstanding this successful example of an equitable implementation, the study identified that most SCT implementations are partially inclusive. This was more evident when the implementations were analysed by SCT type. Based on the analysis, IoT applications were the most exclusive in their implementation. Only about 20% of the studies were inclusive of all stakeholders including locals and low-income populations, 50% were partially inclusive and 30%

were outright exclusionary. This trend indicates that even when the technology such as smart water metering systems using IoT might increase efficiency and ultimately benefit people through lower bills, they tend to benefit formal areas of the cities and pose the threat of exacerbating the current socio-spatial disparities.

The trend is reflected in AI-based interventions in which most (75%) are not inclusive at all. Moreover, none of the instances of AI-based interventions were classified as including vulnerable populations. In contrast, the blockchain-based solutions represent slightly balanced equity outcomes, with approximately one-third fully inclusive and the other two-thirds partially inclusive and no instances of exclusion. These differences are briefed in Figure 3, which shows a heatmap reflecting the equity performance of various SCT types in case examples.

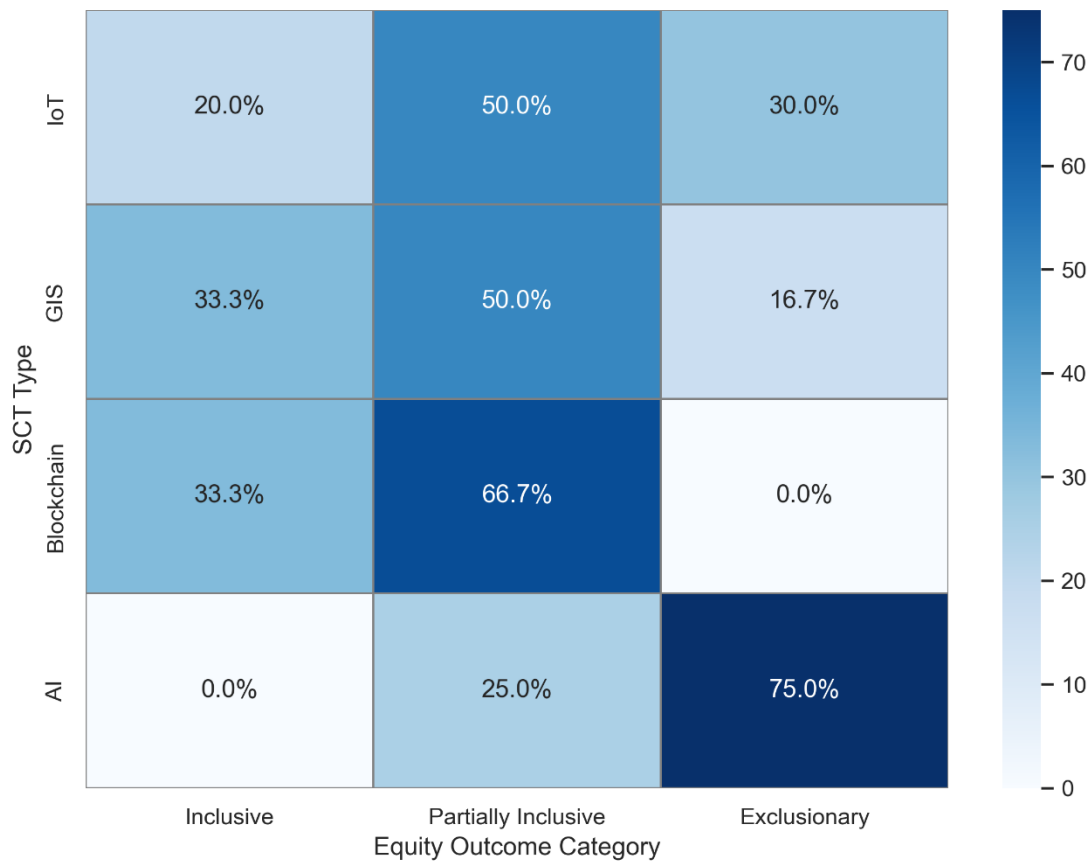


Figure 3. Heatmap of equity outcomes by SCT type.

3.5 Participatory Approaches as Catalysts for Success

A key pattern that emerged from the review is how participatory methods led to more balanced and effective smart city interventions. Projects that engaged communities in planning and decision-making and also integrated local knowledge experienced tangible climate adaptation gains across all populations in the cities (Musungu et al., 2021; Mwaniki, 2017; Kareem et al., 2020). In Windhoek, stakeholder engagement in climate adaptation was facilitated by programmes such as climate-smart agriculture and community learning platforms, though institutional constraints still inhibit their effectiveness (Vhumbunu and Adetiba, 2023). Another example as highlighted by Gambe (2015) is the use of digital systems plus the readiness of available instruments like the SMS alert in the city of Harare has the potential of managing the realities of under-resourced locations better.

These facts indicate that it will be necessary to implement structural changes in governance to make SADC cities more resilient. Collective, more comprehensive forms of organising should supplant fragmented mechanisms, and fair access can be achieved by financing solutions, including subsidies and shared-cost models. To facilitate sustainable effects, there will also be a need to enhance skills locally on the use and maintenance of technology. Combined, these measures can guide the development of an environment in which smart technologies can play a significant role in adapting to climate variability in cities across the subcontinent.

4.0 Discussion

The study revealed a multifaceted relationship between the technological intervention, institutional arrangement and the socio-economic realities in the SADC region. To bring the findings into context, the results of the study are interpreted in using the established theoretical perspectives (STS, urban resilience and capability approach), used in the work to define trends in SCT adoption for climate adaptation in the region.

4.1 Socio-Technical Realities of Smart City Technologies in SADC

The findings demonstrate that technological capacity can only partially affect the success of SCTs in SADC cities. Rather, to succeed, they should be aligned with institutional capacity and community involvement. This is in line with the STS which emphasises that technologies do not exist in vacuum as they need some enabling structures and social authority to operate. This is exemplified by smart meter projects

in Cape Town (Ripunda and Booysen, 2021) and stormwater harvesting in Durban (Mukome, 2024), where their technical creativity eventually ran into the limits of a poor institutional coordination process and lack of citizen participation. Since the most of SCT interventions fail on the STS test (lack of social authority), they end up being short-term (absorptive resilience) initiatives rather than long-term urban climate adaptation processes.

On the other hand, in cities where participatory modalities have enhanced results like in Lusaka, Maputo and Windhoek, these approaches are hardly institutionalised to become a permanent trait of governance. This is an underlying structural limitation of the receptiveness or transformative capability of participatory forms of governance.

Furthermore, fragmented decision-making and siloed planning continue to be major barriers in SCT adoption. The examples of Windhoek and Cape Town prove that in most cases, smart city initiatives work independently of larger urban constructs or national SCT plans (Scott and Taylor, 2023; Musungu et al., 2011). Consequently, emerging ideas cannot be replicated or reconstructed as each city initiates, implements and runs its projects separately.

The patterns identified in the findings demonstrate one of the central insights within the STS theory. The study revealed that SCTs that are not integrated into the institutional structures or align with the priorities of the population cannot be sustained. To illustrate this in cities such as Mzuzu, Harare and Lusaka, smart water and flood resilience initiatives may have achieved technical success but lacked social compatibility which has made the efforts either a continuous tug-of-war (Harare) or led to the abandonment of the initiatives (Lusaka) (Gandidzanwa and Togo, 2022; Vhumbunu and Adetiba, 2023). For SADC cities, without these underpinnings, SCTs face the prospects of enshrining exclusion or even failure in the long run.

4.2 From Absorptive to Transformative Resilience - Pathways and Constraints

To assess SCT interventions, the Urban Resilience Theory provides a valuable typology, including absorptive, adaptive and transformative capacities. The empirical findings indicate that majority of SCT interventions in SADC are in the absorptive stage. Most of these were set up to deal with short term shocks (such as ad hoc water rationing, early warning systems) rather than being vehicle of long-term systemic adaptation.

However, critical analysis of the findings indicate that absorptive strategies dominance is more than just a technical concern since it represents wider structural limitations. Major SCT implementations are pilot-only, donor-led, and unsustainable in the financial scheme of things. They are largely characterised by designs that focus more on the short-term returns rather than long-term integration due to the necessity to adapt the plan to external sources of funding. A prime example is the eThekweni IoT waste management systems and smart metering in Cape Town, which were demonstrably successful initially but could not be scaled and do not comprise an inclusive infrastructure (Blanco-Montero, 2021; Ripunda and Booyesen, 2021).

This partial transformation to adaptive or transformative resilience can further be attributed to the post-colonial legacies of cities, where informal settlements were marginalised both spatially and institutionally (Birkmann et al., 2022). Nevertheless, there has been instances where participatory GIS (PGIS) approaches have enhanced mapping precision, including in Cape Town and Windhoek. However, the inclusion of informal communities in fundamental planning processes remains weak, undermining their long-term effectiveness (Musungu et al., 2011; Scott and Taylor, 2023).

4.3 Inclusion, Equity, and the Limits of Access

Lastly, in the view of the Capability Approach (Sen, 1999), SCTs should increase the real freedoms of people which is the capacity to enjoy, utilise, and access the said technology. The findings, however, depict disturbing trend that emerged of consistent SCT exclusion within SADC cities, especially the low-income community and informal settlements.

The findings show that the major determinant of SCT exclusion was the type of technology underpinning the intervention. For example, IoT interventions are 20% inclusive against AI is very much exclusionary with 75% implementations excluding stakeholders such as the community. This trend can be attributed to the high costs of these novel technologies, inadequate access to digital infrastructure and insufficient digital literacy levels in the community (Birkmann et al., 2022). This has the effect of increasing inequalities instead of decreasing them. For example, smart meters have mostly favoured affluent suburbs, excluding informal settlements because of cost prohibition and infrastructural deficiency (Gandidzanwa and Togo, 2022).

Though blockchain-based apps seem more promising with regard to inclusivity, they are constrained by illiteracy and credibility. Therefore, this study affirms Sen's (1999) assertion that availability (of a technology) cannot be equated with capability unless individuals are free and able to use it in a meaningful and beneficial way. The failure to address this gap in systematic policies to increase digital access and encourage co-design with communities means that SCTs may further entrench socio-economic disparities instead of constructing an equitable resilience.

4.4 Key Strategic Implications for Climate Resilience

To advance equitable and effective SCT deployment in SADC cities, several strategic shifts are needed. Table 3 summarises four critical priorities, governance reform, innovative financing, community participation and capacity building, that emerged from the study's findings.

Table 3. Strategic Implications for Equitable Smart City Technology Deployment in SADC Cities

Strategic Priority	Key Insight	Operational Focus
1. Governance Reform	Fragmented, siloed governance structures limit SCT scalability.	Institutionalise cross-sectoral coordination (for example, between ICT, urban planning, and disaster risk management); embed SCTs in adaptive policy frameworks.
2. Innovative Financing	Donor-driven models are short-term and unsustainable.	Promote decentralised finance models, cost-sharing, and targeted subsidies to ensure equitable access. Encourage private sector involvement.
3. Community Participation	Top-down SCTs risk exclusion; participatory approaches improve resilience.	Embed participatory design processes (for example, PGIS, community-generated data) especially in informal settlements and flood-prone zones.
4. Capacity Building	Even well-designed SCTs fail without skilled personnel and institutional support.	Invest in digital literacy, technical training, and maintenance capacity within municipalities and communities.

These priorities underscore that climate resilience in SADC cities hinges on more than technological innovation. In addition to that it also depends on reconfiguring the institutional and social ecosystems in which technologies are embedded. Governance reform enables strategic alignment and cross-sectoral integration financial innovation broadens access and sustainability; participatory approaches ensure context-sensitivity and inclusion and capacity building secures long-term implementation.

Taken together, these interconnected strategies form the foundation for transitioning from short-term absorptive responses to long-term adaptive and transformative resilience.

5.0 Limitations of the study

The study has a number of limitations which need to be identified to place the results in context. First, the evidence base has been biased towards bigger economies in SADC like South Africa and Zimbabwe where there is more documentation regarding SCT interventions. This hinders the possibility of generalising the results to smaller or poorer-documented member states such as Eswatini, Lesotho, Madagascar or Botswana, in which case implementation dynamics may not be the same at all. Second, this SLR specifically considers only climate adaptation to the exclusion of other interventions that may be mitigation-oriented. This can lead to exclusion of integrated resilience strategies that can overlap with or explain what drives SCTs for urban climate adaptation. Finally, the study used only English-language studies which may have excluded applicable research studies that were written in French or Portuguese, which are official languages in certain SADC countries like Mozambique, Angola and Madagascar. Consequently, the regional diversity of SCT practice and experience might not be comprehensively represented in the analysis.

6.0 Conclusion and Future Directions

The research investigated how SCTs are employed in climate adaptation in SADC cities, including the prevalent technologies, barriers to systemic adoption and whether participatory techniques mediate or produce variations in adoption. The study revealed that IoT and GIS are most implemented, specifically to help with water control and flood risk mapping. The study also showed that more advanced technologies such as AI and blockchain are still in their early stages of implementation and that the majority of SCT interventions are limited to short-term absorptive approaches.

Among the most significant obstacles are the fragmented and siloed governance approach as well as the financial and poor integration among the local institutions. Siloed decision-making prevents embedding the long-term SCTs into long-term resilience planning. Furthermore, SCTs adoption in the SADC region is often top-down implementation which makes low-income populations unrepresented and destroys social confidence. On the other hand, participatory models prove that equity and

effectiveness can be created by integrating the local knowledge. Such strategies are however not well institutionalised but rely on donor funding. Most of the SCT initiatives may end up being stagnant due to the lack of long-term financing mechanisms.

SADC cities should incorporate integrated governance structures to transform to adaptive and transformative resilience by aligning SCTs to participatory urban planning. Financial innovation by means of selective subsidies, cost-sharing, and decentralised financing is necessary to increase access. Greater emphasis and further investment should be placed upon community-led implementation as a means of closing socio-technical divides, in addition to ongoing investment in digital literacy and institutional capacity. The study contributes to the existing literature with the help of a resilience-equity-participation lens of SCTs in the Global South the critical synthesis of the socio-technical and governance system influence on the technological adaptation of needs in the urban context of Africa.

Future research should focus on developing equity-based smart city technology implementation frameworks that are grounded in local contexts and capable of addressing socio-economic disparities in climate adaptation.

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Theoretical Implications of Gendered Subject Selection and Participation in Zimbabwean A-Level Schools: A Case of Masvingo District

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Abstract

This study examines gendered subject selection and participation in Zimbabwean A-Level education through the lens of James Lull's Theory of Gendered Hegemony (TGH). Its objectives were to: distinguish male and female learners' subject perceptions; consider the influence of gender stereotypes on subject selection; review schools' attempts to address gender imbalances; examine how learners' gendered perceptions influence their participation; and suggest curriculum strategies for improving gender equity. While TGH highlights how cultural hegemony, media representation and ideological control reinforce traditional gender roles in education; the current study goes further by analysing empirical findings from Zimbabwean schools. Two purposively identified schools participated for an embedded case study involving gender-balanced cohorts of twelve learners per school, as well as five teachers. After conducting learner Focus Group Discussions (FGDs), one-on-one teachers' interviews and document analysis, the study introduces the Gender Dynamics Framework (GDF) as a real-world model emerging from field data. GDF identifies learner-centred dynamics, societal influences, teacher interactions and resource availability as key elements in shaping gender disparities. This framework offers a transformative approach to fostering gender-equitable learning environments, an approach that updates TGH postulated by Lull in 2011.

Key words: Gendered subject selection; Educational equity; Gender Dynamics Framework; Theory of Gendered Hegemony; Gender-responsive pedagogy

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1.0 Introduction

Gendered subject selection remains a pressing concern in Zimbabwean education, where societal norms, institutional structures, and cultural expectations continue to influence female and male learners' academic choices (Batsirai, 2020; Mavima, 2023; Mukundi, 2021). Empirical data from Zimbabwean institutions indicate a persistent trend: boys gravitate towards sciences and technical subjects, while girls dominate Arts and Humanities (Bhunu & Green, 2023; Chari, 2023). These patterns reflect deeply ingrained gender perceptions, as teachers often misjudge female learners' subject preferences, aligning more accurately with boys' choices (Mukundi, 2021; Ndlovu & Chikohomero, 2023).

To understand how dominant ideologies sustain these disparities, the Theory of Gendered Hegemony (TGH) by Lull (2011) illustrates how societal narratives, cultural expectations and historical gender roles shape learners' academic decisions, reinforcing the division between masculine and feminine academic domains. According to Lull (2011), hegemonic norms are not imposed through coercion but are maintained through institutions such as schools, families and the media. Within education, these norms manifest through gendered subject selection, where STEM fields are perceived as male-dominated, while Arts and Humanities are regarded as female-oriented (Mukundi, 2021; UNFPA, 2021). Teachers, school policies and social institutions further entrench these norms by reinforcing stereotypical expectations about male and female academic capabilities (Chari, 2023; Mavima, 2023).

Empirical literature suggests that the heritage-based A-Level curriculum in Zimbabwe reflects these gendered divisions, with male learners predominantly selecting Sciences, while female learners favour Arts and Humanities (Batsirai, 2020; Mukundi, 2021). Societal norms and cultural expectations, reinforced through families, the media and religious institutions, contribute to these choices (Hlaise, 2023; UNFPA, 2021). This has significant implications for learners' academic participation and career opportunities, as female learners often experience reduced confidence in STEM subjects, while male learners face social stigma when pursuing Humanities (Dube & Mavhunga, 2020; Gwatura, 2021; Mukundi, 2021).

Given the influence of gendered perceptions on subject selection, various interventions have been introduced to promote gender equity in education. Schools have implemented STEM promotion initiatives for girls, inclusive counselling services for boys, and gender-responsive educational policies (Mavima, 2023; Mwebaza, 2020; Zinyama & Mashava, 2023). However, these efforts have yielded mixed results, as entrenched societal norms and institutional barriers continue to limit progress (Hlaise, 2023; Maphosa & Bhebhe, 2019; UNFPA, 2021). Professional development for educators, mentorship programmes, and community engagement are essential strategies for addressing these disparities (Chari, 2023; Konyana & Motalenyane, 2022). Increasing the visibility of diverse role models in STEM and Humanities can also broaden learners' academic and career aspirations, challenge traditional gender roles and expanding opportunities (Chimoto, 2023; Dube & Mavhunga, 2020; Mavima, 2023).

This study adopts an interpretive case study approach to examine gendered subject selection among A-Level learners in Zimbabwe. By incorporating perspectives from learners, teachers and institutional documents, it seeks to identify the underlying factors influencing subject selection and assess the effectiveness of existing interventions. The study introduces the Gender Dynamics Framework (GDF) as an emerging conceptual model that moves beyond ideological analysis to propose structured grassroots interventions for addressing gender inequalities in education (Carlstrom, 2022). Rooted in school-level practices and learners' lived experiences, the GDF aligns with broader gender reform strategies and offers a practical approach to fostering more equitable subject selection processes and progressively democratic academic participation (Chari, 2023; Ndlovu, 2021; UNFPA, 2021).

The study aimed to examine the gendered patterns of subject selection among A-Level learners in Zimbabwean schools, explore the societal factors influencing male and female learners' academic choices and assess the link between these trends and institutional practices. Additionally, it sought to evaluate the implications of learners' gendered subject perceptions on their academic participation and propose a theoretical framework for addressing gender disparities in subject selection and educational engagement.

2.0 Methodology

2.1 Research Paradigm

The study adopted an interpretivist paradigm, which emphasises understanding social reality through subjective experiences and meanings (Carlstrom, 2022). This paradigm was considered appropriate for studying the gender dynamics of subject selection and participation as it allowed for the exploration of learners' perceptions, societal influences and the role of teachers in shaping educational pathways and experiences. Interpretivism recognises that knowledge is constructed through interaction and interpretation (Cardano, 2020), making it suitable for analysing narratives from learners, teachers and school records.

2.2 Research Approach

Gender disparities in subject selection among A-Level learners in Zimbabwean schools were explored through a qualitative approach. Qualitative research is well-suited for investigating social phenomena as it enables an in-depth understanding of participants' perspectives and lived experiences (Busetto et al., 2020). In this study, it examined the factors shaping subject selection and participation among female and male learners, allowing for an in-depth understanding of participants' subjective experiences, perceptions and social contexts (Creswell & Creswell, 2020). The qualitative approach provided the flexibility to capture the context-specific experiential insights that may not be fully represented in quantitative data. Thus, the qualitative approach facilitated a rich, holistic exploration of gendered subject selection, capturing the interplay of personal, institutional and societal factors that influence learners' educational trajectories.

2.3 Population and Sampling

In-depth perspectives on gender dynamics within A-Level education were obtained from purposively sampled participants. The study population comprised A-Level learners and teachers from selected schools, ensuring a diverse representation of subject specialisations and experiences. Sampling frames included class registers, departmental records and teacher rosters, which facilitated the identification of participants with relevant insights. Learners were selected based on their enrolment

in A-Level subjects, with attention to gender distribution across disciplines, while teachers were chosen for their direct involvement in curriculum delivery and student guidance. Inclusion criteria required learners to have completed at least one academic term within the A-Level curriculum to ensure familiarity with subject selection patterns and gendered experiences. Teachers, on the other hand, needed a minimum of two years of experience in A-Level instruction to provide informed perspectives on gender dynamics in subject selection and participation. Additionally, documentary analysis included class registers and performance records to triangulate findings for a credible research. The approach ensured data saturation by capturing a comprehensive range of viewpoints on the influence of gender perceptions in A-Level subject selection and participation.

2.4 Data Collection Methods

A multi-instrument approach was employed to enhance the credibility of findings through triangulation (Cardano, 2020; Creswell & Creswell, 2020). The data collection instruments included:

2.4.1 FGDs

FGDs were conducted with female and male A-Level learners to capture their perceptions and experiences regarding subject selection. Each discussion involved twelve participants and was gender-balanced, ensuring diverse perspectives while maintaining manageability. Semis-structured discussions were guided by open-ended questions to encourage in-depth responses and uncover underlying motivations and constraints affecting subject selection and participation. The FGDs provided insights into societal expectations, gendered stereotypes and personal career aspirations influencing learners' decisions and participation thereafter.

2.4.2 Teachers' interviews

These were administered on teachers to examine their perspectives on gendered subject selection and their role in shaping learners' choices. The use of a semi-structured interview instrument allowed flexibility in questioning while ensuring coverage of key themes such as gender biases, classroom interactions and

institutional policies. The interviews provided valuable contextual understanding and professional insights into the observed trends in educational gender dynamics.

2.4.3 Document analysis

School records, including class registers and subject performance data, were analysed to complement qualitative findings. Document analysis helped verify trends in subject enrolment, gender distribution and academic performance disparities. It also provided an empirical basis to assess the extent of gendered subject selection and the influence of school policies on learners' participation.

2.5 Data Analysis

Data analysis followed a thematic approach, involving systematic coding and categorisation of recurring themes (Busetto et al., 2020; Cardano, 2020). The researchers transcribed the FGDs and interviews word-for-word and drew out key themes through a thorough review of the transcripts. Thematic coding enabled the identification of patterns related to learner-centred dynamics, societal influences, teacher interactions as well as resource availability in subject selection and participation. Document analysis findings were integrated with qualitative data to validate emerging themes and reinforce interpretations. The study employed reflexivity to minimise researcher bias, ensuring that interpretations remained grounded in participants' narratives (Smilde & Hanson, 2023).

2.6 Ethical Principles Considered

This research obtained ethical clearance from the appropriate educational authorities and secured informed consent from all participants – including guardians in the case of learners aged below eighteen, and anonymity was maintained by assigning pseudonyms to learners and teachers. Participants were assured of confidentiality, and data was stored securely to prevent unauthorised access. Thus, the study adhered to ethical research principles, ensuring voluntary participation and respect for the dignity and perspectives of all respondents.

2.7 Limitations

While the qualitative approach provided rich insights into gendered subject selection, its findings are not statistically generalisable. Additionally, social desirability bias may have influenced some responses, particularly in FGDs. However, data triangulation helped enhance the study's credibility. The rigorous qualitative methodology illuminates the socio-institutional factors shaping gendered subject selection among A-Level learners in Zimbabwe.

3.0 Findings

Field data collected from Zimbabwean schools indicate that gender disparities in subject selection are influenced by multiple interacting factors. The study synthesises these factors into GDF, which presents four core dimensions that shape subject selection and participation:

3.1 Learner-Centred Dynamics

Boys and girls express distinct academic preferences based on perceived difficulty, career aspirations and social expectations. Male learners gravitate towards STEM subjects due to perceived prestige and economic potential, while female learners tend to favour Arts and Humanities due to societal reinforcement and accessibility. Table 1 below summarises the FGD and interview contributions related to personal learner discernments.

Table 1: Field findings supporting learner-centred dynamics of subject selection and participation

Verbatim Quotes from Participants	Interpretation by Researcher
We are told to not be misled by O-Level passes in difficult subjects because as a woman grows, she loses endurance gradually. Girl 5, FGD2	Female learners frequently view STEM subjects as overly difficult and unsuitable, influenced by societal norms and gender expectations. They often favour narrative-based subjects that prioritise expression over strict calculations. Social and family expectations encourage them to pursue subjects aligned with traditional gender roles. Meanwhile, male learners associate STEM with prestige and financial success, while societal pressures deter them from Arts, reinforcing its perceived lack of economic value.
We girls happen to enjoy narratives, naturally, but the old History syllabus involved mathematical cramming of dates, which we hated. Girl 2, FGD2	
I am not studying Commercial subjects, yet one of my dreams is to become a successful businesswoman. Society is awash with examples of businesswomen who studied Arts. I have come to believe that Arts subjects teach us girls to be resourceful. Girl 2, FGD1	

Verbatim Quotes from Participants	Interpretation by Researcher
We are made to believe that Arts are for boys who hail from the underclass because artistic professions are typical examples of begging. The son of a rich person will be contradicting his status if he goes forth to study Arts. Boy 4, FGD2	
As the eldest son of my entrepreneur parents, I am motivated to study Business Management considering that I should inherit my family's enterprises. Society deems me the rightful heir to inherit the businesses after my parents. Boy 1, FGD2	
Girls seem to prefer subjects considered less demanding, like Family and Religious Studies (FRS), while viewing Sciences as too difficult because of the rigorous career paths they entail. Conversely, Arts subjects are seen as more manageable and suitable for those who juggle multiple tasks. Female Teacher 1, School 1	
Girls' reluctance to pursue Sciences tends to enhance boys' confidence, as choosing these subjects becomes a source of masculine pride. Female Teacher 1, School 1	
Whenever I am presenting or conducting an experiment, the teacher poses questions which switch off my confidence. Girl 6, FGD2	

Document analysis confirms gendered subject selection, with boys dominating STEM and Commercial subjects due to societal prestige and career expectations, while girls favour Arts, influenced by accessibility and traditional roles. Performance disparities align with classroom interactions, where boys excel in STEM and girls in narrative-based subjects. Subject transfers reflect societal pressure, with boys avoiding Arts and girls withdrawing from STEM. Classroom records show boys engaging more in STEM discussions, reinforcing their confidence. These findings highlight entrenched biases requiring targeted interventions for equitable academic participation.

3.2 Societal Influences

Parents, peers, and community perceptions play a crucial role in subject selection. Many learners reported feeling pressured to conform to traditional gender norms, discouraging girls from pursuing Sciences and technical subjects. Field contributions of learners and teachers that support the role of societal influences are summed up on Table 2:

Table 2: Field findings attributing gendered subject selection and participation to societal influences

Verbatim Quotes from Participants	Interpretation by Researcher
Society condones parental dictatorship and yet most parents want their boys to study Sciences being custodians of industrialisation, to the extent of transferring the boys to another school if the current school will not grant this wish. Girl 4, FGD2	Societal norms and parental influence reinforce gender stereotypes in subject selection. Girls face pressure to avoid STEM, favouring traditional feminine roles, while boys are steered towards financially rewarding fields, dismissing Arts and domestic roles. Cultural beliefs and career expectations sustain gendered academic divisions, with schools struggling against deep-rooted societal influences that shape learners' educational and career choices.
We think twice if not thrice before choosing any one of the subjects that society previously reserved for boys. We believe it was like that for a reason. Girl 1, FGD1	
Shona traditions say that girls must not pursue education too far up because they will cease to be ideal future wives. Further education is deemed a potential source of problems for wives who end up being uncontrollable. Boy 2, FGD2]	
I was raised with the belief that as a girl I should go to school for enlightenment only and not as preparation for any economic roles as my future husband will be the breadwinner. As a result, I have been comfortable with enlightening subjects offered in the Arts class. Girl 4, FGD1	
Role models for girls as depicted in media are largely in Arts-based professions. Boy 5, FGD2	
Girls choose less demanding categories like Arts because they have a lot of womanly duties to perform back home. Male Teacher 1, School 1	
The local job market admits girls who studied Arts and Humanities as well as boys who did Sciences in general. There is less risk of not finding a job in this order. Female Teacher 2, School 2	
Industry threatens women while reassuring men. As a result, boys comfortably study industrial-oriented subjects like Sciences and Engineering, while girls study them only insecurely. Male Teacher 2, School 2	

The analysed class registers and records of marks support the findings that societal influences significantly shape subject selection. Boys dominate STEM fields due to parental expectations and economic prospects, while girls lean towards Arts, aligning with cultural beliefs about femininity and domestic roles. Marks analysis reveals

gendered performance trends, reinforcing confidence disparities. Subject transfers reflect societal pressure, with boys moving into sciences and girls withdrawing due to perceived difficulty. These patterns highlight entrenched gender biases in education and career aspirations.

3.3 Teacher Interactions

Educators' attitudes significantly influence subject choices. Some teachers reinforce gender biases, either subtly by discouraging girls from taking challenging STEM subjects or overtly through differentiated classroom treatment. Interview and FGD responses attaching gendered subject selection and participation to teacher interactions are given on Table 3.

Table 3: Insights from interviews and FGDs gendered subject selection and participation to teacher interactions

Verbatim Quotes from Participants	Interpretation by Researcher
We senior girls do not feel confident in our current school uniforms. The school seems bent on very long skirts, but as a postmodern girl, I feel awkward in such a skirt. As a result, I might not do well in subjects which demand utter confidence. Girl, FGD1	Teachers' interactions shape gendered subject selection and performance by reinforcing stereotypes. Some discourage girls from STEM by emphasising difficulty or expressing surprise at their success, while boys receive more encouragement and hands-on opportunities. Gendered expectations also see boys steered away from Arts. Classroom dynamics often reflect biases, influencing learners' confidence and reinforcing academic divisions.
My teacher is always failing me whenever she marks my work. I realised that it is sheer favouritism when I copied word-for-word the work of someone else. I failed and the copied person passed. This showed me that either the teacher does not mark at all or there is some issue between us. Personally, I've given up on the subject but I don't have the courage to alert my guardian who pays my school fees reliably. Girl 1, FGD1	
Boarding masters allow boys to be in the classrooms even throughout the night. This is actually mentioned by boys who chide other boys saying, 'You can't be beaten by a girl, man. You have all the time to read while girls sleep, man.' This actually explains why boys often outperform girls in sciences because these subjects are revision-intensive. Girl 6, FGD1	
I'm too shy to approach the teacher on my own, but in a group of learners, it feels different. I think the teacher sees me differently when I'm part of a group, and working together helps protect me from any bias. Girl 4, FGD2	

Verbatim Quotes from Participants	Interpretation by Researcher
If you choose sciences, you really need time to revise. We are privileged to have such time which the girls don't necessarily have due to extra chores outside study time. Boy 5, FGD1	
Girls do not match boys in their range of capabilities as viewed from sociocultural lenses. Girls generally have a narrower choice in the Arts and Humanities unlike boys who are customarily cut for studying Sciences. Male Teacher 2, School 2	
The school has encouraged teachers to be role models in championing gender equality. We have therefore inspired learners to pursue their educational goals without gender limitations. However, while girls are increasingly gathering courage to tackle Sciences due to this, female teachers are lacking in the Sciences department. Female Teacher 2, School 2	
Our school has established counselling services and support networks that specifically cater to the needs of male learners. In fact, there are similar services arranged for girls too. The school recognises that boys may require a different approach to address their emotional and mental health concerns. Male Teacher 2, School 2	

Document analysis of class registers and academic records corroborates the influence of teacher interactions on gendered subject selection. Boys' dominance in STEM is reinforced by greater encouragement, longer study hours, and fewer domestic responsibilities, while girls often lack confidence due to discouragement and unequal revision opportunities. Marks and teachers' comments reveal disparities linked to perceived favouritism, possibly unconscious bias. Subject transfers further reflect these trends, as girls withdraw from sciences due to discouragement, while boys avoid Arts, mirroring classroom biases.

3.4 Resource Availability

Unequal access to ICT tools and study materials disproportionately affects subject participation. Male learners often have better access to digital resources, while female learners face structural disadvantages, particularly in rural settings. Table 4

summarises the learners’ and teachers’ views that ascribe gendered subject selection and participation to resource availability.

Table 4: Participant quotes citing resource availability as influencing subject selection and participation

Verbatim Quotes from Participants	Interpretation by Researcher
What depresses us worst is the fact that we pay equal school fees but boys get more food and more exercising outside. Girl 5, FGD1	Resource availability influences gendered subject selection and performance, with boys often having better access to food, leisure, ICT tools and study resources. Girls face mobility restrictions and limited digital engagement, disadvantaging them in STEM subjects. Structural inequalities and socioeconomic factors further widen the gap, reinforcing gender disparities in technological proficiency, academic confidence and subject selection.
The food inequality is serious and it affects our concentration in academic and extracurricular work. Sometimes we boycott the activities quietly because we are shy to protest openly. Girl 1, FGD1	
My parents said, “Pick subjects that won’t waste money. If you fail, it’s a small loss, but if you pass, you must get a job quickly.” That’s why I didn’t choose Sciences. Girl 3, FGD1	
STEM created conditions for imperfect competition in the A-Level classes. There was a literal stampede to enrol in sciences, not necessarily out of career drives but for the allure of funding. To forge a picture of gender equitableness, the initiative enrolled even under-qualified girls who soon failed to endure as demonstrated by the sudden drop of female numbers after a few years. Girl 5, FGD2	
Families, especially those with limited resources, often view investing in a girl’s education as risky. They prefer she chooses subjects that will guarantee immediate returns. Male Teacher 2, School 2	
Families are generous with money when funding boy education, but when it comes to girl education, the cheapest choices are considered excellent. Male Teacher 4, School 1	
To achieve gender balance in the A-Level curriculum, we need to start by ensuring that our instructional materials and resources are designed to be gender-neutral; including gender-fair educational content and inclusive examples. Female Teacher 1, School 1	
In some extracurricular activities like sports, there may still be disparities in resources and opportunities between male and female students, affecting their performance and confidence. Female Teacher 1, School 1	

The analysis of class registers and marks aligns with findings on resource disparities. Boys' higher enrolment in STEM subjects correlates with greater access to ICT tools, study materials and revision time. Meanwhile, girls' lower participation rates and higher dropout levels in sciences reflect structural barriers, including financial constraints and societal expectations. Performance records further reveal that boys benefit from technological engagement, while girls' academic struggles in resource-intensive subjects reinforce gendered subject selection patterns, perpetuating educational inequalities.

4.0 Discussion and Analysis

This section compares the principles of Lull's TGH with the findings of the current study in light of the emerging GDF and within the context of subject selection and participation.

4.1 Learner-Centred Dynamics

The study's findings on gendered subject selection largely align with Lull's TGH, which argues that culture—through media—shapes individual choices and reinforces gendered behaviours. Male learners drifted towards STEM subjects due to perceived prestige and economic potential, reflecting cultural narratives that associate masculinity with technical and business success as represented in public media (Hlaise, 2023; Lull, 2011). This mirrors past literature, which highlights the tendency for boys to favour technical fields, influenced by both culture and familial pressures (Chari, 2023; Konyana & Motalenyane, 2022; Mangena & Waliaula, 2021; Mavima, 2023). Conversely, female learners tended to prefer Arts and Humanities, with subjects like FRS seen as more manageable and aligned with traditional feminine roles (Hlaise, 2023; Lull, 2011). This trend is supported by past studies, noting how girls are often discouraged from pursuing STEM due to perceived difficulty and cultural beliefs about their suitability for such fields (Mavima, 2023; Zinyama & Mashava, 2023). However, the study updates TGH by illustrating a more learner-centred dynamic where learners actively negotiated their subject selection in response to both external pressures and personal agency, rather than defencelessly yielding to public media trends. For instance, some girls, while facing societal discouragement towards STEM, actively pursued these fields, motivated by aspirations beyond traditional

gender roles. Similarly, some of the boys, while culturally expected and encouraged to excel in STEM, expressed discomfort with Arts subjects, despite no overt familial or societal discouragement. These clues highlight that learners are not passive recipients of cultural norms and media narratives but engage with them in complex, sometimes resistant ways. This challenges TGH's more deterministic view of culture's role in shaping subject selection and underscores the importance of considering individual agency in educational choices.

4.2 Societal Influences

The findings of this study align with TGH in suggesting that the influence of parents, peers and community expectations on subject selection reflects deeply ingrained gender stereotypes. Girls faced societal pressure to avoid STEM subjects, which were perceived as unsuitable due to cultural beliefs about their roles as future wives and mothers (Lull, 2011). This is consistent with other previous studies where girls are discouraged from pursuing technical fields, as these subjects are seen as masculine and financially unappealing for women (Chari, 2023; Ndlovu, 2021). On the other hand, TGH assumes boys are steered towards sciences, viewed as economically rewarding and aligned with traditional masculine roles. This is reflected in the findings, where male learners, driven by parental expectations and career prospects, dominated STEM subjects. However, the current study differs from TGH by illustrating that the pressures of social institutions on both genders are more complex and dynamic than traditionally understood. While TGH suggests a clear-cut gendered division, the findings reveal that girls' resistance to societal norms was more pronounced, with some actively seeking to challenge institutions and their expectations, even in the face of adversity (Maphosa & Bhebhe, 2019; Sibanda, 2020). Furthermore, the study reveals that boys, despite societal pressures to excel in STEM, face subtle discouragements in non-technical fields, indicating a more delicate interaction between gender roles and subject selection. This highlights the need to update TGH by considering the active agency of learners in navigating and resisting sociocultural influences on their academic choices, rather than focusing exclusively on institutions as sole perpetrators.

4.3 Teacher Interactions

The study aligns with TGH by highlighting how teachers' biases—both subtle and overt—affect learners' confidence and subject selection, perpetuating gendered educational divisions. Girls, for instance, were often discouraged from pursuing STEM subjects through negative reinforcement, such as surprise at their success or a lack of encouragement. Female learners felt unsupported in STEM areas due to perceived biases and unequal revision opportunities, reinforcing Ndlovu and Chikohomero's (2023) call to retrain teachers to counteract these biases as schools may end up perpetuating inequalities (Lull, 2011). Furthermore, the study reflects TGH's connection of masculinity with rationality and academic success in technical fields, with boys receiving greater encouragement and more opportunities to engage with revision-intensive subjects like sciences, supported by extended study hours and fewer domestic responsibilities. However, the study departs from TGH by showing a more complex interaction between teacher behaviours and gendered subject selection. While TGH suggests teachers and schools consciously perpetuate gender roles, the findings in this study suggest that teacher bias may also be unconscious, reflecting a broader societal norm rather than intentional discrimination. For example, the lack of female teachers in STEM and the tendency to reinforce gender stereotypes through informal classroom interactions indicate a more systemic, entrenched issue (Chimoto, 2023; Ndlovu & Chikohomero, 2023; Ruche & Ndlela, 2020). This finding updates TGH by suggesting that biases are not solely a result of teacher intention but are also deeply embedded in the structures and practices of educational institutions.

4.4 Resource Availability

In line with TGH, the findings from this study highlight how resource availability shaped gendered subject selection and participation, particularly in the context of unequal access to food, leisure, ICT tools, study materials and study time. The current results reveal a significant disparity between female and male learners, with boys enjoying better access to digital resources, study materials and more leisure opportunities, while girls face structural disadvantages such as limited mobility and restricted access to technology (Batsirai, 2020; Sibanda, 2020). This reinforces gendered expectations and educational inequities, particularly in STEM subjects, where digital proficiency is crucial among other targeted structural and policy improvements (Mavima, 2023;

Mwebaza, 2020). The study also touches on socioeconomic factors, with families often viewing investing in a girl's education as risky and preferring subjects that guarantee immediate returns (Chari, 2023; Gwatura, 2021; Washe, 2021). These patterns of unequal resource distribution resonate with past literature, which suggests that girls are typically discouraged from pursuing resource-intensive and career-driven subjects like sciences due to financial constraints and socio-structural pressures (Mukundi, 2021). However, this study introduces a new dimension to the TGH by suggesting that unequal access to resources may not only reinforce gender stereotypes but actively create structural inequalities at policy and implementation levels that limit the learners' academic participation.

Table 5 compares the theoretical framework used in this study with the one emerging from the current findings as discussed above.

Table 5: Comparison of TGH and GDF in Addressing Gender Disparities in Education

Dimension	TGH	Gender Dynamics Framework
Focus	Critique of gendered power structures	Practical interventions to address gender imbalances
Agency	Gender norms are reinforced by institutions	Change is possible through targeted interventions
Role of education	Schools perpetuate gendered hierarchies	Schools can transform into gender-sensitive spaces
Media influence	Media reinforces stereotypes	Media can be leveraged to promote gender equity
Policy implications	Structural changes are difficult	Policy reforms and targeted interventions are key

5.0 Study Conclusions

5.1 Learner-Centred Dynamics

The study finds that gendered subject selection among A-Level learners in Zimbabwe is influenced by cultural narratives, societal expectations and individual agency. Consistent with Lull's (2011) TGH, which argues that media and culture reinforce gendered academic choices, the findings show that male learners lean towards STEM subjects due to perceived prestige and economic prospects. Conversely, female learners tend to prefer Arts and Humanities, viewing subjects like FRS as more manageable and aligned with traditional gender roles. However, the study challenges TGH's deterministic perspective by highlighting learners' active negotiation of subject

selection. Some girls pursue STEM despite societal discouragement, while some boys hesitate to take Arts despite no overt opposition. These findings underscore the need for gender-responsive career guidance and school-based interventions to support learners' autonomy in subject selection.

5.2 Societal Influences

The study's findings reaffirm TGH's assertion that parental, peer and community expectations reinforce gendered subject selection, with girls being steered away from STEM due to cultural beliefs linking their future roles to domestic responsibilities. Similarly, society encourages boys to pursue Sciences, perceived as economically rewarding and aligned with traditional masculinity. However, the study extends TGH by demonstrating that gendered pressures are more nuanced, as learners actively negotiate and, at times, resist societal norms. Sometimes girls challenge institutional expectations by pursuing STEM, despite discouragement, while boys face subtle barriers in non-technical fields, contradicting the notion of a rigid gender divide. These findings call for policy reforms that move beyond reinforcing gender-neutral subject promotion to actively addressing hidden biases. Schools must implement gender-sensitive career guidance and curricular adjustments that empower both genders to pursue their academic interests free from societal constraints.

5.3 Teacher Interactions

The study confirms TGH's assertion that teacher biases, both explicit and implicit, shape learners' subject selection and reinforce gendered educational divisions. Girls often face discouragement in STEM subjects through subtle negative reinforcement and limited revision opportunities, while boys receive greater encouragement in technical fields, aligning with the broader association of masculinity with rationality and scientific success. However, the study extends TGH by revealing that teacher biases are not always deliberate but often reflect broader societal norms rather than conscious discrimination. The systemic nature of these biases, exacerbated by the scarcity of female STEM teachers, underscores the need for policy reforms. Schools must implement gender-responsive teacher training, equitable study support and active recruitment of female STEM teachers. Addressing these entrenched biases

requires institutional change that moves beyond awareness to structural interventions fostering gender-inclusive learning environments.

5.4 Resource Availability

The study reaffirms TGH's argument that resource availability significantly influences gendered subject selection, with male learners benefiting from greater access to ICT tools, study materials and leisure time, while female learners face structural disadvantages such as restricted mobility and limited digital access. These disparities reinforce gendered educational inequities, particularly in STEM, where technological proficiency is essential. Additionally, socioeconomic pressures shape subject choices, as families often prioritise investment in boys' education while steering girls towards subjects perceived as financially low-risk. However, this study goes beyond TGH by revealing that resource disparities do not merely reinforce stereotypes but create systemic inequalities that hinder learners' academic participation. Addressing these gaps requires policy reforms promoting equitable access to digital resources, gender-responsive funding models, and school-based interventions that mitigate structural barriers, ensuring all learners can fully engage in their academic pursuits regardless of gender.

The above conclusions boil down to the following framework emerging from the study. Figure 1 below presents the Gender Dynamics Framework as a modification of Lull's (2011) TGH based on the current findings.

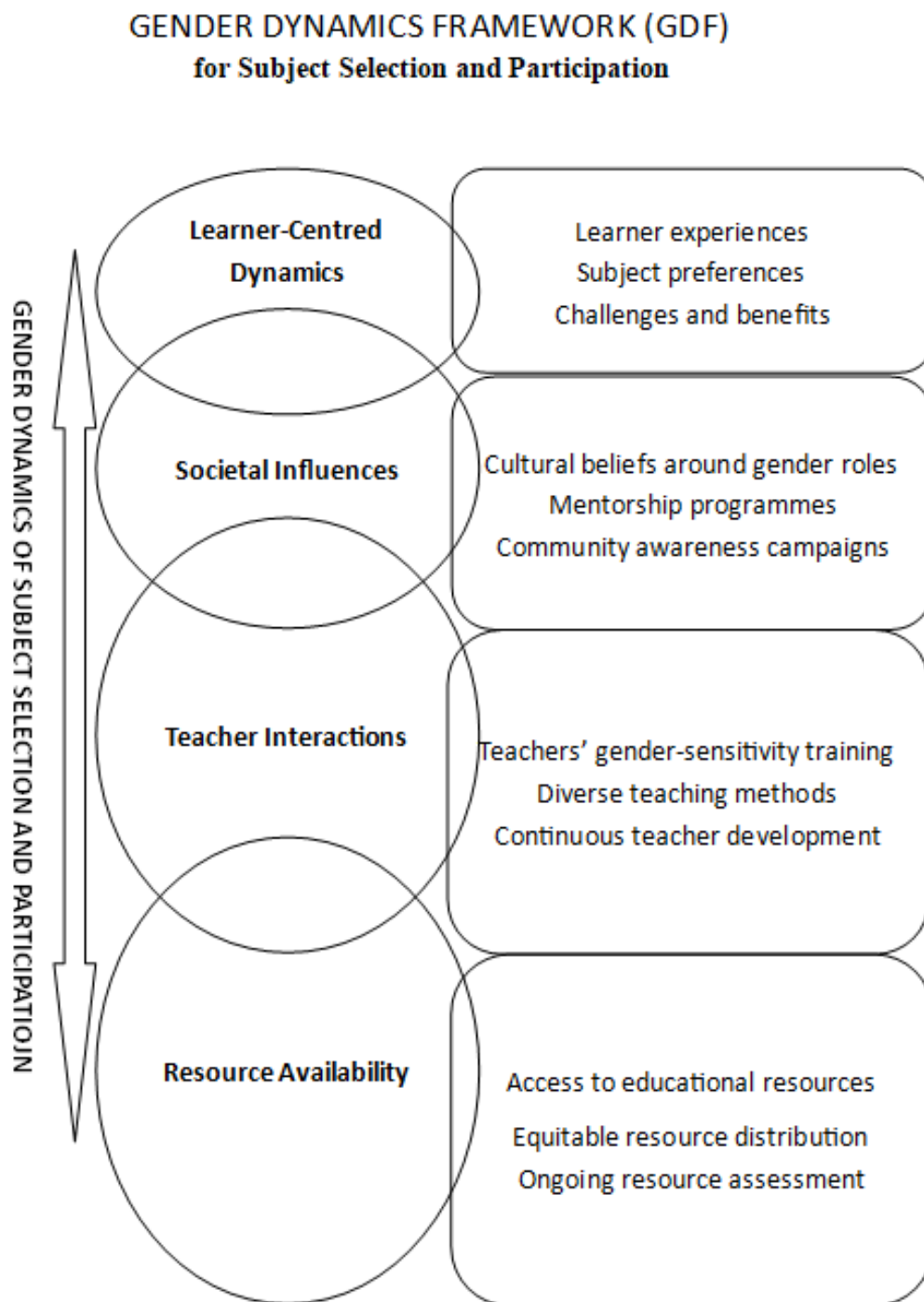


Figure 1: The Gender Dynamics Framework for subject selection and participation (by author)

6.0 Implications for Policy and Practice

6.1 Dynamic curriculum

A gender-sensitive curriculum should accommodate diverse learning needs, allowing for flexible coursework deadlines and inclusive content that challenges traditional gender roles. Schools should integrate more gender-responsive approaches in career guidance sessions.

6.2 Community engagement

Parents and communities should be engaged in dialogues that challenge societal norms shaping subject selection. Schools should collaborate with local leaders and stakeholders to create awareness campaigns promoting diverse academic pathways.

6.3 Teacher development

Schools should implement gender-responsive pedagogies that counteract stereotypes, ensuring that both male and female learners feel supported in their subject choices. Continuous professional development should equip teachers with the skills to encourage equitable participation.

6.4 Resource distribution

Equitable access to learning materials and ICT tools should be prioritised to ensure that gender disparities in subject participation are minimised. Government and non-governmental organisations should invest in school infrastructure that supports gender-inclusive learning.

6.5 Ongoing research

Continuous research is essential to monitor and address emerging gender disparities in subject selection and participation to further update theoretical comprehension of educational gender issues. Longitudinal studies must assess the impact of current interventions in the long run, and identify persistent barriers to gender equality in education. Schools, policymakers and researchers should collaborate to generate data-driven strategies that ensure sustained progress in closing gender gaps.

Additionally, research should explore how evolving societal norms, technological advancements and economic shifts influence gendered academic choices. By maintaining a strong evidence base, education systems can adapt policies and practices to create more inclusive learning environments that empower both female and male learners.

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Statement of competing interests

There are no competing interests of any kind pertaining to this work.

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Artificial Insemination in Smallholder Farming: An Exploration of Farmer Perspectives and Determinants in Beitbridge, Zimbabwe

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Abstract

This study investigated the perceptions of communal farmers in Beitbridge, Zimbabwe, regarding the adoption of artificial insemination (AI) technology in cattle breeding. A semi-structured questionnaire was administered to 80 cattle farmers who had participated in the Zimbabwe Resilient Building Fund Government Communal Cattle Insemination program between 2017 and 2021. The results revealed that 99% of the farmers did not regularly utilize AI services due to the absence of locally based AI service providers (97.5%), discontinuation of service between government programs, and insufficient knowledge of AI technology (72%). Uncontrolled breeding systems and poor seasonal nutrition were identified as major challenges by 100% and 80% of the farmers, respectively. The majority of farmers (77.5%) preferred using both AI and natural mating if available. The perceived low adoption of AI in communal areas was attributed to a shortage of locally based inseminators, inadequate farmer awareness of assisted reproductive technologies (ARTs), and the absence of structured communal breeding programs. The study recommends collaboration among cattle stakeholders to address the challenges in optimizing cattle productivity through ART implementation and adoption in rural areas, including enhancing the capacity of government workers and lead farmers, decentralizing service providers, and institutionalizing community-led sustainability frameworks. Alternative methods of

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technology dissemination are also needed to improve farmers' awareness of fundamental aspects of AI and synchronization protocols.

Keywords: Artificial insemination technology; Smallholder farming systems; Cattle Farmers perceptions; Adoption determinants; Beitbridge, Zimbabwe

1.0 Introduction

In Zimbabwe, the agricultural sector has been demonstrated to be the foundation of the economy, with livestock contributing significantly to the country's economic output. Cattle account for 35% to 38% of the Gross Domestic Product contributed by the agricultural sector (Food and Agriculture Organization, 2020). Cattle serve various social and economic functions in communal areas, underscoring their importance in agricultural production and livelihood systems (Mavedzenge et al., 2006). These functions include income generation, wealth storage, utilization as draught animals, meat and milk production, and manure for fuel and fertilizer (Ndebele et al., 2007). Most households in communal areas in semi-arid southern Zimbabwe depend on livestock farming for subsistence. Musemwa et al., (2012) emphasized that reliance on livestock farming is influenced by unreliable rainfall resulting in recurrent droughts and water shortages; consequently, livestock production is more feasible for communities focusing on mitigating food shortages, achieving nutritional and economic security, and improving economic growth. However, cattle productivity in these farming areas is low because of numerous factors, including poor or non-adoption of optimal farming systems and promoted technologies. This challenge may stem from human perceptions rather than a lack of technological advancement.

The poor genetic potential of indigenous breeds has contributed to low livestock productivity (Fillipo, 2015). Hence, various biotechnologies, such as artificial insemination (AI), which is defined as the introduction of semen and viable sperm into the female reproductive tract via artificial means (Schook et al., 2017), have been promoted to improve the genetic composition of communal cattle. For livestock improvement in developing countries, technologies, such as AI, must be comprehended and effectively transferred to farmers (Shehu, 2010). Consequently, the Division of Research, through Matopos Research Institute, has been promoting artificial cattle insemination in communal areas, artificially inseminating 300 animals in

Mwenezi (2018) under the CROPS project, 1197 cattle in Beitbridge (2018, 2019, 2020) under the Zimbabwe Resilience Building Fund - Program for Growth and Resilience (ZRBF-PROGRESS) project, and 460 in Matobo and Insiza districts (2021) under the Zimbabwe Agriculture Knowledge Innovation System (ZAKIS) project, which is one of the Zimbabwe Agricultural Growth Programmes (ZAGP), with a calving rate range of 40–45% from single cow insemination services. These programs aim to propagate superior genetics from improved indigenous breeds and enhance the participating farmers' understanding of AI technology.

In areas where AI has been implemented, there has been an improvement in calving rates, with 25-30% (Institute of Rural Technology, 2010) improvement observed among smallholder farmers in semi-arid areas and 65-70% in commercial farms (Washaya et al., 2019), as well as a reduction in the calving period and an increase in calf weight (Mushonga et al., 2009). With improved herd performance and productivity that can be realized in communal areas due to rapid genetic gain from AI, the rural economy would be sustained by high cattle off-take rates, thereby reducing poverty and improving household food security (Mugwabana 2018). Communal cattle farmers in rural areas can adopt and utilize these technologies to address the shortage of bulls, reduce the transmission of venereal diseases, minimize the costs associated with acquiring and managing high-quality bulls, and improve calving rates (Kubkuhoma, 2018).

Despite these well-documented advantages, there is generally a low rate of AI technology adoption in rural communities, with an AI coverage of 3.25% recorded in Zimbabwe (Mlemba, 2011). The rate at which a particular technology is adopted in a community depends on how the technology is perceived (Ntshangase et al., 2018), the socio-economic attributes of the intended beneficiaries, their level of education, and linkage with extension structures (Adesina and Baidu-Forson, 1995). According to Tatlidil et al. (2009), technologies that are perceived negatively will have a low-to-zero adoption level. Ntshangase et al. (2018) highlighted that farmers have numerous reasons for adopting new farming technologies; some may be rational in their behaviour, and their perceptions may be influenced by the information available to them, community demographics, farm enterprises, cultural practices, and alternatives to the technology available to them. Therefore, there is a need to conduct studies to generate empirical data and insights on how communal farmers and stakeholders

perceive potential challenges and benefits that could be derived from adopting AI in communal cattle production systems as a cost-effective method of breed improvement. This information is critical for designing improved models and implementing methods for such technologies for better acceptance by farmers. This study was conducted to determine farmers' perceptions and demographic dynamics of cattle artificial insemination technology under communal farming systems in Zimbabwe.

2.0 Materials and Methods

2.1 Data Collection Site

The study was conducted in LIPS-ZIM participating wards in the Beitbridge district, located in Matabeleland, South province of Zimbabwe. The district was selected primarily because of the availability of farmers whose cattle were artificially inseminated by the Matopos Research Institute under the Zimbabwe Resilience Building Fund Program for Growth and Resilience (ZRBF-PROGRESS) project, the abundance of cattle produced under communal systems, and the representation of many rural parts of semi-arid Zimbabwe. Beitbridge is characterized by communal livestock production, where 1197 animals were inseminated between 2018, 2019, and 2020 in the communal areas. Mean annual temperatures in Matabeleland South Province range between 25 °C in summer months and 27.5°C during winter months. Rainfall in the province ranges from 300 to 600 mm per annum, with an average of 332 mm per annum (Matsa and Dzawanda, 2019). Vegetation varies from savannah in deep fertile soils to shrub savannah in shallower soils.

2.2 Data Collection Sampling Procedure

Farmers who participated in the ZRBF-PROGRESS funded cattle artificial inseminations conducted by Matopos Research Institute were selected as lead AI farmers for the survey. Lead AI farmers and farmers who were trained as community-based inseminators were selected with the assistance of agricultural extension and veterinary personnel involved in the ZRBF-PROGRESS AI program, as well as project implementation coordinators in the respective wards. The lead farmers in this study represent the farmers described by Kundhlande et al. (2014) as experienced model farmers who are utilized in demonstrating improved farming systems. Only three

targeted wards were employed because it has been observed that when in-depth interviews are to be conducted with a targeted group of respondents, the sample size will have a minimal impact on the outcome of the studies (Crouch & McKenzie, 2006; Marshall et al., 2013; Small, 2009)

2.3 Data Acquisition Strategy

A semi-structured questionnaire comprising closed- and open-ended questions was developed and validated prior to its administration to the targeted group of farmers who had previously participated in cattle insemination activities under ZRBF-PROGRESS, encompassing 80 households. Data collection was conducted by co-investigators and ward-based government extension officers (Agricultural and Rural Development Advisory Services) in wards 3, 5, and 11, utilizing digital means through an application called KOBO (see Appendix 1 for the questionnaire).

2.4 Inferential Analysis Approach

The data generated from the questionnaire were analysed using the Statistical Package for Social Sciences version 22 (Armonk, NY, USA). Descriptive statistics were used to determine frequencies, means, and ranges. The reliability of the data was assessed using Cronbach's α based on standardized items (0.952). A chi-squared (X^2) test with a 95% level of significance was used to measure the statistical association between the demographic characteristics of the participants and their perceptions of cattle artificial insemination.

3.0 Results and Discussions

Table 1 presents the demographic characteristics of the cattle farmers and their association with their knowledge of artificial insemination. This study assessed 80 farmers in Beitbridge regarding their understanding and perception of cattle artificial insemination. The majority of the respondents (78.85%) were male, with females comprising 21.25% of the sample. The household head gender distribution consisted of 67.5% males and 32.5% females. All participants reported awareness of the government-led ZRBF-PROGRESS implementing an artificial insemination program in their district. The predominant breeding method was uncontrolled natural bull mating, with artificial insemination considered in government-sponsored programs.

Gororo et al. (2017) and Nyamushamba et al. (2017) reported that the primary hindrance to breed improvement in the communal areas of Zimbabwe was uncontrolled breeding, which resulted in high levels of inbreeding depression and poor cattle reproductive performance (Tada et al., 2013). Isolating breeding cows may present a challenge, as 80% of the respondents indicated insufficient grazing in their communities (Figure 1). The majority of farmers indicated greater familiarity with natural mating than artificial insemination, having been exposed to AI for the first time between 2017 and 2020 (64%), despite varying years of farming experience (Table 3).

Table 1. Participant farmers' demographic profile, farming enterprise and experience and association with AI related activities

		Frequency (%) N=80	breeding method preference if AI is available		Did you have any say in AI semen selection		Do you prepare cows for AI		Do you keep Farm Breeding Records	
			Bulls	AI & Bulls	Yes	No	Yes	No	Yes	No
Gender of respondent	Male	63(78.8)	23(36.5)	40(63.5)	44(69.8)	19(30.2)	23(36.5)	40(63.5)	61(96.8)	2(3.2)
	female	17(21.3)	5(29.4)	12(70.6)	14(82.4)	3(17.6)	4(23.5)	13(76.5)	16(94.1)	1(5.9)
	P Value		0.771		0.374		0.395		0.517	
Age of the household head	<25 years	4(5)	3(75)	1(25)	4(100)	0(0)	1(25)	3(75)	3(75)	1(25)
	26-35 years	1(1.3)	1(100)	0(0)	1(100)	0(0)	0(0)	1(100)	1(100)	0(0)
	36-45 years	12(15)	5(41.7)	7(58.3)	10(83.3)	2(16.7)	7(58.3)	5(41.7)	12(100)	0(0)
	46-65 years	42(52.5)	12(28.6)	30(71.4)	28(66.7)	14(33.3)	28(66.7)	14(33.3)	40(95.2)	2(4.8)
	> 66 years	21(26.3)	7(33.3)	14(66.7)	15(71.4)	6(28.6)	17(81.0)	4(19.1)	21(100)	0(0)
	P Value		0.227		0.504		0.117		0.168	

Education Levels of household head	Primary/No Education	61(76.3)	19(31.2)	42(68.9)	43(70.5)	18(29.5)	21(34.4)	40(65.6)	2(3.3)	59(96.7)
	Secondary	13(16.3)	5(38.5)	8(61.5)	9(69.2)	4(30.8)	1(7.7)	12(92.3)	0(0)	13(100)
	Tertiary	6(7.5)	4(66.7)	2(33.3)	6(100)	0(0)	5(83.3)	1(16.7)	1(16.7)	5(83.3)
	P Value		0.211		0.291		0.005		0.190	
Occupation of the household head:	Off-farm self-employment	12(15)	4(33.3)	8(66.7)	8(66.7)	4(33.3)	2(16.7)	10(83.3)	11(91.7)	1(8.3)
	Formal employment	10(12.5)	4(40)	6(60)	7(70)	3(30)	5(50)	5(50)	10(100)	0(0)
	Farming	58(72.5)	20(34.5)	38(65.5)	43(74.1)	15(25.9)	20(34.5)	38(65.5)	56(96.6)	2(3.5)
	P Value		0.936		0.855		0.251		0.576	
Which farming enterprises do you have on your farm	Livestock only	5(6.3)	0(0)	5(100)	5(100)	0(0)	3(60)	2(40)	5(100)	0(0)
	Crop-livestock	75(93.8)	28(37.3)	47(62.7)	53(70.7)	22(29.3)	24(32)	51(68)	72(96)	3(4)
	P Value		0.094		0.155		0.200		0.649	

Number of years practicing farming	10 years	9(11.3)	4(44.4)	5(55.6)	8(88.9)	1(11.1)	4(44.4)	5(55.6)	8(88.9)	1(11.1)
	11-20 years	27(33.8)	8(29.6)	19(70.4)	20(74.1)	7(25.9)	6(22.2)	21(77.8)	27(100)	0(0)
	21-30 years	20(25)	6(30)	14(70)	13(65)	7(35)	9(45)	11(55)	18(90)	2(10)
	+30 years	24(30)	10(41.7)	14(58.3)	17(70.8)	7(29.2)	8(33.3)	16(67)	24(100)	0(0)
	P Value		0.709		0.894		0.605		0.138	

Nevertheless, most households expressed a preference for both breeding methods if available. No significant association ($P > 0.05$) was observed between sex and breeding method preference across all age groups. Cattle farmers aged 46–65 years constituted the majority of participants (52.5%), followed by those aged 66 years and above (26.3%). Notably, the economically active age group of 26-35 years demonstrated lower involvement in farming (1.3%) within the sample size. However, knowledge of cattle artificial insemination technology was not significantly associated ($P > 0.05$) with participant age across all parameters measured.

The educational level of most participants (76%) was at the primary level or below, with 16% and 8% of participants having reached the secondary and tertiary educational levels, respectively (Table 2). Educational level was positively correlated with the perceived level of satisfaction with AI, as 50% of respondents with tertiary education expressed satisfaction with AI, compared to 46% and 45% of farmers who had secondary and primary education, respectively. However, the differences were not statistically significant.

Significant differences were observed between the level of education and farmer cow preparation for AI ($P < 0.05$). Similar observations have been noted in other regions where it has been reported that the educational status of households is directly related to the perception of farmers in estrus synchronization, with illiterate farmers not preparing cows for artificial insemination in Ethiopia compared to educated farmers (Destalem et al., 2015). There was also no statistically significant association ($p > 0.05$)

between years of farming experience and knowledge of cattle artificial insemination. This may have been influenced by the fact that most participants (64%) indicated that they had no exposure to AI before 2017, when the ZRBF program was introduced in the district, regardless of years of experience (Table 3). This observation aligns with reports from earlier work by Gororo et al. (2017), who revealed that 40% of farmers in communal areas have never heard of the term assisted reproduction technologies (ART), with only 1% awareness of estrus synchronization for AI. Therefore, it is critical to continuously provide extension services to smallholder cattle farmers on the advantages of artificial insemination, detection of estrus, estrus synchronization for timed artificial insemination, potential problems associated with breeding, and good animal management practices. The findings corroborate the recommendations by Abebe and Alemayehu 2021, who suggested that knowledge and skill-based training should be provided regularly to both smallholder cattle producers and AI technicians, as it may enhance the technology's effectiveness and the attitudes of communal farmers towards cattle artificial insemination technology.

Table 2: Farmer education level in relation to satisfaction on AI

		Educational level of the household head			Total
		Primary	Secondary	Tertiary	
Are you satisfied with the overall AI service <i>P</i> =0.982	Yes	28 (45)	6 (46)	3 (50)	37 (46)
	No	33 (55)	7(52)	3 (50)	43 (54)
Total		61 (76)	13 (16)	6 (8)	80 (100)

Table 3: Relationship between years practicing farming versus when farm first heard about AI

		When did you first hear about artificial insemination			Total
		2017-2020	2010-2016	<2010	
Number of years practicing farming <i>P</i> =0.491	10 years	6	2	1	9 (11)
	11-20 years	15	5	7	27(34)
	21-30 years	13	1	6	20 (25)
	+30 years	17	1	6	24 (30)
Total		51(64)	9(11)	20 (25)	80 (100)

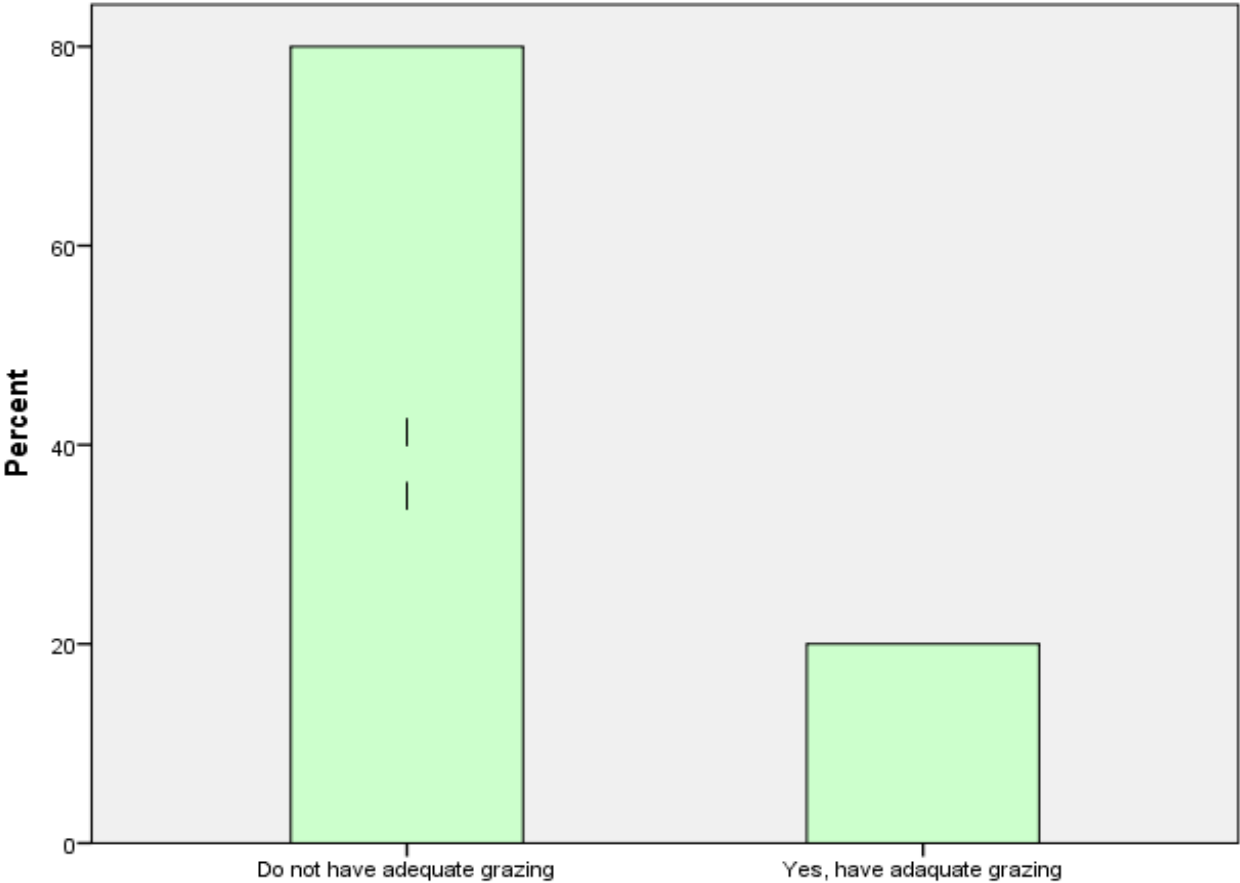


Figure 1: Availability of adequate grazing

Table 4: Farmer perception of AI technician's cooperation, access to AI service, satisfaction with AI service

		Ward 3	Ward 5	Ward 11	Total
AI technician cooperation $P = 0.991$	Cooperative	22(27.4)	23(28.8)	34 (42.5)	79 (98.7)
	Non-cooperative	0 (0)	0 (0)	1 (1.3)	1 (1.3)
	Total	22 (27.4)	23 (28.8)	35 (43.8)	80 (100)
Access to AI service post ZRBF $P = 0.611$	Have Access	1 (1.3)	0 (0)	1 (1.3)	2 (2.5)
	Do not Have Access	21 (26.3)	23 (28.8)	34 (42.5)	78 (97.5)
	Total	22 (27.4)	23 (28.8)	35 (28.8)	80 (100)
Satisfaction $P = 0.128$	Satisfied	11 (13.8)	14 (17.5)	11 (13.8)	37 (46.3)
	Not Satisfied	11 (13.8)	9 (11.3)	23 (28.8)	43 (53.7)
	Total	22 (27.4)	23 (28.8)	35 (28.8)	80 (100)
Do you have all the information you need on AI $P = 0.609$	Yes	6 (7.5)	8 (10)	8(10)	22 (27.5)
	No	16 (20)	15 (18.7)	27 (33.7)	58 (72.5)
	Total	22	23	35	80

The survey revealed that 79 (98.7%) farmers perceived the AI service technicians as cooperative across all three wards, with no significant association ($P \geq 0.05$) observed between ward and perception of farmer AI technicians (Table 4). However, almost all respondents did not practice AI outside government-sponsored initiatives, with 97.5%

of the farmers indicating that there are no cattle artificial insemination practitioners in the district, and 53.7% of the farmers reported dissatisfaction with the service due to lack of access to critical information on AI (72.5%). This sentiment was consistent across all wards, with no significant differences observed ($P > 0.05$). The results of the current study corroborate the findings of Juneyid et al. (2017), who reported that the majority of communal farmers in Ethiopia have a negative perception of using AI services because of a lack of locally based artificial insemination technicians and limited inputs. These findings indicate that farmers in the Beitbridge communal area are unable to access AI services when needed, particularly during the optimal insemination window for animals in estrus, to improve their animals' genetic potential and productivity. Only 22 of the 80 farmers indicated that they possessed comprehensive knowledge of AI across all wards, with 75.5% lacking full understanding of AI. These observations align with the findings of Gororo et al. (2017), who noted that only 1% of farmers had knowledge of synchronization, although some (59%) were aware of artificial insemination technology.

4.0 Conclusions and Recommendations

This study examined farmers' perceptions and determinants of artificial insemination (AI) technology in communal farming systems in Beitbridge, Zimbabwe. Factors such as demographic profiles, farming experience, education, and satisfaction with AI services were investigated. Findings indicate that education levels may influence satisfaction with AI services and that farming experience correlates with awareness of AI technology. The study also examined the availability of grazing, perceptions of AI technician cooperation, access to AI services, and overall satisfaction. Communal farmers in Beitbridge primarily use natural mating, with AI and estrus synchronization only during government or NGO-sponsored programs. Low AI adoption is due to insufficient awareness and lack of structured breeding programs, leading to uncontrolled mating in communal grazing lands.

Respondents noted challenges in implementing ARTs like estrous synchronization and AI due to the lack of local inseminators, relying on government programs, and insufficient information on insemination services. This inaccessibility to reproductive technology practitioners has limited AI and synchronization use in communal areas. The study recommends collaboration among cattle stakeholders to address

challenges in optimizing cattle productivity through ART. The ART project should ensure continuity beyond government/NGO periods by training government workers and lead farmers as inseminators and decentralizing service providers. Community-led sustainability frameworks should support government efforts in rural cattle farming.

Alternative methods for technology dissemination are needed as many communal farmers lack awareness of AI fundamentals, such as breeding equations and synchronization protocols. These results highlight the complex interplay of factors affecting AI adoption and perception in communal farming. The outcomes may improve AI implementation and acceptance in similar contexts. Further research is recommended to explore additional factors influencing AI adoption and develop strategies for enhancing AI program effectiveness in communal farming systems. The findings can guide policymakers and agricultural extension services in better supporting farmers in adopting and benefiting from AI.

STUDY HIGHLIGHTS

-  Farmers in communal areas overwhelmingly prefer natural mating over artificial insemination for cattle breeding.
-  Government and NGO-sponsored programs are the primary contexts for artificial insemination usage.
-  Artificial Insemination adoption is constrained by the scarcity of locally-based insemination services.
-  Limited knowledge of assisted reproductive technologies (ARTs) among farmers poses a significant challenge.
-  In communal grazing lands, unmanaged breeding practices are prevalent, with cows frequently mating with unknown bulls.
-  The shortage of structured breeding initiatives in communal areas impedes the adoption and effectiveness of Artificial Insemination.
-  ARTs require a collaborative stakeholder approach to boost cattle productivity in smallholder farming sector.

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Conflict of Interest declaration:

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Author Contributions:

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by SS; SW; XZ; AC; and ICJ. The first draft of the manuscript was written by BT; GT; TDM; and GS and all authors commented on subsequent versions of the manuscript. Review & editing to the manuscript were guided by NA. All authors read and approved the final paper.

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Climate Change Adaptation and Resilience Capacity Building in Sub-Saharan Africa: A Policy Framework Approach

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Abstract

Climate change related disasters are increasing in severity and frequency across Sub-Saharan Africa worsening an already desperate socio economic and political climate. El Nino induced droughts, floods, cyclones and related disasters have increased community vulnerabilities especially on the rural poor that make up the majority of the population of Sub-Saharan Africa. This paper argues that climate change has become an inherent and permanent aspect of contemporary development discourse and trajectories. Therefore, the study discovered that resilience capacity building rests only on a robust policy framework tailor made to respond to climate change induced vagaries for a particular region as opposed to a one size fits all approach borrowed mainly from western based multinational institutions. Research results show that policy decay has led to repeated and worsening vulnerabilities. Adaptation and resilience to such dangers, hence requires a deliberate, meticulous and well-balanced response strategy enshrined in an equally well thought and inclusive policy framework. It is argued therefore that policy decadence is the major cause of the worsening vulnerabilities and policy paradigm shift is the major catalyst to a climate change resilient community. The research relied mainly on qualitative research methods and the collected data was analysed using the exploratory analytical method. The finding of this research is that policy decadence has led to ever increasing vulnerability across Sub-Saharan Africa in general and Zimbabwe in particular.

Key words: Vulnerabilities, resilience, climate change, policy framework, adaptation, El Nino, livelihoods, Sub-Saharan Africa, qualitative research, exploratory

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1.0 Introduction

The third world in general and sub-Saharan Africa in particular has been facing a number of climate change hazards that have threatened socio-economic and political development. World over, climate change is no longer a debatable issue but a certainty and its effects are also no longer up for debate. The academia and climate related institutions generally agree that the developing world is the least emitter of greenhouse gases but is the worst hit by the effects of climate change compared to their more industrially advanced counterparts who, ironically, are responsible for most of the emissions. The region is prone to a number of socio-economic, political and environmental vulnerabilities that include a number of failed and fragile states. Instability across most of the third world has made the states weak and unable to adapt to or mitigate the effects of climate change. As alluded to by Clar et al (2013) and Abegunde et al (2019), political instability affects agricultural activities causing hunger and starvation as wars cause internal displacement and forced migration. Climate change has also led to economic challenges especially in countries reliant on hydro energy. The depletion in water levels has led to reduced electricity output leading to debilitating power outages that have affected small scale and large-scale industrial activities and enterprises as well as agricultural production ultimately leading to reduced income and worsening vulnerability. This challenge is exacerbated by numerous government changes and policy shifts such that there is lack of consistency in terms of climate change policy or indeed any development policy.

In some cases, knowledge gaps exist as the population of developing nations lack adequate awareness to the challenge of climate change. Any policy framework therefore should also aim to address this anomaly as argued by Aldunce et al (2010). Building capacity for adaptation, resilience and mitigation to climate change therefore requires a robust shift in policy where the policies are supposed to be inward looking taking into cognizance social, political, economic and environmental factors prevalent in the particular community. This notion is supported by studies such as those by Ambani and Percy (2014) that show the extent to which characteristics such as cultural heterogeneity, language and communication problems are barriers to policies of climate change adaptation. Poorly structured and poorly implemented policies usually do not have a positive impact on climate change capacity building or adaptation. This is enunciated in researches by Musolesi and Mazzanti (2014) who provide empirical

evidence supporting the idea that policies are critical in reducing carbon emissions but when they analysed the Kyoto protocol, they found no evidence showing that the protocol had led to a reduction in global carbon dioxide emissions a position supported by the findings by Boakye (2017) in his study of the same protocol. These scholars argue that the Kyoto protocol had several structural weaknesses that contributed to its failure.

The major questions which need answers in as far as climate change vulnerability in Sub-Saharan Africa is concerned are basically few but very pertinent. Firstly, what is the extent of Africa's vulnerability to climate change. Secondly, why do we have persistent and even worsening climate change vulnerability in most parts of Sub-Saharan Africa? What are the policy challenges existing in Sub-Saharan Africa that somehow contributes to the current vulnerability malaise?

Furthermore, what is the main answer to continued vulnerability, resilience and mitigation challenges of the populations of Sub-Saharan Africa? These are the key questions this research sought to find answers to.

Sub-Saharan Africa's climate change policy framework therefore should be premised on existing realities. Institutions should be strengthened and governance should be improved to allow effective policy formulation and implementation. Acemoglu (2010) lauds institutional strengths in adaptations to climate change and argues that without strong institutions climate change adaptation will never succeed. The region can take a leaf from South Korea's adaptation strategy which is hailed by environmentalists as a beacon of policy success from the setting up of green growth committees, green growth laws, smart adaptation policies, regulatory frameworks and decision-making processes. Collier et al (2008).

Sub-Saharan Africa should therefore implement technologically driven capacity building policies that hinge on food security, good governance, community inclusivity and political stability among a host of interconnected factors and aspects critical to effective climate change adaptation, resilience and mitigation. The study exposes policy deficit within Sub-Saharan Africa manifesting through increasing vulnerability to climate change related disasters. This information is well documented with the World Food Program (2022) Global Outlook report putting Africa's food insecurity at 150% increase since 2019. About 149 million Africans were food insecure with 122 million

living in countries facing conflicts. The same report suggests that about one in four people in 2022 faced severe food insecurity with Central Africa having 78.4% of the population facing food insecurity with Southern Africa at 25.9% being food insecure. Country statistics show high food insecurity prevalence in DRC with 24.4 million being food insecure, South Sudan 7.8 million people, Sudan 20.3 million and Ethiopia 20.1 million people. Burundi, Burkina Faso, Mauritania, Somalia, Niger and Eritrea are some of the most food insecure nations in the region owing in part to chronic armed conflicts that have displaced millions and disrupted agricultural activities.

Zimbabwe has had an increase in climate change vulnerability over the years epitomized mainly by food insecurity manifesting in the form of hunger and starvation especially at the turn of the millennium. The El Nino induced droughts, dry spells, cyclones and other related disasters have led to increased vulnerabilities across the country. In some instances, wide spread starvation was only averted by concerted efforts of multilateral aid agencies as was the case in the 2007 drought. It should be noted that in the first ten years of independence where governance and policies were relatively sound, vulnerability to climate shocks was low as compared to the new millennium era where national development policies were pivoted around political grandstanding more than national development. The new political dynamics around the year 2000 where the Movement for Democratic Change threatened to overthrow the ruling ZANU PF party saw the government abandoning good governance policies in favour of populist policies like the Land Reform Program which became a monumental disaster. In the meanwhile, there was no sound climate change policy to respond to the climate crisis and its related social, economic, environmental and political effects. The Zimbabwe National Climate Response Strategy and the National Climate Policy promulgated in the year 2014 were a direct result of an international requirement by the UNDPCC and though the wording of the document appeared lofty, it exposed a huge disconnect between the realities on the ground and the contents of the document. The creation of the National Adaptation Plan of October 2024 follows a very familiar and worrying path that Zimbabwe has followed over the years. This is mainly the creation of policy after policy, realise deficiencies in that policy leading to the formation of another one and the pattern goes on and on. The document appeared like a long wish list crafted in paradise. The proposed recommendations have or no way of being implemented under the current socio economic and political environment

prevailing. Worse still, only a small percentage of the population actually know the policy exists.

Zimbabwe in particular has had its share of policy challenges leading to increased vulnerability such that one year the country can declare a bumper harvest and good rains, the next, it is declaring a state of emergency. These fluctuations in vulnerability indicate failure of proactive planning and utilization of available resources to build resilience and provide effective mitigation measures against the vagaries of climate change that continue to affect the population with reckless abandon.

2.0 Literature Review

Climate change has been topical in contemporary development discourse with a number of nations placing it at the centre of development blueprints. There is a general and silent consensus among scholars that climate change is a key development issue. This has resulted in a number of initiatives to either curb climate change or effectively deal with its disastrous effects. Climate change induced hazards however, continue to wreak havoc across the developing world especially Sub-Saharan Africa. This therefore entails that the existing mitigation and adaptation policies, in limited cases where they exist, are failing to stem the tide of destruction and underdevelopment epitomized by growing abject poverty and increased vulnerability caused by climate change induced hazards. Scholars like Brunschwenger and Ingold (2023) and Bandielli (1976) as far back as 1976 attributed this phenomenon largely due to policy deficiencies in formulation, implementation or evaluation.

What this effectively means is that the vagaries of climate change continue to worsen because both mitigation and adaptation policies do not exist or are not being implemented effectively. There has been little literature on this aspect and there hasn't been much information on the effectiveness of climate change mitigation and adaptation policies in Sub-Saharan Africa and the recommendations thereof. Most scholarly work dwelt on the presence or rather absence of climate change adaptation and mitigation policies. This article calls for a thorough, scrutiny of the whole policy formulation and implementation process by African nations since this appears to be the major reason why climate change induced hazards continue to plague Sub-Saharan Africa. Masud and Khan (2023) are among the most recent scholars to explore policy implementation challenges to climate change adaptation and resilience

in the developing world. The two scholars focusing on Pakistan, concluded that the top-down approach to policy implementation has created policy misinterpretation and wrong policy goals. This has contributed to Pakistan's continued vulnerability that has placed it among the world's top '8' most climate change vulnerable nations. In recent years Sub-Saharan Africa has been focusing on trying to reduce carbon emissions as advocated for by the first world and multinational development institutions which provided funding for carbon reduction policies more than the more urgent adaptation policies. A number of scholars have criticized these policies crafted in the West in a totally different social, economic, environmental and political environment to be implemented in Africa without question in a copy and paste manner.

This research hence advocates for a more measured adoption of such policies adjusting them to suit the local environment since research conducted across the world show evidence of institutional failure which slows down policy planning and implementation. It has been proven too that financial constraints and political will are key factors negatively affecting climate change policies. In a study of San Francisco, Ekstrom and Moser (2016) discovered that lack of finance and political will were common impediments to adaptation. They discovered that the principality had sound policies that did not have any financial backing of the treasury hence several disasters had severe effects on the local people unlike in other cities close to it. This financial constraint challenge is paramount in Sub-Saharan Africa where a huge debt hangs like an albatross more likely militating against policy success though little research has been made to this effect. According to the IMF (2024) report, Africa owed Western multilateral financial institutions about 1.152 trillion dollars by end of 2024 or an equivalent of 24.5% of their GDP with some countries spending more on debt repayment more than critical services like health and surely climate change adaptation would be more of a luxury under such phenomena. Furthermore, studies in Kenya, Uganda, Ethiopia and Ghana by Ampaire et al (2022) expose lack of financial resources to implement a climate change adaptation plan which in any case, rarely appeared in the national development agendas. It has been noted further by a number of academics that funds towards climate change adaptation and capacity building even through the United Nations Framework Convention on climate change finance is grossly unable to meet the between USD 50 Billion to 500 Billion by 2050 needed to fight climate change.

As argued by Machingura et al (2018), Sub-Saharan African countries also do lack the political will to create solid policies and implement them successfully with a number of African nations ranked among failed states with the likes of Libya and Somalia coming to mind and an equally worrying number, being ranked among the highly corrupt. A good number that includes Mali, Burundi, DRC, Burkina Faso, Niger among others is entangled in perpetual conflicts and instabilities such that policy formulation and implementation becomes a huge challenge. OECD (2009). It has been noted too that climate change mitigation initiatives have become cash cows for corrupt bureaucrats with some climate adaptation funds from international donors and institutions disappearing into private pockets. Other scholars like Guja and Bedeke (2024) lamented fragmentation of climate change policy knowledge among the people as a key challenge to policy success a view shared by Jones et al (2015) who advocated for a bottom-up approach to policy formulation.

There exists a tendency by governments in Sub-Saharan Africa to view climate change as an environmental problem. Evidence suggests the contrary. Climate change has become a national development problem and relegating it to the periphery of development has led to increased poverty levels across the developing world especially Sub-Saharan Africa. Zimbabwe's climate change policy for example is the prerogative of the ministry of environment and tourism rendering it peripheral to development as well as being structurally deficient on account of its rather narrow outlook. This is especially so given the reliance of the country on Kariba dam hydroelectricity. There has been reduced electricity output with the Zambezi River Authority citing reduced water levels as the source of reduced electricity. This has multiple ripple effects including energy challenges which hits at the core of manufacturing and related productive and service sectors leading to declining GDP, reduced household income and worsening exposure to climate change vagaries.

Though blessed with abundant resources and generally good climate, Sub Saharan Africa remains caught and trapped in a quagmire of abject poverty and extreme underdevelopment that makes effective response to climate induced hazards very difficult. Large sums of unbudgeted financial resources continue to be poured towards unexpected climate change disasters creating a development vacuum that appears like it is never going to be filled. Adaptation and mitigation policies ought to start with acknowledgement and prior planning for these unforeseen natural hazards. Disasters

like cyclones and EL-Nino induced droughts continue to plunge the continent into ever present hunger crises. The already fragile conflict-ridden states have borne the brunt of these disasters with thousands of children being malnourished and starving to death. The frequency of these disasters recorded in literature and their effects shows a huge policy gap that can only be filled through a holistic approach that brings climate change adaptation and capacity building to the nucleus of development trajectories. These policies should be inclusive and cut across all sectors, should be well funded and religiously implemented and evaluated.

Nate (2023) highlighted that current global carbon emissions rates continue to skyrocket with the world expected to breach the critical 1.5% threshold by 2030 yet climate change adaptation funding meant for the least developed nations continues to decrease just as the devastating effects are increasing at an alarming rate. This challenge is also captured in The United Nations Environment Program (UNEP) (2023) report which lamented the injustices of the climate crisis where the wealthy countries, the main culprits in this climate crisis, have largely failed to assist developing nations to adapt to and mitigate the negative impacts of climate change. This therefore calls for a new policy paradigm shift in developing countries to craft homemade, inward looking, realistic adaptation and resilience capacity building policies that speak to the generality of the population falling victim to climate change.

The COP29 summit, like its predecessors, hastily pledged an increase in climate finance to \$300 billion by 2035 with the ultimate goal being \$1.3 trillion annual target. This target though most likely to fail on account of previous policy failure, falls far too short of the needed funding and there is no end in sight for fossil fuels use. There has been noise about transition to green energy but apart from a few experiments with solar energy and wind energy in some European nations like Denmark and Norway, the rest of the continent still lags far too behind in the clean energy transition. In fact, industrialised countries continue to rely on fossil energy such that any slight disruption as happened in the Russo-Ukrainian conflict rattled western economies pushing costs of living upwards. It appears therefore that even the COP30 summit to be held in Brazil from 10-21 November 2025 will see the usual glamour and rhetoric even as hunger and starvation continues to increase at an alarming rate across Sub-Saharan Africa. According to World Vision (2024) report 20% of the entire population is malnourished and a further 57 million facing hunger. An estimated figure of 868 million people are

said to have experienced moderate food insecurity in Africa in 2002 with one third of those facing severe food insecurity yet the future of climate finance looks even bleaker with the new US administration led by Trump withdrawing from the Paris agreement.

According to IPCC, (2018) and Roberts (2013) economically less developed countries have a higher risk of negative impacts by climate change than the more industrialised nations. These sentiments were echoed by Scheaneder and Waggerman (2012) who noted the effects of glaciers in the Himalayas causing flooding in Nepal, Bangladesh, Pakistan and parts of India. Khan et al (2010) observed the severe impact of the 2010 flood in Pakistan which affected about 20 million people. Aligisher et al (2022) weighed in arguing that anthropogenic climate change will cause about 1 billion people to face water shortage and drought by 2050.

In spite of all these widely recorded literatures of these disasters in developing countries, Singh et al (2017) and Spires et al (2014) discovered the absence of much literature on adaptation to climate risks in the underdeveloped world.

The research paper therefore argues that if climate change is to be combated effectively, there is need for improved policy decisions by governments as observed by Dupuis and Knoepfel (2013) who posit that effective climate change policies crafted for adaptation are the best way forward to institutionalize mechanisms that can help build resilience in different communities. This surely should be the best foot forward for Sub-Saharan Africa.

A careful analysis of Zimbabwe in particular exposes shocking structural policy deficiencies that led to increased vulnerability and reduced mitigation capacity against climate volatility. There is empirical evidence showing that Zimbabwe has been particularly prone to climate change induced disasters since independence with about three droughts recorded in the years 2015/16, 2019 and 2023/24. Each drought created its unique vulnerability of the Zimbabwean population as has been specifically explained by Matunhu (2012) and Chigora (2013). Both scholars discovered policy inconsistencies as a key factor in increasing climate change vulnerability. Sillah (2014) added gender and children dimension to vulnerability exposing how climate change has a paramount effect on women and the children. Of note, Mantoshi (2010) and Chitambara (2010) dwell on the Land Reform Policy as the beginning of vulnerability. Mandaza (2006), Makumbe (2002) and Moyo (2013) cite policy challenges as

precursor to poverty and economic meltdown of Zimbabwe. Zimbabwe has had a number of economic blue prints that have failed to trigger economic development since 1980 none of which put climate change at the centre of development. That was a fatal error that left Zimbabweans extremely vulnerable to cyclones like Eline and Idai that left a trail of destruction and worsening poverty. The country relies mainly on rain fed agriculture which in itself is susceptible to climate variability such that any slightly below normal rainfall spells drought and starvation.

As a response to international pressure, the Zimbabwean government adopted the National Climate Policy. This document was crafted by and limited to, the Ministry of Environment and tourism making it narrow in outlook. As argued in this study, a climate adaptation policy is expected to be holistic in outlook and takes into consideration various line ministries and institutions. The ministry of Energy, Agriculture, Local Government Finance among others are all very critical to the effectiveness of a climate response policy and their inputs are vital to climate mitigation and adaptation policy success but were largely ignored in the policy formulation stage.

The study exposes a policy vacuum that has led to incessant and often disastrous vulnerabilities. There are a number of policies none of which are effective enough to improve climate change adaptation and mitigation as well as resilience capacity building. The study advocates a paradigm shift that leads to the crafting of a holistic, all round, multi-faceted policy framework approach to foster effective climate change adaptation and resilience capacity building. Technology needs improvement, finance is needed, laws need to be changed, and energy needs to be transformed among other interconnected factors to be considered if the policies are to be effective.

3.0 Methodology

This study was mainly premised on the qualitative research paradigm though quantitative research was used to a limited extent. Qualitative research was carefully chosen in this study as it allows for an in-depth analysis of causal relationships between variables. With regard to policy effectiveness analysis in climate change policy formulation and implementation, quantitative methods are grossly unable to capture relevant information including a change in lifestyle, opinions of the community as well as general happiness and wellbeing in times of disaster. These are generally regarded as key policy outputs.

The sampling design used in this research was a non-probability sampling method. This sample was carefully selected through recommendations (snowballing) as well as specific characteristics critical to the research. In this case, the researcher specifically targeted key sources like renowned scholars, well known organizations and multinational institutions like WFP, FAO, IPCC among others. The researcher also targeted Zimbabwe's local institutions like the Meteorological department, Civil Protection Unit, Statistical office, key ministries like Ministry of Environment & Tourism, Ministry of Agriculture and Ministry of Finance among others. However, when interviewing key respondents in both urban and rural areas, the sample was chosen randomly as the researcher attempted to ascertain the level of vulnerability which included poverty levels, number of meals per day, access to education and other services, income levels as well as assets which could be used in times of crises among other measurements of vulnerability.

The researcher carried out about fifty random interviews in Harare and fifty unstructured interviews in Seke District with respondents of varying age groups. ten were elderly women, ten elderly men, ten youths, ten traditional leaders and ten girls.

These groups were carefully chosen because they represented the most vulnerable groups in the district. The data was then analysed using exploratory data analysis strategy. The researcher was able to notice key survival patterns and income generating activities which respondents conducted for survival. The research also looked for exposure to weather volatility crises among the respondents.

Since climate change effects are multidimensional and often cut across various social strata and situations, qualitative research helps to bring in a number of factors likely to contribute to the phenomena under study. Unlike quantitative methods that rely on extensive data, make assumptions that often produce generalised findings that do not reflect the diversity of outcomes and effects on different social groups, qualitative methods like focus group discussions offer a broader conceptualization of situations. Individuals usually have different opinions concerning the effectiveness of a policy. Mahoney (2010). With regard to climate change, it is essential to harness the different opinions of individuals with regards to a specific policy. It has been argued by a number of scholars like Acemoglu (2012) that for a policy intervention to be successful, it has to be accepted by the intended target population. There is evidence of a number of policies that have failed because the much needed buy-in from the general population

was absent. Bryman (2012) argued that qualitative methods enable a detailed analysis of different situations providing a deeper understanding of underlining systematic factors, how they interact and contribute to various levels of success in climate adaptation.

The study therefore made use of unstructured interviews, case studies, analysis of journals, climate change reports, country development reports among a number of qualitative methods. The paper is premised on the Moser and Ekstrom (2010) policy analysis principles. The argument is that there is need to examine problems that arise from planning to implementation stage of a policy. The study has simplified the whole framework and narrowed it down to general analysis of policy failure highlighting its importance in exposing areas which can be affected by a number of factors. The conceptual framework of the study also borrows from Gordon et al (1977) policy analysis research that emphasizes the need for policy evaluation in order to improve policy formulation where feedback is key to improved policy formulation. Using this approach, a number of policies on climate change across Sub-Saharan Africa were analysed leading to the conclusion that there is poor policy formulation. Semi structured interviews were used in this research with a number of interviews including with several officials from various ministries and organisations in Zimbabwe. Information from the Civil Protection Unity, Meteorological Services, Ministry of Environment and tourism, Ministry of local Government among a number of related ministries and institutions was solicited through these interviews. The data was mainly collected through open ended questions which solicited discussions from participants who included general public in the rural areas, chiefs and headmen included.

An extensive analysis of disasters and their effects across Africa as well as trends of poverty and general underdevelopment and possible causal factors was done through the study of reports and country responses to those disasters and effects thereof. The method adopted here was deemed sufficient and effective in leading to the conclusion that adaptation, capacity building and mitigation across Sub-Saharan Africa in general and Zimbabwe in particular fail at policy formulation and implementation stage. Therefore, most climate change induced disasters have severe effects because of policy failure.

4.0 Results

The findings of this research proved that the increase in climate change vulnerability is a direct result of policy deficiency and failure on the part of the governments. All literature sifted through showed the existence of a number of policies that sought to trigger economic growth but largely ignored climate change issues. As a result, when disasters struck the countries where ill-prepared to respond to the crises. Research showed too that large sums of money were being diverted from development issues to disaster mitigation with alarming frequency thereby contributing to a decline in economic performance which in turn lowered disaster preparedness. The net result was that any slight variability in weather led to crop failure, hunger and starvation. Even the climate change policy and the Climate Action Plan promulgated by governments were documents in isolation as there were no proper synergies between them and other related sectors like the economic sector, legal architecture and political reforms across most of Sub-Saharan Africa. Evidence suggests that climate change continues to increase and worsen weather unpredictability meaning therefore that all economic blue prints should live with this stark reality and put climate change resilience capacity building at the epicentre of every development trajectory.

The results of the research showed also that all the economic development policies being implemented by the governments of Sub-Saharan Africa have largely been affected by climate change leading to general community underdevelopment as budget are affected by costs of drought relief and post disaster rebuilding. Evidence gathered during the research also shows that climate change has political, economic, social and environmental effects that are interconnected like a web with each being affected by and also affecting the other.

It was discovered through a number of literatures that all those governments that have internalized climate change mitigation and adaptation in their development trajectories have successfully managed to build resilience and mitigation against climate change. Result shows that the recovery period in the event of a climate change related disaster has been very short in such countries. Key examples have been drawn from China, the European Union, Egypt and Mauritius among a number of nations that have successfully integrated climate change into their development plans and reduced vulnerability by significant percentages.

Countries that have carried out policy transformations pivoted around climate change resilience capacity building showed higher degrees of sustainability as indicated above. The communities from the mentioned case studies showed greater pace of development even during periods of severe droughts or cyclones. This resilience was mainly founded upon food security. The mentioned states have faced numerous droughts but have never declared state of emergencies or declared hunger or starvation. An analysis of their economic development policies showed seamless integration of economic, environmental, political and social policies hinging upon one another.

Closer home, Zimbabwe's perennial food insecurity and worsening poverty was also seen as a direct result of policy failure at formulation and implementation stages. The country is endowed with a multiplicity of water bodies and good soils yet the country goes around with a begging bowl with astonishing frequency. It was discovered during research that before the chaotic land reform exercise, a small percentage of the population was food insecure. Several droughts that occurred before the year 2000, though requiring some external assistances were not as disastrous as the post 2000 droughts that almost brought the country to the brink of total collapse. Even the national growth rate averaged upwards of 5% GDP in the first 20 years of independence only to shrink to negative figures after the land reform policy.

Research carried out showed worrying climate change vulnerability levels. 80% of the respondents interviewed in Harare and Seke rural area, lived well below the poverty datum line and also survived through menial jobs like brick moulding, selling mice and gardening. It was discovered, too, that 75% of the respondents mainly relied on rain fed agriculture for survival and had very few livestock which included cattle, goats and chickens. Some of the respondents claimed to have sold some of their livestock in the 2023-2024 El Nino induced drought and they did claim that some of the livestock had also perished due to the drought. Almost all of the respondents expressed knowledge of a number of donors present in their community. These donors dished out a few food handouts. About 20% of the respondents also claimed to receive presidential inputs every year though these, they claimed, were not adequate to cover the needed inputs. 80% of the respondents claimed to have failed to access the presidential inputs though they flatly refused to give reasons for the situation. The researcher later discovered that the area was politically charged with both poverty alleviation handouts and

presidential inputs being distributed along partisan lines hence the respondents feared political persecution.

When asked about existence of any government programs in the area, many expressed ignorance of same. It was a few donors like WFP that funded a few nutritional gardens near Dema Growth Point, close to Muda dam along Hunyani river. The researcher did notice too that the district was now home to hundreds of new settlers and mostly new home seekers who had acquired land from some of the respondents. It appears a new source of income in the district is illegal sale of ancestral land to home seekers. This has ultimately led to reduced pasture and farmland, compounding the vulnerability of the population. The research also showed that apart from Agritex workers, Census and Voter registration officials, no other government officials visit the area. This therefore explains why some of the government policies are out of touch with reality on the ground. No successful mitigation and resilience building policy can be formulated and implemented without prior assessment of the prevailing situation.

Through thorough analysis of the multiple journals and reports by multilateral institutions, renowned scholars and donor agencies show a worrying trend of worsening poverty and vulnerability to weather shocks across Sub-Saharan Africa in general and Zimbabwe in particular.

The challenges created by weather variability was worsened by a litany of economic policy missteps since 1980 including ESAP, the ill-fated Economic Structural Adjustment Program, the Zimbabwe government's involvement in the DRC war, War veterans gratuities of \$50-000 each, a number of high profile corruption scandals like the Willow gate, NOCZIM and GMB scandals towards the turn of the millennium sparking a dramatic rise in the cost of living and increased vulnerability to weather and climate shocks. Droughts created more starvation than before with the WFP (2003) country report showing a 43% increase in vulnerability and poverty from 2000 to 2003 and successive reports have shown the same worrying upward trend.

However, this research discovered that there was little investment in Agricultural technology accompanied by a shambolic land ownership and a legal framework that disincentivised agriculture through a number of controversial legislatures including but not limited to price controls of maize. Further to that, former commercial farmers

controversially lost farming land to a new breed of indigenous farmers including unproductive peasants. As a result, agricultural output plummeted by 70% on average yearly and recovery remained very elusive in spite of several policy interventions in the sector such that as climate change vagaries hit in 2002 and 2007 in the form of droughts, 90% of the population was left vulnerable and faced starvation to levels never known in Zimbabwean history. A catastrophe was only averted by Multinational Aid Agencies that rushed with food aid. Bizarrely, the Mugabe regime insisted that it was food secure.

These disasters showed that climate change vulnerability is a direct result of policy failure at a national level. The failure by the government to transform land into a security and bankable asset led to a decline in agricultural productivity and an increase in food insecurity especially when faced with climate change induced droughts.

5.0 Discussion

The research discovered that across the globe all countries that have implemented solid adaptation and resilience capacity building policies have largely averted climate change induced catastrophes and have significantly reduced vulnerabilities. Research by Ahmed et al (2009) shows that over the last half century western Europe and the USA have witnessed increased budgetary investments in climate change resilience mitigation, significantly reducing the vulnerability of the population by an annual average of 20%. Morton (2012) also noted huge investments made in agriculture and technology in western Europe, with the European Union's Common Agriculture Policy (CAP) being the most celebrated of the bloc's food security initiative, with an investment of about \$230 billion from 1997 to 2012. FAO 2024 report put the CAP agriculture investment at a whopping \$420 billion by 2025. EU farmers have been subsidized making the produce much cheaper than imports leading to food security.

However, as the west's vulnerability is decreasing steadily over the years, Schlenker and Lobell (2010) expose a very rapid increase of climate change induced vulnerability across the third world especially Sub-Saharan Africa especially on agriculture.

A number of countries in Sub-Saharan Africa are facing vulnerabilities of different proportions. Countries such as Niger, Mauritania, DRC, Burundi, Burkina Faso, Eritrea, Somalia, Ivory Coast among others have perennially been named by a number of multilateral institutions among the most vulnerable and fragile states in the world.

Kalinowski (2020). A quick look at these countries shows political insecurity leading to policy decay. The net result is increased vulnerability to climate change induced hazards. This therefore proves that without a solid policy base, populations are bound to face increased vulnerability as alluded to by Eborle et al (2020).

The research paper focused on assessing the major reasons behind the increase in vulnerabilities of Sub-Saharan African countries to climate change induced hazards as well as a lack of resilience and adaptation capacity building. This is especially so given that a number of mitigation, adaptation and resilience building policies have been implemented over the years with no meaningful impact. Presence of a number of policies and an increase in vulnerabilities indicates parallels between the two. Evidently, it is the policies which are either out_of sync with reality on the ground or simply not being implemented properly. This paper discovered the existence of data suggesting that in some cases, policies are so shambolic that they are actually deemed non-existent and, in some scenarios, they are poorly implemented. After a careful analysis of the patterns of vulnerability increase and existing policy frameworks, it was concluded that for sustainable climate change resilience capacity building the whole policy framework needs to be dismantled and be replaced by more pragmatic, holistic and tailor-made policy framework that takes into cognisance socio-economic, political and environmental factors prevalent in a particular community.

The paper discovered that the major negative outcome of climate change which is food insecurity is a direct result of policy failure as governments fail to provide holistic policies that respond to the effects of climate change especially climate variability that has adversely impacted on agriculture, the mainstay of the undiversified economies of the third world. It was noted that the agricultural sector employs about 60% of the third world work force and is connected to all other sectors. For example, drought leads to reduced demand for agricultural inputs and machinery meaning that those industries do suffer leading to reduced production as well as ensuing job cuts thereby worsening vulnerabilities. It was established too that overreliance on hydro energy like the Kariba dam hydro energy plant has led to severe economic challenges epitomized by electricity challenges. The resultant power cuts affect severely, Small to Medium Scale enterprises and the informal economy which make up the majority of the population's means of survival. It means therefore that energy challenges resulting from climate change reduces national growth as well as compromising livelihoods. Mugano (2022)

has noted that Zimbabwe's economy is very informal and this makes it highly susceptible to climate shocks.

The study further unearthed abundant evidence of monumental policy blunders that have led to national catastrophes in history. The great leap famine that occurred between 1959 and 1961 that killed about 15 million people in China was, according to Hoddinot (2006), a direct result of Mao's failed policies that disrupted food production as agriculture was now centrally planned and controlled by central government. People were driven into communes or cooperatives whose production was appropriated by the state and distributed at its discretion. Hence other scholars argue that food was available but was not well distributed yet others argue that food output was reduced. Following Hoddinot's analysis, policy failure led to mass starvation.

The second such disaster caused by human policy failure was the Bengal famine of India that occurred in 1770 where about 3.8 million people are deemed to have died due to policies put across by the British East India Company including mass purchase of rice for the army. The Indian Gomasthas also created monopolies of grain such that rice prices rose steeply and the ensuing drought worsened matters leading to mass starvation. Dell et al (2012).

These two examples clearly show how policy failure leads to disasters, catastrophes and hence worsening vulnerabilities. Such policy gaffes are repeated across the developing world at an alarming pace. A combination of poor governance systems that lead to poor institutions coupled with chronic wars that have gone on for decades across sub-Saharan Africa have disrupted food supply and increased presence of food insecurity often requiring food aid from multinational organisations like USAID and Oxfam.

A quick look at current national policies would show a very disturbing legal framework and architecture that has led to perennial food shortages across Sub-Saharan Africa. Sachikonye (2012 looking at Zimbabwe, discovered that the country declined from being the bread basket of southern Africa at the turn of the millennium to being a basket case owing to disastrous land reform policies that were carried out with little regard for social and economic implications. The result was that the land reform policy led to an increase in food insecurity from the year 2000 upwards owing to an average food crop reduction of about 80% according to FAO (2008). These results were

collaborated by WFP (2010) country report which put agricultural output decline at an average of 75%. The government attributed these to the droughts of 2002 and 2007 yet evidence suggest that since independence in 1980, Zimbabwe has faced a number of droughts some of them worse than the contemporary ones yet the level of food insecurity was not as severe as currently obtaining thereby suggesting the presence of other factors which included land management policies. It should be pointed out that the government changed the land management and ownership laws by bestowing all the land into the land of the government through the infamous Chidyausiku ruling of 2005. Hungwe (2014).

Title deeds were banished and all land was bestowed into the hands of the president. What it effectively meant was that land was no longer bankable as the 99 year leases that replaced title deeds did not attract investment as banks refused to offer agricultural loans. Various efforts in injecting life into the sector provided futile as the bank tasked with spearheading agricultural turn around, Agribank, suffered from cash challenges. Agro checks and presidential inputs also failed to tame the slide. The net result of this policy was that any slight decrease in rainfall, led to food shortages as the country also failed to invest in new and modern agricultural technologies. Matunhu (2012). As has been noted earlier on, a number of countries like Egypt and Israel which receive less than 20% of the annual rainfall received by Zimbabwe are always food secure showing that it is actually not about rainfall but government's agricultural policy. The government has recently proposed to reintroduce title deeds in an effort to rejuvenate agriculture and whether this will bear fruits remains to be seen. The government, therefore, ought to make agricultural development a policy priority and that is only possible through a number of innovations and policy changes that address both land ownership and utilization challenges. The government is also expected to increase agricultural budget to include new technologies and necessary weather information to improve productivity.

Zimbabwe also has had its share of general policy challenges over the years. In no chronological order, these included the Growth with Equity, ZimAsset, STERP I, STERP II, MERP and NERP. Kinsey (2004) noted that none of these policies put climate change at the center of national developments plans. As a result, the county's development path continued to face hurdles because quite huge chunks of the national budget would go towards hunger alleviation. Tibaijuka (2005) report on effects of

Operation Murambatsvina noted increased urban poverty and vulnerability triggered by policy missteps like murambatsvina. The authorities seemed to have learnt very little from the perennial_droughts as evidenced by the absence of a robust climate change adaptation and mitigation strategy.

This paper proposes that climate change adaptation and capacity building should hinge on food security premised on agricultural transformation which, itself, should not be tackled in isolation. There is an urgent need for revision of land use, land tenure and land management laws. There is need also to be proactive in anticipating droughts, flooding and other related hazards. Adaptation policies should target small communities which are supposed to be included in the development strategies and policies being implemented.

6.0 Recommendations

The study recommends the following measures to enhance climate change adaptation, resilience and mitigation policy making and implementation processes. These recommendations are premised on the fact that climate change adaptation success pivots around meticulous policy planning and implementation.

Firstly, there is need for inclusivity when formulating climate change policies. The input of different stakeholders is critical in making a climate policy successful. The research advocates for integration of information from various stakeholders in order to have a solid adaptation and mitigation policy that is effective and also speaks to the generality of the community. Community engagement is therefore key in this endeavour.

Secondly there is need for governments to place climate change adaptation and mitigation at the centre of any development blueprints. It was discovered in this research that climate change is worsening vulnerabilities because national development plans exclude climate change adaptation, resilience building and mitigation.

Thirdly, the research recommends improvement in governance where institutions dealing with climate related issues are strengthened and capacitated so that there is national stability as these are vital conditions for sustainable development. There is evidence that countries with strong institutions and good governance have higher chances of positively reacting to climate change vagaries. Many countries in sub-

Saharan Africa are politically unstable thereby making resilience, adaptation and mitigation difficult.

Fourthly, the governments of developing nations should prioritise information technology innovation to spearhead green economies and smart energy development initiatives that can drive smart agriculture development to improve food security. Irrigation schemes have to be enhanced to substitute rain fed agriculture that is exposed to climate and weather volatility.

Finally, it is recommended that governments prioritise adaptation and mitigation in their national budgets to cater for crises like the recent El Nino induced drought that severely hit southern Africa prompting governments of Zimbabwe and Zambia to declare state of emergencies. These state of emergencies impact negatively on other development programs and projects as unbudgeted expenditure. It should be noted that these recommendations are not exhaustive and as climate change data continues to filter in, new measures should be analysed for possible implementation.

7.0 Conclusions

The study concluded that sub-Saharan Africa in particular and the developing world at large is increasingly becoming vulnerable to climate change. A number of policies implemented to improve capacity for adaptation and mitigation have largely failed as starvation, malnutrition and susceptibility to other climate change related hazards continues to worsen.

This therefore points to the fact that, to a large extent all policies that were initiated to tackle challenges of climate change have largely failed. The research unearthed a number of impediments to policy success and this include poor policy formulation and non-implementation of formulated policies.

In most sub-Saharan Africa climate change policy formulation is relegated to institutions that deal with weather and climate or environment. This is a grave error that has contributed to policy failure since it has been noted that climate change affects and is also affected by almost all facets of existence be they environmental, social, political or economic. As a result, the research advocates for an inclusive all stakeholders approach to climate change policy formulation and implementation to enhance adaptation and resilience capacity building.

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Community-Led Conservation: Mitigating Wildlife Conflict Through Collaboration

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Abstract

This study examines the relationship between Human-Wildlife Conflict (HWC) management and Community-Based Conservation (CBC), highlighting the part that local communities contribute in promoting sustainable wildlife management practices. The study underlines the importance of cooperative approaches based on community agency and stewardship are to the management of HWC and biodiversity conservation. The study employs a mixed method approach, and the researchers used focus groups and expert interviews to gather the needed data in the Save Conservative area (Chivi, Mwenezi & Chiredzi Districts). A sample size of 300 for quantitative method and 20 for qualitative method were used. The findings of this research were (1) collaborative governance, local knowledge and social-ecological resilience in Human-Wildlife Conflict is important and, (2) human wildlife conflict is a major challenge for conservation efforts. In light of these results, it was determined that community involvement in decision-making is essential because it fosters community ownership and engagement, which results in better conservation outcomes. Furthermore, there is need for collaborative management as it promotes community engagement and ownership.

Key words: Community-Based Conservation, Human-Wildlife Conflict, Conflict Management, Collaborative Governance and Social-Ecological Resilience.

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1.0 Introduction

Human-wildlife conflict (HWC) is a prevalent challenge, especially in African countries, with the potential to wipe away all the global biodiversity conservation and sustainable development gains achieved so far (Long *et al.*, 2020, Egriet *et al.* 2022) as cited by Zvidzai *et al.*, (2023). Because human activities are intruding into wildlife areas, HWC is becoming a more urgent global. Human–wildlife conflicts (HWCs) are a worldwide problem, especially around protected areas where human and wildlife need overlap (Chakuya *et al.*, 2023; Pisa and Katsande, 2021 and WWF, 2021). With climate change projections for Southern Africa pointing to drier conditions (Feng & Fu, 2013; Ragab & Prudhomme, 2002), the intensity of human–wildlife conflict is likely to increase (Matema *et al.*, 2022). In their research, Chakuya *et al.* (2023) highlighted that climate change plays a further role in aggravating HWC. Alterations in food and water availability due to severe droughts, temperature changes and flooding force wildlife to migrate in search of more suitable habitats. HWC is often triggered when people and wildlife compete for limited resources in the form of space, food, and water, (Zvidzai *et al.*, 2023).

The roots of HWC are deeply intertwined with human encroachment into wildlife habitats, which has been accelerated by urbanization, agricultural expansion, and infrastructure development (Chakuya *et al.*, 2023). Jeke (2014) highlights that the conflicts are exacerbated as humans encroach on wildlife corridors and, potentially, as wildlife repopulate human-dominated landscapes. The core root of the problem is being caused by conflicts which are brought on by increases in both human and wildlife populations where the wildlife territories are expanding into the regions where people live and on the other hand, human settlements are encroaching into protected areas. One of the key aspects of the 2000 land reform programme was an emphasis on the direct redistribution, equity and land for crops, with little attention on wildlife management (Dhliwayo *et al.*, 2022 and Wolmer *et al.*, 2004). This intentionally or unintentionally resulted in the 2000 land reforms transforming all the affected areas such as the Save Valley Conservancy (SVC) significantly and in certain circumstances converted wildlife areas into agricultural land (Dhliwayo *et al.*, 2022 and Scoones *et al.*; 2012).

Accordingly, HWC tend to manifest when, wildlife physiological requirements are deemed to prove direct or indirect negative consequences on the aims and aspirations of humans, (Zvidzai et al., 2023). These interactions often lead to adverse impacts on human life, property, or livelihoods (Redpath et al., 2017). As human populations continue to grow and settle in proximity to natural ecosystems, the frequency and intensity of these conflicts are expected to rise (Owen-Smith et al., 2022). The communities and wildlife in the Save Valley Conservancy (SVC) in southeast Zimbabwe have been significantly impacted by this conflict. It has resulted in a decreased space for game, declining wildlife populations and the contentious sharing of limited space between humans and wildlife (Stoldt et al., 2020). HWC has an enormous financial effect, especially on rural areas that depend mostly on agriculture and livestock. These consequences are particularly noticeable in areas where people and wildlife live side by side, making interactions common. Livestock predation by large carnivores, such as lions, wolves, and hyenas, can lead to significant financial losses for farmers, which can directly dissuade them from engaging in conservation efforts aimed at protecting these species (Mishra et al., 2021).

In India, for example, a study conducted in the Indian states of Madhya Pradesh and Uttarakhand found that the annual economic loss due to livestock predation can reach upwards of \$1,500 to \$2,000 per household, a staggering amount for communities that often live on a few thousand dollars a year (Mishra et al., 2021). As people try to maintain their agricultural productivity while replacing animals that perish or making investments in preventative measures, this economic strain may end up in cycles of poverty.

Moreover, the destruction of crops by herbivores such as elephants, deer, and wild boars can lead to food insecurity, particularly in regions heavily dependent on subsistence agriculture (Hazzah et al., 2019). These animals' crop raiding may destroy crops, resulting in both immediate financial losses and long-term effects on communities' access to food. Occasionally a family's ability to sustain itself for a whole season is dependent upon the loss of a single crop. This exacerbates the cycle of economic vulnerability, fostering resentment toward wildlife, which can often result in retaliatory killings a phenomenon that frequently negates conservation efforts (Treves et al., 2021; Maxwell et al., 2016; Nyumba et al., 2020; Mayberry et al., 2017; Sampson et al., 2021;). The opportunity costs associated with HWC are another critical aspect

in understanding its economic impacts. For instance, when farmers lose livestock or crops due to wildlife interactions, they may turn to less sustainable agricultural practices such as overgrazing or increased use of pesticides to protect their crops (Owen-Smith et al., 2022). These actions undermine the natural resources that these populations eventually rely on by endangering local ecosystems and causing long-term decreases in biodiversity.

Given these difficulties, tackling the financial effects of HWC is essential to creating conservation plans that work and are accepted by the community. This calls for specialized interventions that can improve community resilience, like programs to make up for losses caused by wildlife and encouraging non-agricultural and non-livestock livelihood options. Communities may be more inclined to embrace conservation techniques that safeguard their means of subsistence as well as the species they interact with if financial incentives are established. The Government of Zimbabwe's conservation philosophy is underpinned by a holistic human–wildlife conflict mitigation approach, exemplified by the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), implemented since the late 1980s (Matema et al 2022). The guiding philosophy of CAMPFIRE is sustainable rural development that enables rural communities to manage and benefit directly from indigenous resources (Child 1996). Although extensively supported by most indigenous Zimbabweans, CAMPFIRE's approaches and implementation remain embedded in colonial ideology (Dzingai 1995). The programme is largely directed by external organisations and the private safari operating industry and business and operational agreements are mainly between Rural District Councils and the private safari industry (Murombedzi 1991). Human-animal conflict is still a major problem that has not been effectively resolved in Zimbabwe (Mhlanga 2001).

In addition to economic consequences, human-wildlife conflict often causes significant psychological distress for affected people. People's daily routines, social interactions, and farming practices can all be altered by a persistent fear of wildlife attacks. The emotional toll of living under the threat of wildlife, especially among vulnerable populations such as women and children can contribute to increased anxiety and stress levels (Davis et al., 2021 and Jeke 2014). Positive attitudes toward wildlife can be cultivated through community involvement and education, which highlight the ecological roles and benefits of wildlife conservation. Implementing effective education

programs that promote coexistence, the ecological importance of wildlife, and alternative strategies for managing conflict can help mitigate fear and enable communities to appreciate wildlife as valuable ecological partners (Davis et al., 2021). through Problem Animal Control, wildlife managers and rangers have been instrumental in intervening in HWC conflicts (PAC; Gandiwa et al., 2012 and Dube & Kavhu 2022).

Therefore, a comprehensive understanding of HWC needs to take these psychosocial aspects into account. More successful instructional and engagement methods might be framed by acknowledging that unfavourable attitudes of wildlife are frequently rooted in first-hand experiences of conflict. In the end, lowering the psychological and social aspects of conflict between people and wildlife necessitates all-encompassing strategies that incorporate financial assistance, community education, and active participation in conservation decision-making. A more peaceful cohabitation between people and wildlife can be achieved by addressing these many variables, opening the door for sustained coexistence. Therefore; this paper is going to address the research's main question which is how can community-led conservation initiatives, through collaborative approaches, effectively mitigate human wildlife conflict and promote coexistence between humans and wildlife?

The following hypothesis were tested the:

H₁: There is no difference on human-wildlife community incidents between community-led community and non-community-led areas.

H₂: there is no relationship between community engagement and livelihood engagement.

1.1 Theoretical Frameworks on Community Participation

A strong theoretical basis is necessary to comprehend conflicts between humans and wildlife as well as the efficacy of conservation measures. A number of frameworks provide light on the interactions between wildlife and human populations, highlighting the significance of local participation in conservation initiatives.

1.1.1 Traditional Ecological Knowledge (TEK)

Traditional Ecological Knowledge (TEK) is defined as “a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment” (Berkes, 1993, p. 3). This definition concurs with the observations of most scholars namely, that such a knowledge system is dynamic, cumulative, evolving, place-based and geographically specific (Johnson, 1998; Charnley et al., 2007). TEK is rooted in social institutions (governing through customary rules, prohibitions and sanctions) (Osemeobo, 2001; Adom et al., 2016; Sinthumule and Mashau, 2020). It also encompasses worldviews or cosmology (beliefs, spirituality, sacred objects) of local people (Melaku Getahun, 2016; Kosoe et al., 2020) that shape environmental perceptions, factual observations and experiences, as well as resource management systems and practices (Joa et al., 2018). Such knowledge has been aided in the development of scientific management plans and is becoming more widely recognized as a source of data for natural resource conservation, management, and sustainable usage (Fritz et al., 2019).

In Africa, various scholars have reported the use of different (categories) but interrelated forms of TEK in the current research (Sinthumule (2023). These include taboos and totems, customs and rituals, rules and regulations, metaphors and proverbs, traditional protected areas, local knowledge of plants, animals and landscapes, and resource management systems (Sinthumule, 2023). These categories of analysis in traditional knowledge and management systems are based on a knowledge-practice-belief framework introduced by Berkes (1999). The communities who have taboos in their culture do not necessarily perceive them as instruments of resource conservation; however, they play an important role in conservation of natural resource (Sinthumule and Mashau, 2020).

Natural resources are critical to the lives and livelihoods of local communities, particularly in developing nations (Sinthumule (2023). To avoid ecological destruction and degradation, natural resources are protected through customary laws and regulations that help to facilitate common agreement on the use or non-use of a particular ecosystem service (Boafo et al., 2016; Asmamaw et al., 2020). These rules and regulations do not function independently; they usually complement other aspects of TEK such as taboos, sacred sites and resource management systems (Nadasdy

1999). Traditional rules and regulations on natural resources are achieved through strict sanctions and fines that are charged to offenders who are found to have violated such rules and regulations (Jimoh et al., 2012; Bofo et al., 2016; Mavhura and Mushure, 2019; Asmamaw et al., 2020). In Zimbabwe, penalties can be in the form of livestock or buckets of grain to the traditional leaders (Mavhura and Mushure, 2019). As a result, TEK offers crucial ecological insights as well as a network of knowledge that incorporates principles that might aid in ecosystem restoration (Haq et al., 2023). By integrating TEK into conservation policies and practice, organizations can promote a sense of ownership among local stakeholders. Such integration not only enriches biodiversity conservation efforts but also affirms the rights of indigenous peoples, ultimately fostering a more inclusive approach to environmental management (Berkes, 2012).

1.1.2 Social-Ecological Systems Theory

Social-Ecological Systems (SES) Theory provides a conceptual framework for understanding the interconnectedness of human and natural systems (Berkes & Folke, 1998). With the increase of a series of uncontrollable extreme climate events (such as drought, flood, snow disaster, etc.), the vulnerability of human society and ecosystem to climate change is gradually exposed, that is, the vulnerable nature of social-ecological system to climate change disturbance and pressure, which shows that the system is developing in a direction that is not conducive to its own stability and human interests (He, Zhou & Ahmed, 2021). The concept of social–ecological systems has been shown to analyse development issues arising from complex interactions between people and the environment on a regional scale (Folke et al., 2016; and Steffen et al., 2011), and is based on the perspective of *“the division between society and natural system is artificial and arbitrary”* (Berkes & Folke 1998). Social–ecological systems, also known as a *“composite human–earth system”* or *“composite human–nature system”* (Wang et al., 2018; Fischer et al., 2015), refers to the coupling system with complexity, nonlinear, uncertainty, and multilayer nesting characteristics formed by the interaction between human beings and the environment (Wang et al., 2020; Gain et al., 2020). In this regard, Flint, Kunze, Muhar, Yoshida, and Penker, (2013), indicate that the theme, traits, purpose, and character of human study can all be used to classify the interaction between the social system and the natural ecosystem.

1.2 Methodology

1.2.1 Study Area

Three regions surrounding the Save Conservancy, thus Chivi, Chiredzi, and Mwenezi, were examined in the research study. It is situated in the Masvingo Province in the southeast of Zimbabwe. Respondents were selected from the Sengwe, Tshovani, Chitsa, and Marimba communities. The ownership and operational structure of the SVC are now markedly diverse (Dhliwayo et al. 2022). In its northern part, which was not affected by the land reform, most properties are supported by Bilateral Investment Promotion and Protection Agreements (Kreuter et al. 2010). Lahiff, and Scoones, (2003) posits that in the southern region of the SVC, land reform brought significant changes. Large settlements in the western and eastern areas have led to wildlife areas being transformed into crop and livestock spaces (Scoones et al., 2012; Wels, 2000). The other remaining wildlife pockets in the SVC are now under the custodianship of the Zimbabwe Parks and Wildlife Management Authority (Dhliwayo et al 2022).

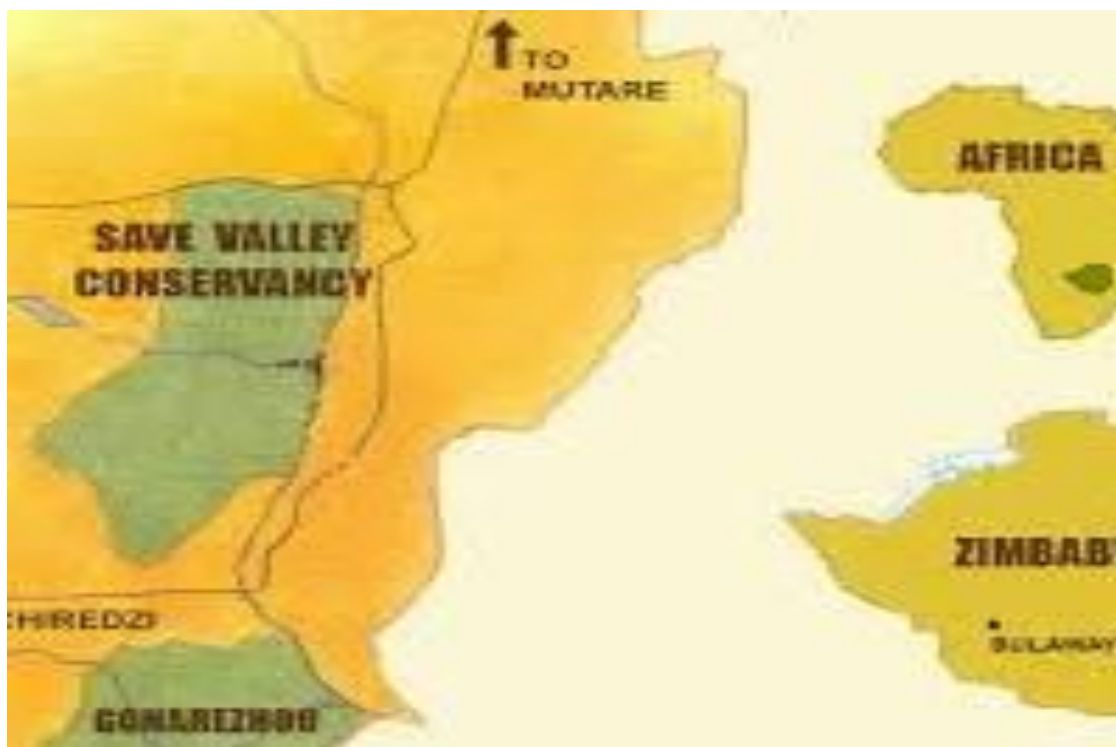


Fig 1: Save Valley Conservancy, Zimbabwe

1.2.2 Study methodology

The study used a mixed method approach where 300 questionnaires were distributed to respondents. Interviews were done to 20 respondents using purposive sampling method as well as focus group discussions were held with key informants from the communities and conservation stakeholders. Participants were also assured that their contributions would be strictly used for academic purposes and would remain confidential, with the guarantee that no information would be divulged to anyone outside the research context (Ferreira & Serpa, 2018). Data analysis used both descriptive statistics to and thematic analysis from interviews and focus group discussion data.

The regression analysis is used to understand the relationship between a dependent variable and independent variable. In this case the dependent variable is livelihoods improvements while the independent variable is the community engagement. This is a linear regression analysis, given by the following formula.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon$$

Where Y = dependent variable

X = independent variable

β = Beta coefficient

ϵ = Epsilon (error term)

1.3 Results

1.3.1 Demographic data

1.3.1.1 Response rate

The response rate for the questionnaire was 100 percentage, which is considered excellent depending on context.

1.3.1.2 Age Distribution & Engagement

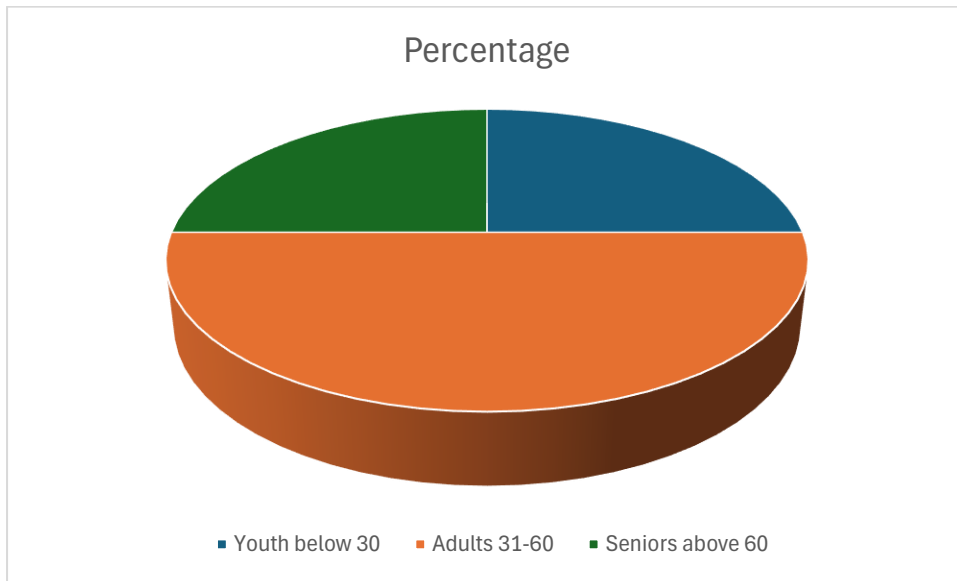


Fig 1.2: Age distribution of respondents

Source: Field data

Fig 1.2 shows the age distribution of the respondents, the youth accounted for 25%, the adults and seniors accounted for the 75%.

1.3.1.3 Gender Dynamics and Roles

Table 1.1 Involvement in Conservation:

Gender	Total	Percentage
Female	120	40
Male	180	60

Source: Field Data

From Table 1.1, 40% of females participate in community meetings while 60% males participate in decision-making.

1.3.1.3 Ethnic & Cultural Composition

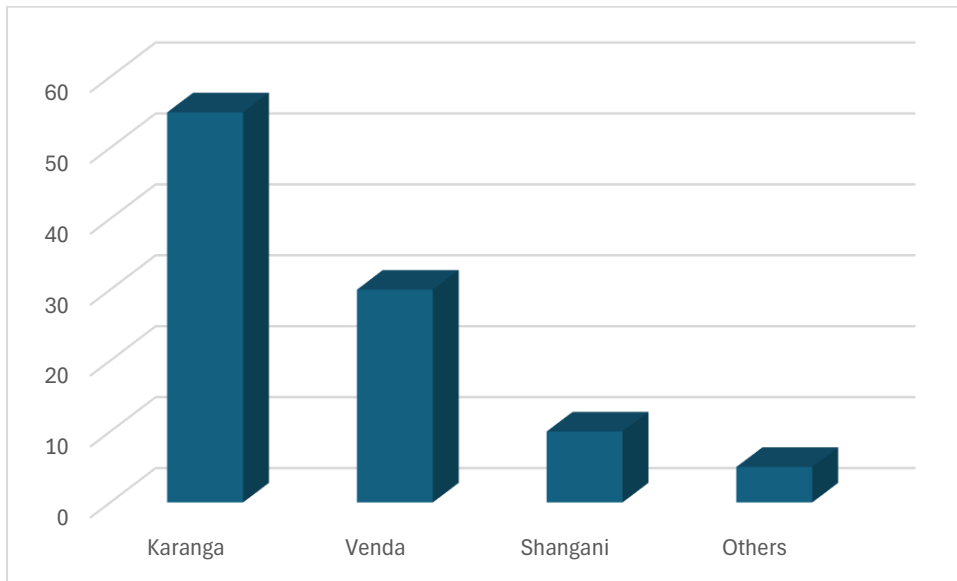


Fig 1.3 Ethnic and Cultural Composition

Source: Field Data

Fig 1.3 shows that the Karanga Ethnic group dominates the respondents.

1.3.1.4 Education & Literacy Levels

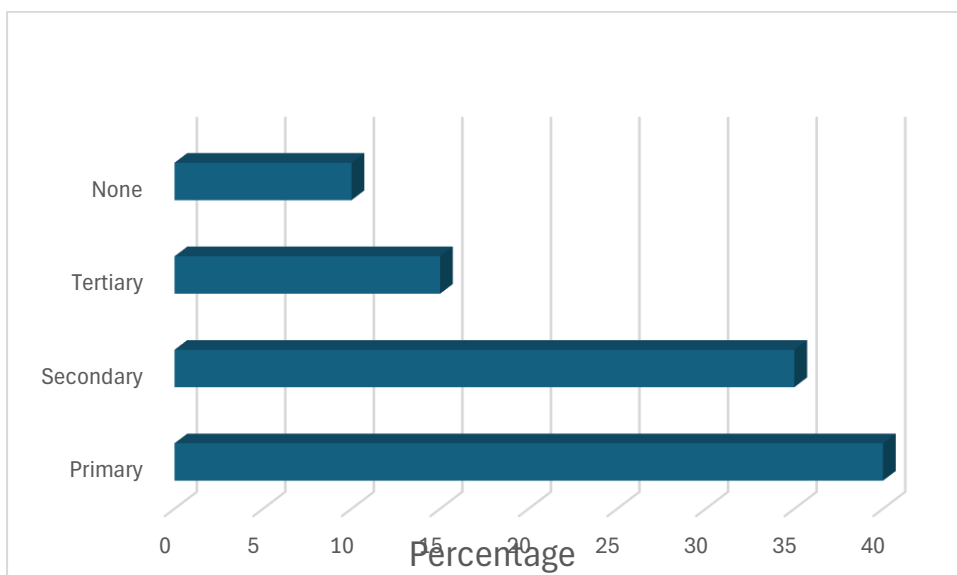


Fig 1.4 Education and Literacy Level

Source: Field data

From Fig 1.4 above, 10% of the respondents are not educated.

1.3.1.5 Livelihood & Dependency on Natural Resources

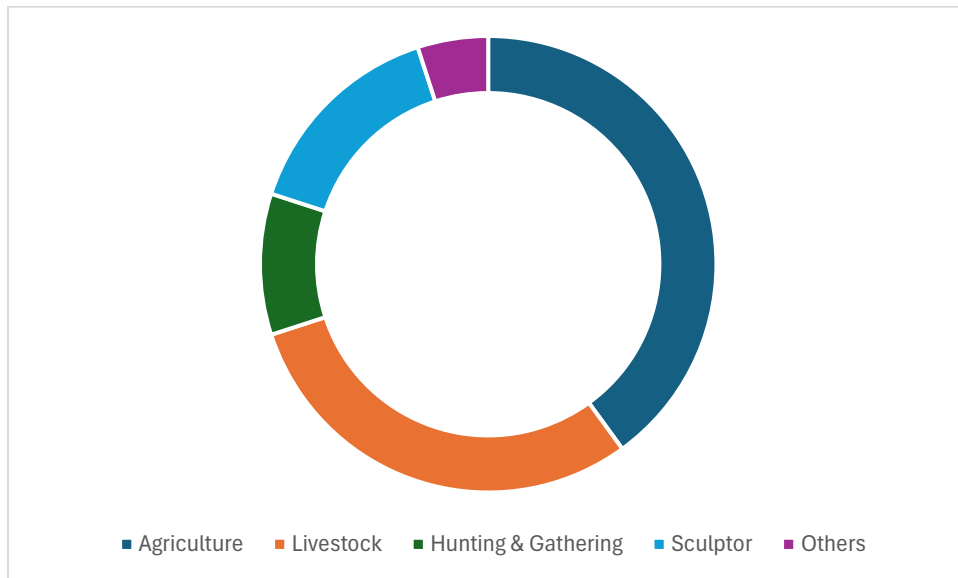


Fig 1.5 Livelihood & Dependency on Natural Resources

Fig 1.5 shows wildlife conflict drivers of livestock and agriculture account for a combined 70%.

1.3.2 Quantitative Results

1.3.2.1 Descriptive statistics

Table1.2 Reduced HWC

Category	Frequency	Percentage
Crop damage	120	40%
Livestock depredation	90	30%
Property damage	60	20%
Human injury	30	10%
TOTAL	300	100%

Source: Field data

The results show that crop damage is the most common type of human wildlife conflict incident, accounting for 40% of all incidents, followed by livestock depredation accounting for 30% of the respondents.

Table 1.3 Increased community engagement

Level of engagement	Frequency	Percentage
High	180	60%
Medium	90	30%
Low	30	10%
Total	300	100%

Source: Field data

The survey results indicate a high level of community engagement in CLC activities, with 90% of the respondents participating in conservation efforts.

Table 1.4 Improved livelihoods

Level of improvement	Frequency	Percentage
Significant	150	50%
Moderate	90	30%
Minimal	60	20%
Total	300	100%

Source: Field data

The results show that 50% of respondents reported a significant improvement in their livelihoods, while 30% reported a moderate improvement and 20% reported a minimal improvement.

1.3.3.1 Inferential Statistics

Table 1.5 Comparison of HWC incidents between CLC and non CLC areas

Area	Mean	Standard Deviation	t-value	p-value
CLC	2.5	1.2	-3.5	0.001
Non CLC	4.2	1.5	-	-

Source: Field data

The results show that the mean number of human wildlife conflict incidents is significantly lower in the Community led Conservation area compared to non CLC area.

1.3.3.2 Correlation coefficient

Table 1.6 Correlation between community engagement and livelihood improvements

Variable	Coefficient	Standard error	t-value	p-value
Community engagement	0.65	0.12	5.4	0.001
Livelihood improvement				

Source: Field data

The results show that there is a significant positive correlation between community engagement and livelihood improvement.

1.3.3.3 Regression Analysis

Table 1.7 Predictors of human wildlife Conflict Incidents

Variable	Coefficient	Standard error	t-value	p-value
Community engagement	-0.35	0.15	-2.3	0.05
Livelihood improvement	-0.28	0.12	-2.1	0.05
Constant	3.5	0.8	4.3	0.001

Source: Field data

The results show that community engagement and livelihood improvement are significant predictors of Human wildlife conflict incidents.

1.3.4 Qualitative Results

1.3.4.1 Theme 1: Community Engagement and Participation

1.3.4.1.1: Community led conservation initiatives

Community leader, “We started a community led conservation initiative to protect our forest and wildlife. We work together to monitor the forest and prevent poaching.”

Farmer, “The community led conservation initiative has helped us to take ownership of our natural resources and protect them for future generations.”

Conservation committee member, “We have seen a significant reduction in poaching and habitat destruction since we started the community led conservation initiative.”

1.3.4.1.2: Community participation in decision-making process

Community leader, “We make sure that everyone in the community is involved in the decision-making process. We hold meetings and discussions to ensure that everyone’s voice is heard.”

Conservation organisation representative, “Community participation in decision making process is crucial. It ensures that everyone is on board with the conservation efforts and that we are working towards a common goal.”

Government agency official, “We have seen that when the community is involved in decision making processes, they are more likely to support and participate in conservation efforts.”

1.3.4.1.3: Community ownership and responsibility

Community leader, “We take ownership of our natural resources and are responsible for protecting them. We work together as a community to ensure that our resources are conserved for future generations.”

Conservation organisation official, “Community ownership and responsibility are key to successful conservation efforts. When the community is invested in the conservation of their natural resources, they are more likely to protect them.”

Government agency official, “We have seen that when the community takes ownership of their natural resources, they are more likely to adopt sustainable practices and protect their resources.”

1.3.5.2 Theme 2: Human Wildlife Conflict and Livelihood Impacts

1.3.5.2.1: Crop damage and livestock depredation

Farmer, “Crop damage and livestock depredation are major problems for us. We lose a significant amount of our crops and livestock to wildlife every year.”

Community leader, “Human wildlife conflict is a major challenge for us. We have to deal with crop damage and livestock depredation on a regular basis.”

Conservation committee member, “We have tried various methods to prevent crop damage and livestock depredation, but it is an ongoing challenge.”

1.3.5.2.2: Economic impacts of human wildlife conflict

Farmer, “Human wildlife conflict has a significant economic impact on us. We lose income and livelihoods due to crop damage and livestock depredation.”

Community leader, “The economic impacts of Human wildlife conflict are severe. We have to spend a lot of money to repair damaged crops and livestock.”

Conservation organisation official, “Human wildlife conflict affects our livelihoods and income. We need to find ways to mitigate these impacts.”

1.3.5.2.3: Social impacts of human wildlife conflict

Farmer, “HWC has social impacts on us. We have to deal with stress and trauma of losing our crops and livestock.”

Community leader, “The social impacts of HWC are significant. We have to deal with the emotional toll of losing our livelihoods.”

Government agency official, “HWC affects our social well-being. We need to find ways to address these impacts.”

1.3.5.3 Theme 3: Collaborative Management and Partnerships

1.3.5.3.1: Collaboration between local communities and conservation organisations

Community leader, “We work closely with the conservation organisation to protect our natural resources. They provide us with technical assistance and support.”

Conservation organisation official, “Collaboration between local communities and conservation organisations is crucial. It ensures that conservation efforts are community led and effective.”

Government agency official, “We have seen that collaboration between local communities and conservation organisations leads to better conservation outcomes.”

1.3.5.3.2: Partnerships between government agencies and local communities

Community leader, “We partner with the government agency to protect our natural resources. They provide us with funding and technical support.”

Government agency official, “Partnerships between government agencies and local communities are essential. They ensure that conservation efforts are supported and effective.”

Conservation organisation official, “We have seen that partnerships between government agencies and local communities lead to better conservation outcomes.”

1.3.5.3.3: Benefits and challenges of collaborative management

Community leader, “Collaborative management has many benefits. It ensures that conservation efforts are community led and effective.”

Conservation organisation official, “Collaborative management also has challenges. It requires a lot of time and effort to build trust and partnerships.”

Government agency official, “We have seen that collaborative management leads to better conservation outcomes, but it requires careful planning and implementation.”

The paper’s findings suggest that CLC is an effective approach to reduce HWC and promote community engagement in conservation as the study highlights the importance of trust building between community members and conservation officials.

1.3.6 Discussions

1.3.6.1 Discussions from Demographic results

A high response rate indicates strong engagement and provides confidence in the representativeness of the findings. This was supported by Cummings and Worley, (2019) and Kreuter et al., (2020) who indicated in their researches that achieving a response rate of 100% from 300 participants demonstrates strong participant involvement in the study. Conversely, a lower response rate may suggest potential response bias or the need for improved follow-up strategies in future surveys. Thus, it may be deduced that younger populations may be more receptive to conservation

education; elders may hold traditional knowledge. Gender roles also influence participation and collaboration strategies and on the other hand the implication of the cultural attitudes varies in perceptions of wildlife and conservation practices. The majority of the respondents in the study are literate enough to understand conservation and collaboration strategies. There is a high competition for land and resources in Save Conservancy which results in conflict.

1.3.6.2 Discussions from Quantitative results

From the research done, it is noted that there reduced HWC in Save Conservancy which suggest that human wildlife conflict is a significant issue in the study area. This is consistent with previous studies that have shown that human wildlife conflict is a major concern in many parts of the world, (Sibanda & Chomba, 2019; Chidziya & Moyo, 2020, Kareiva, et al, 2020 and Plummer, et al, 2017). HWCs can take a variety of forms, including attacks on humans, depredation (Matseketsa et al, 2019, Larson et al, 2016), and crop-raiding (Mhuriro, et al 2018, and Siljander, et al, 2020). Communities near protected areas (PAs) suffer from crop-raiding and livestock predation, which is often the biggest cause of conflict in Africa (Siljander, et al, 2020). People residing inside PAs are even more exposed and vulnerable to problem causing wild animal species (Akrim, et al, 2021 and Sekhar, 1998). A study carried out in Ethiopia by Tamrat et al. (2020) concluded that livestock predation is intense in and around a protected sanctuary, crop damage caused by wildlife can inflict substantial financial losses for farmers and, at the same time, create negative attitudes towards wildlife and conservation efforts. This may result in negative interactions with wildlife, culminating in increased HWCs (Grosset al., 2018).

Findings for increased community engagement is in support with Hlengwa and Maruta, (2020) who highlighted that local communities need to be involved from the planning phase of community-based tourism projects, which are meant to benefit them socio-economically, while also empowering them to participate actively in the conservation of local environmental assets. For improved livelihoods the findings suggest that livelihood improvement is a significant outcome of conservation efforts in the study area and this resonates with the study done by Mekonen, (2020) who indicated that communities in and around parks benefit immensely from proceeds obtained from sales of wildlife.

Community led conservation is effective in reducing human wildlife conflict incidents. Treves (2007) noted that it is very important that farmers be involved in the process of developing new solutions from the beginning. In addition, they understand how the situation affects them and what kinds of intervention are likely to be acceptable and feasible within the local culture, providing there is adequate representation from the different types of stakeholders involved, (Parkhurst, 2006). It is also important to highlight the impact of community engagement in improving the livelihood of the population. This was supported by researches done by Meyer et al., (2021a); Meyer et al., (2021b) and Bandyopadhyay et al. (2009) who posited that the community led conservation initiatives positively affect income, hence, HWC may still result in trade-offs between attracting wildlife numbers and socioeconomic impacts of livelihoods. Community engagement and livelihood improvement are also critical for reducing human wildlife conflict incidents and derive benefits from the proximity to the protected zones (Dixit, Poudyal, Silwal, Joshi, Bhandari, & Hodges, 2024). This is a significant finding as human wildlife conflict is a major concern in many parts of the world and this is propounded by researches done by Dickman et al, (2019); Matseketsa et al. (2018); Pooley et al, (2017) and Moyo & Chidiya, (2018).

1.3.6.3 Discussions from Qualitative results

1.3.6.3.1 Community Engagement and Participation

It can be deduced that community led conservation initiatives are essential for effective conservation outcomes and promote community ownership and responsibility, leading to more effective conservation outcomes. As noted by Kareiva et al (2020) and Berkes (2017) community led conservation initiatives are important in human wildlife conflict management. Thus, these findings highlight that community participation in decision-making processes is a critical and promotes community engagement and ownership leading to more effective conservation outcomes. This is supported by earlier studies by Armitage et al, (2019) and Plummer et al, (2017). Emphasizing and building shared understandings of fundamental assumptions regarding wildlife conservation could enhance the participatory process, improve ecological understanding and aid conservation success (Heisel et al., 2021). Community engagement is critical during the restoration process, especially when working with communities that have a wealth of traditional knowledge related to biodiversity and natural resource management (Ogar, Pecl and Mustonen, 2020).

1.3.6.3.2 Human Wildlife Conflict and Livelihood Impacts

Human wildlife conflict is a major challenge for conservation efforts. Research by Pooley et al (2017) pointed out that crop damage and livestock depredation are significant economic and social impacts of human wildlife conflict. Dickman, et al, (2019) and Salerno et al.'s (2020, 2021) posited that human wildlife conflict is a cause for concern. They further noted that human wildlife conflict can lead to significant social impacts, including stress, trauma and conflict. In the same vein, Chidziya and Moyo, (2020) indicated that human wildlife conflict results in economic and social impacts on human lives.

1.3.6.3.3 Collaborative Management and Partnerships

There is need for collaborative management as it promotes community engagement and ownership in decision- making processes. Earlier studies have also pointed out the need for collaborative management in human wildlife conflict management, as this facilitates improved communication strategies and prompt reaction to human–wildlife conflict reports (Dube & Kavhu 2022; Armitage et al, 2019; Plummer, et al, 2017; Sibanda & Chomba, 2019, Moyo & Chidziya, 2018 and Mbereko et al. 2017). Creating an action plan for forest protection should begin by convening local communities, scientists, resource managers, and government representatives in workshops (FA, 2020). Such a strategy would be in accordance with the UN Decade of Ecosystem Restoration (2021–2030), which requires governments across the countries to integrate local communities and their indigenous knowledge with management goals (Mbah, Ajaps, and Molthan-Hill, 2021).

1.4 Conclusion

The study concluded that:

- i. Demographic factors influence community-led conservation success and also the data underscores the importance of inclusive participation in community led conservation strategies.
- ii. community led conservation is effective in reducing human wildlife conflict incidents.
- iii. community engagement and livelihood improvement are critical for reducing human wildlife conflict incidents.

- iv. community participation in decision-making processes is critical because it promotes community engagement as well as ownership, leading to more effective conservation outcomes.
- v. HWC is a major challenge for conservation efforts as it results in crop damage, livestock depredation and human injury.

This paper therefore, emphasises the benefits of collaborative management, including shared decision-making and joint problem solving as it promotes community engagement and ownership. In the same vein, the study also highlights the paramount importance of active participation by community members in wildlife conservation initiatives (Milich, Sorbello, Kolinski, Busobozi, & Kugonza, 2021). One of the major challenges in the SVC, as illustrated in this study, is HWCs, which are mainly caused by a lack of shared understanding and vision as was supported by Makumbe, *et al.*, (2022). Mogomotsi, Stone, Mogomotsi, & Dube, (2020) propounds that there is a necessity for enhanced engagement of community members regarding wildlife conservation.

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1.5 Recommendations

The paper makes the following recommendations:

- i. There is need to tailor strategies considering age, gender, ethnicity, and livelihood improve collaboration.
- ii. Collaborative management should be fostered among the communities affected by wildlife so that there is community ownership and control over conservation efforts.
- iii. There is need for collaborative management in the conservative efforts in order to reduce HWC.
- iv. There is need for trust building among the stakeholders in order to foster shared decision making and joint problem solving in reducing human HWC.
- v. Further research should be done in a different context.

Conflicts of interest

Nothing to declare.

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Author contributions

All the three authors collaborated on this paper from abstract, introduction, literature review, research design, fieldwork, primary data analysis and write up of this research.

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Developing Inclusive Climate Resilience Strategies for Children with Autism in Gwanda, Matabeleland South: An Exploration of Adaptation to Climate Change

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Abstract

This study takes into account the interaction of autism spectrum disorders (ASD), vulnerable populations, and climate change. Global concern in phenomena such as climate change, where awareness of its impacts is crucial, is mostly for the vulnerable, such as individuals with ASD. People with autism are likely to exhibit distinctive sensory sensitivity and insistence on sameness, whose extent could be undermined by climate change effects. This study examines how climate resilience strategies for children with ASD can be developed in Gwanda. The importance of this study is that it will provide insight into successful home and policy adjustments to support individuals with ASD under climate change. The key findings are that climate change is inevitable and children with ASD need to learn to accommodate change in spite of their resistance to changing. The study concludes that through active engagement the education sector can fulfil its moral and ethical obligation to address climate change effects.

Key words: Autism, climate change, inclusion, climate resilience

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1.0 Introduction

Climate change is now a social fact influencing the daily lives of humans just the same way it is diverting the environment by challenging the very existence of the numerous varied types of life on this planet. Palmer (2021) contends that it has hit the vulnerable, marginalized and poor disproportionately to cause severe social injustices of divisions, inequality and exclusion. On this basis, it has also become an ethical issue. Hitzhusen & Tucker (2018) claim that the United Nations Framework Convention on Climate Change (UNFCCC) (1992) sets real-world principles to guide responsible and fair international action against climate change. The Convention presumes that the driving factors in the climate change challenge are largely anthropogenic in nature. Human beings are the offender, main victims and maybe the remedy of the climate challenge. The United Nations Summit in 2015 set seventeen Sustainable Development Goals (SDGs) and these have some interrelated targets that show education has a pivotal role in a green and sustainable world. Specifically, SDG 13 demands immediate action to counter climate change. Dube (21) states that target 13 Climate Action deals with taking urgent action to mitigate climate change and its impacts, and precisely Target 13.3 to "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning." Such ideals can only be attempted through community and local level institutions. The study sought to investigate the children's everyday practices in coping with climate stressors, establish context-specific, participatory climate resilience strategies and theorize climate change effects on autism support and policy.

2.0 Methodology

Research methodology is a scientific and systematic approach used for collecting, analysing, and interpreting quantitative or qualitative data to answer research questions or to test hypotheses (Beamish & Bryer, 2022). Shukla (2020) also adds that it describes the techniques and procedures by which information to be retrieved and analysed on a particular research problem is determined. In an attempt to pinpoint the data for the research effectively, the researchers utilized qualitative research methods, including interviews and observations.

2.1 Face to face individual interview

Creswell (2009) notes that in research, semi-structured interviews are qualitative in nature. They are basically used as an instrument of inquiry in market research, social science, survey research, and other research fields. They are also commonly used in field research involving multiple interviewers, giving them all one conceptual framework, but giving them the freedom to explore different facets of the research problem. Semi-structured face-to-face interviews are often thought of as "the best of both worlds." Austin (2020) goes on to state that by intertwining elements of structured and unstructured interviews, semi-structured interviews capture the benefits of both: comparable, consistent data, and ease to ask follow-up questions. No interruption is present, and the convenience of being able to have a thematic structure beforehand retains both the interviewer and the interviewee focused, avoiding interruptions while enhancing two-way communication. Moreover, richness and detail are a major advantage. McMillan and Schumacher (2006) contend that while similar approaches-wise to questionnaires, structured interviews, and surveys, semi-structured interviews provide more richness and detail due to their greater openness. Interviewees can be asked to explain, elaborate, or rephrase their answers if required. There is also low validity since the adaptability of semi-structured interviews also decreases their validity. But it will be challenging to contrast participant responses depending on the extent to which the interviewer diverged from the pre-established list of questions. Creswell (2009) adds that there is high risk of bias since the open-endedness in semi-structured interviews poses the risk of asking leading questions, which biases your answers. In the same way, the interviewees will also attempt to offer the answers they think the researcher wants, which causes social popularity bias.

2.2 Non participatory observation

Beamish and Bryer (2022) assert the observation process as a three-stage funnel, beginning with descriptive observation, where scientists make extensive scope observation in an attempt to get a feel for the environment, progressing to focused observation, where they start paying attention to a limited subset of the events of most interest to them, and finally selected observation, where they investigate connections between the phenomena they've defined as most intriguing. Non-participant

observation is generally used in conjunction with other data collection methods, and has the potential to generate a richer “nuanced and dynamic” understanding of less easily captured contexts by other means (Austin, 2020).

2.3 Population

Population is the collection or the group of all the units to which the research results are to be generalized (Silverman, 2019). It consists of all the elements on which research results can be generalized. This research’s population is Gwanda District in Matabeleland South Province, Zimbabwe, with 151,691 people in the 2022 census.

3.0 Results

3.1 Climate change understanding

The participants understood the term climate change differently as some interchanged climate and weather.

MM 3 *“these are changes over a period of time that is, more than 10 years.*

MM 1 *Temperature, rainfall patterns and the environment may be changing as well.*

MM 16 *Trees flowering patterns have changed significantly”.*

Whilst another respondent MM 9 said that it meant “Less drinking water, more rain. Drought, confused weather.”

Thirteen of the participants felt that that climate change is exactly what is happening in Zimbabwe generally and particularly in Gwanda. Participants indicated that it is no longer possible to plant maize and expect to harvest from rainfall. Seasons seem to be changing and the changes are not logical. Very hot summers, late rains which is unlike the previous years. 5 pointed out that some of the causes of climate change are human activities whilst some are beyond anyone’s control as they are supernatural. General consensus 80% of the participants felt that climate change was more supernatural than human influenced.

3.1.1 Discussion

Climate change is a change in climate that is caused directly or indirectly by human activities that alter the physical characteristics of the Earth's atmosphere and occur in addition to natural climate variability on similar timescales (Elverskog, 2020). It is any climatic alteration over time, either from natural reasons or caused by human activities. The requirement of routine is not optional for most people with ASD but a need to cope with the dynamics of social interactions and self-regulation (Aparecida, 2023). The manifestation of sudden extreme weather conditions has the ability to disrupt usual routines, thus increasing stress and anxiety levels. For instance, on a rainy day of non-participant observation, ASD students who were accustomed to some outdoor activities were compelled to stay indoors, disrupting their regular schedule. Evacuation drills for wildfires also demand rapid adaptation in new locations, new habits, and new sensory input changes, which are quite challenging for people with ASD.

3.2 Experience of learners with autism in adapting to climate-related stressors

The interviews raised a number of points

MM10 Learners with ASD enjoy being outdoor and they seem to thrive in the environment.

MM11 Thunderstorms with the loud sound and flashing lights are too much for their sensory processing ability, so anxiety and stress levels rise in students with the ASD.

MM15 The disorder and chaos of evacuation during compulsory fire drills amplify sensory sensitivities, with the noise, confusion and disruption of personal space and routine having expressively negative effects on the health and wellbeing of students with ASD.

MM7 Children with autism struggle with toilet training due to the condition of the bathroom itself. Most often we find that people with ASD will be very diplomatically

cautious so the environment itself needs to be as neutral as possible. There needs to be ample space around the toilet so they are not claustrophobic.

MM18 Learners manifest fewer indications and worked better after activities in green space.

3.2.1 Discussion

One of the most potential yet less researched features of the outdoor environment that has been found to influence health outcomes is nature access (Sumon, 2021). Kaplan (2023) cites that for neurotypical children like ASD, natural outdoors has been discovered to reduce stress, create emotional resilience, provide functional and imagination play, and support cognitive functioning. This was also felt while conducting non-participant observation. Exposure to nature can also reduce symptoms in kids who have other disorders, such as attention deficit hyperactivity disorder (ADHD) or attention deficit disorder (ADD) and can help the cope. Children with ASD who were on a park walk did better on their attentional performance, compared to kids who were on an urban walk (Georgio and Parlalis, 2024). In everyday life, children who play in green space have less severe symptoms compared to children who play mainly in indoor and built outdoor spaces (Pratt, 2017). The sensory routines of change can also be extremely stressful for individuals with ASD.

Cyclone or continuous rain has the potential to halt rudimentary services like electricity temporarily, interfering with routines based on screen time or using phones, fans, or other appliances during hot days, even causing stress, anxiety, and even fear in ASD learners (Gumbo, Tumushime & Chaminuka, 2021). Furthermore, the outcome of such events tends to be a prolonged process of adaptation to a new temporary or permanent residence where customary supports and arrangements cannot be readily accessed (Chitando, 2019). Manjowa & Makoni (2023) report that it is indeed for the best if the setting is warm and at home parents and at school educators can address that modifying the setting can often reduce behavioural occurrences. Teachers need to extend circumstances, association, locations and possibilities that function. They need to try, if available, to change or remove circumstances which serve as triggers

for unsolicited behaviour. In addition, they need to include ways of reducing frustration and nervousness and extending understanding.

3.3 Context-specific, inclusive climate resilience strategies

The respondents seemed agreed that there is great need to have a custom-made strategy for inclusive climate resilience.

MM3 There is need to prevent by changing our activities in the environment. For example, by being environmentally conscious in the society, thereby reducing the impact of climate change.

MM18 People need to practice tolerance especially for children with ASD by sharing losses, changes in actions or of site and restoration in the environment.

MM7 Adaptation of measures that assist people, societies, organizations and ordinary systems in dealing with the impacts of unavoidable climate change

3.3.1 Discussion

Nwagbira, Iijoma & Chima (2018) posit that climate change is one of the biggest global phobias that are challenging world development with developing countries being most susceptible due to their low adaptive capacity and high reliance on climate sensitive industries. Chirongoma (2021) reports that, over the past decades, Zimbabwe has been experiencing high frequency and severity of droughts, prolonged mid-season dry spells, severe storms and activities of tropical cyclones. The climate change is having detrimental effects on water, agriculture, health, forestry and biodiversity, infrastructure, human settlements and tourism sectors. Palmer (2021) contends that there needs to be a modification in natural or human systems after actual or expected climatic stimuli or their influences, reducing damage or exploiting favorable opportunities. The National Development Strategy 1 (NDS1) (2021–2025) leads transformation to low carbon and climate resilient development trajectories and the National Adaptation Plan (NAP) achieves this through climate change concerns

mainstreamed into national and subnational development planning processes. In the process of Climate Change NAP development, there was a consultation process involving multi-stakeholders towards the anticipation that the NAP will make a good platform for mainstreaming climate change in all the major socio-economic sectors in order to attract an integrated response from all the various sectors. The Government is now poised for additional cooperation and assistance in the implementation critical phase of this NAP according to His Excellency, President of the Republic of Zimbabwe, Cde. Dr. E. D. Mnangagwa's vision to leave no individual and no place behind.

3.4 The implications of climate change for autism support and policy

MM13 By playing an active role in climate change action, the good and right roles can be fulfilled while using its wide coverage and popularity to increase awareness, build capacity, and mobilize action.

MM17 Emphasising environmental stewardship and promoting sustainable practices, the education society in Gwanda can contribute to making a stronger and environmentally conscious society.

3.4.1 Discussion

Kaplan (2023) begs that the desire for routine is not merely a preference for most individuals with ASD; rather, it is a necessity for coping with the difficulty that social interactions and self-regulation pose. Fluckiger (2019) reports that severe weather conditions' abrupt arrival has the potential to disrupt established routines, triggering significant stress and anxiety. The evolving climate is powerfully enhancing the frequency and severity of extreme weather events like floods, wildfires, heavy rainfall, thunderstorms, and heat waves (Mupangwa, 2023). These changes present special challenges to individuals with Autism Spectrum Disorder (ASD), who are most likely to rely on consistent and predictable environments as one means of managing their daily tasks effectively.

4.0 Conclusions

The climate system is a complicated, cooperative phenomenon consisting of the atmosphere, the land surface, snow and ice, the oceans and other waters, and living things. The research was carried out with a purpose of creating ways of constructing inclusive climate resilience strategies for children with ASD in Gwanda. Findings of the study show that actors in the education sector possess varied beliefs towards climate change and what is happening in Zimbabwe currently and throughout the world. In their discussions, seasons have been changing. Extremely hot summer, late rains, drought, heat waves and cyclones that is unlike the past years. Climate change in Gwanda has localized and it has serious consequences on livelihood and food security. Recurrent droughts have led to scarcity of water and massive loss of fresh water. The study also concludes that by being deeply engaged in climate change work, the education community can be in a strong position to fulfil its good and moral obligations while leveraging its far-reaching influence and reach to educate, build capacity, and mobilize action. With the focus laid on environmental stewardship and good sustainable practice, Gwanda schools are in a position to contribute towards an even more sustainable and environmentally conscious society. In an effort to combat the complex problem of climate change, natural disasters, and the use of renewable energy-based interventions for Autism Spectrum Disorder (ASD) individuals, Aparecida (2023) posits that a prudent and holistic approach should be used. Individuals with ASD face many challenges from their greater sensory sensitivities and reliance on scripted programs, which are too easily disrupted by environmental variation and crises. Putting renewable energy in place has twice the benefit: it lessens climate change's impact on the environment and improves the living environment of individuals with ASD by making their environment more predictable and stable. The economic impacts of renewable energy, while negative at first due to the involved expenditure, provide an opportunity that can be funded through judiciously designed economic assistance programs so that sustainability becomes affordable for families with ASD needs. In addition, such installations and upkeep need to be done judiciously so that such systems do not cause disturbances in people's regular lives grappling with ASD. Along with healthcare provider endorsement, policy and public support are crucial since streamlining regulatory processes and favouring fair policies will help in erasing the barriers to access to renewable energy solutions. Moreover, sensitizing

the public and involving people with ASD in planning and execution stages will ensure that not only are these drugs effective, but endorsed by the very people for whom they are intended. The aim is to make a resilient, equitable, and sustainable world that is supportive of people with ASD to survive against adversity caused by climate change. By considering the special requirements of people with ASD in our climate change interventions as well as renewable energy programs, we can make our interventions meaningful and beneficial to society at large.

5.0 Recommendations

ASD individuals are particularly vulnerable to disruption by natural disasters and environmental events such as storms, wildfires, and flooding because of their highly developed sensory sensitivities. Such events pose serious threats to the sensory environment, leading to a drastic escalation of stress and anxiety levels. Successful countermeasures involve creating emergency response plans that incorporate sensory-friendly shelters and evacuations. Additionally, reducing the stimulation and making public warnings and announcements more inclusive can also reduce sensory overload in periods of stress. The uncertainty of weather disasters and natural disasters with climate change also presents tremendous challenges with routines that are so important to people with ASD. It is of the highest importance that community-level planning and disaster preparedness incorporate ASD specific needs with an eye to enabling rapid reestablishment of routines following disruption. Simulation of emergency status in controlled environments can also habituate individuals with ASD to become accustomed to possible changes. The financial factor is also of the highest importance with the cost of adopting renewable technologies such as wind turbines and solar panels (Pratt, 2017). While they are cost-reducing in the long run, their initial implementation is costly, which can be financially expensive for ASD financially stressed families. Government economic sponsorship initiatives that focus on such families are thus crucial. The programs would be capable of financing initial purchase of the renewable energy equipment and installation connections, and must be preceded by efficient communication on the incentives and support provided. Renewable energy installation and maintenance also interrupt routines, so important to individuals with ASD. Scheduling installation and maintenance during slower periods and utilizing technicians with ASD sensitivity training can help alleviate anxiety

in these individuals. This thoughtful planning permits more gradual acclimatization to new technology, facilitating acceptance and minimizing the possibility of conflict.

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Disclaimer

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Author contributions statement

G.B and T.H wrote the main transcript. G.B interviewed 10 participants whilst T.H interviewed 10. Both authors reviewed the manuscript.

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Edible Insects: A Climate-Resilient and Inclusive Livelihood Strategy for Zimbabwe

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Abstract

Innovative farming methods are critical in a world under siege of increasing climate change induced food insecurity. This study explores the transformative opportunity that edible insects commercial farming propounds towards climate change livelihood adaptation in Zimbabwe. The study focuses on marginalised groups - women and the youth - examining how gendered challenges create barriers to decision-making, accessing resources and full participation and growth in the edible insect value chain in the country. 20 participants engaged in the edible insects' sector were engaged through semi-structured qualitative individual interviews, three focus group discussions and field observations. The data were then analysed to identify patterns leading to the formulation of key themes. The findings suggest that commercialising the production of edible insects increases food security, advances women and youths' business agency within the agrobusiness sector, increases income, all while promoting environmental sustainability. However, despite the critical role that women play in the edible insects' value chain - from insect gathering, preparation and retailing, they face a multitude of challenges and barriers in accessing business resources, markets and in decision-making power. Likewise, the youth though drawn to the edible insects' sector due to its attractive income potential and low entry barriers, face challenges in the form of lack of business, technical and structural support. The commercial production of edible insects provides an attainable means towards climate change resilience and inclusive development in Zimbabwe. However, in order to realise this pathway's full potential, targeted support for the youth and gender-transformative support for women in the edible insects' value chain are necessary from both the private and public sectors. Thus, through the engagement of the business' ecosystem towards overcoming these barriers and challenges, edible insects' production can contribute to sustainability and equity in Zimbabwe.

Keywords: Climate Change, Food Security, Edible Insects, Sustainable Livelihoods, Gender, Youth, Zimbabwe.

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1.0 Introduction

The effects of climate change, poor political decisions and declining agricultural production have birthed a state of economic uncertainty and rising food insecurity in Zimbabwe (Moyo, 2024). Magwegwe et al., further explains how extreme weather patterns experienced in the country over the past two decades, characterised by erratic rainfall patterns interspaced with prolonged droughts, have had an adverse effect on maize and other staple crops in Zimbabwe. Their study, focused on quantifying the effects of climate change in a rural Zimbabwean district, found that rural livelihoods dependent on rain-fed subsistence farming, are the most affected with 38% of families experiencing annual food shortages (Magwegwe et al., 2024). Further to this, the country's growing economic instability marked by rising inflation, is increasingly making it difficult for Zimbabwean families to secure affordable nutrition (Moyo, 2024). In such a situation, Weru (2022) proposes that there is an urgent need for alternative, climate-resilient food sources that are both nutritionally rich and economically viable.

Scholars agree that in Africa, edible insects have long played an important role in traditional diets (Hlongwane & Munyai, 2021; Ogwu & Izah, 2025; Matiza Ruzengwe et al., 2022). It is particularly true in rural areas, where mopane worms (*madora/amacimbi*), flying termites (*ishwa*), soldier termites (*majuru*), and stinkbugs (*harurwa*), serve as an accessible and nutrient-dense protein sources (Hlongwane et al., 2020). In addition to their high vitamin and micronutrient content, edible insects are an essential and accessible source of protein. Unlike traditional sources of animal protein, they require minimal land, feed, water and management (Weru et al., 2021; Ogwu & Izah, 2025). Thus, in an age of rising food production costs, edible insect production is an attractive alternative food option (Moruzzo et al., 2021; Ogwu & Izah, 2025). However, despite their potential role towards sustainable food security, edible insects are currently underutilised in modern agricultural and commercial systems, primarily due to informal market structures, limited investment, and policy gaps (R. Caparros Megido et al., 2024).

While edible insects have been part of Zimbabwean diets for centuries, as in the rest of Africa, their full potential as a sustainable food source remains untapped in policy and commercial systems (Ogwu & Izah, 2025). Wijerathna-Yapa and Pathirana (2022) caution that existing food production systems are highly exposed to climate shocks

and economic fluctuations due to their focus on current staple crops and conventional livestock requiring high inputs, feed and water. Musundire et al. (2021) concur and propose the commercialisation of edible insects as an adaptive alternative. However, as the researchers readily acknowledge, edible insect production faces systemic neglect in terms of investment, policy integration, and value-chain development (Musundire et al., 2021; Ogwu & Izah, 2025). This marginalisation results in edible-insect farmers and retailers having little structured support to scale up operations, improve market accessibility, or integrate insect-based products into mainstream food supply-chains. Thus, the convergence of economic and climate pressures demands new, low-cost yet nutrient-dense food systems.

Women's contributions to insect farming and trade often go unrecognised and undervalued. This fact highlights a critical gap in gender-inclusive agro-policy research. The youth too, are less engaged in insect farming, primarily due to perceptions of the sector as informal, outdated, thereby more difficult to realise profits (Dokubo et al., 2023). Without targeted support to improve market conditions, access to credit, and regulatory frameworks, edible insect farming will continue to be restricted to informal economies, preventing it from reaching its full potential as a viable and sustainable agribusiness (Ameixa et al., 2020; Tanga et al., 2021).

In addition, edible-insects farming and commercialisation in Zimbabwe is understudied. The majority of literature focuses on the nutritional profiles of edible insects and the cultural practices associated with them. However, scholars agree that there is little emphasis on policy frameworks, gendered barriers, or commercial scaling in the production of edible-insects in the country (Chikonyani, 2022; Manditsera, 2019; Mutai, 2024).

It is with this in mind that this study poses and is guided by the overarching research question: *“Under current cultural and policy conditions, how can the farming of edible-insects be developed into a climate-resilient, gender-inclusive and economically viable livelihood strategy in Zimbabwe?”*

To address this question, this study explores the potential of edible insect farming as a climate-resilient and inclusive livelihood strategy in the country. Specifically, this study aims to fill the identified gaps by systematically examining the socioeconomic, gendered, and policy dimensions of edible insect farming in Zimbabwe.

1.1 Significance

The importance of this study lies in its potential contributions to academic research and practical policy implementation. By recognising these traditional, indigenous protein sources as alternative sustainable food systems and climate adaptation strategies, this study provides a detailed analysis of the economic feasibility, social acceptance, and gendered dimensions of edible insect farming, and filling a critical gap in existing literature (Kelemu et al., 2015; Moyo, 2024; Dagevos, 2021). From a policy perspective, this research provides recommendations for government agencies, development organisations, and private sector stakeholders towards the development of inclusive policies that support small-scale edible insect farmers and traders. The paper contributes to the discourse on promoting the creation of regulatory frameworks that ensure food security, standardising the edible insects' market, in addition to promoting consumer awareness and facilitating access to finance and training for women and youth entrepreneurs in this sector. Thus, this study aims to contribute to developing a more resilient, gender-inclusive, and sustainable agricultural system in Zimbabwe, ensuring long-term food security and economic empowerment.

2.0 Literature Review

2.1 Theoretical Framework

This study is anchored by three key theoretical frameworks that provide a lens for analysing edible insect farming as a climate-resilient and inclusive livelihood strategy in Zimbabwe. These are the Sustainable Livelihoods Approach (SLA) developed by Chambers and Conway (1992), the Gender and Development (GAD) perspective, developed by feminist scholars in the 1980s (Rathgeber, 1990), and Ajzen's (1991) Theory of Planned Behaviour (TPB).

2.1.1 Sustainable Livelihoods Approach (SLA)

As Morse and McNamara (2013) attest and Ragie (2016) confirms, the Sustainable Livelihoods Approach (SLA) is a widely used framework in development studies that examines how households and communities build resilience and access resources to maintain and improve their livelihoods. SLA emphasises five capital assets: human, social, natural, physical, and financial capital, that determine a household's ability to withstand shocks and sustain economic well-being (Jele, 2012; Morse, 2025).

Ogwu and Izah (2025) and Morse (2025) agree that SLA is particularly relevant in edible insect farming, as it highlights how low-cost, high-protein insect farming can enhance food security, generate income, and reduce environmental pressure on conventional agriculture. A comparison of Mrabet's (2023) analysis of cattle and poultry farming requirements, and Fernández's (2025) report on the substantially lower production requirements for edible insects, indicates that edible insects are a more sustainable alternative for rural households facing climate-related agricultural challenges. On the other hand, other scholars argue that institutional barriers, limited financial support, and weak value chains constrain the scalability of edible insect farming (Ameixa et al., 2020; Mrabet, 2023). Thus, the viability of commercially producing edible insects requires both public and private interventions to improve access to market infrastructure, credit, and technical knowledge (Chidozie Ogwu, 2025).

2.1.2 Gender and Development (GAD) Perspective

According to Miller and Razavi (1995), and Onyike et al. (2025), the Gender and Development (GAD) perspective is critical to understanding the unequal access to resources, economic opportunities, and decision-making power in insect farming. The perspective foregrounds gender inequality concerning women in Zimbabwe, who though contributing significantly to agriculture, remain marginalised in land ownership, financial access, and market participation (Musundire et al., 2021).

Chikonyani's (2022) study offers insight into the dilemma by showing how despite Zimbabwean women's involvement in harvesting, processing, and selling edible insects, they continuously lack formal recognition in the industry, thereby creating an environment of diminishing empowerment as the women's lower bargaining power corresponds to their limited business profitability (Chikonyani, 2022). GAD provides a lens to examine how institutional and policy interventions can address these disparities by enhancing women's access to training, credit, and cooperative networks in the edible insect sector (Hlongwane et al., 2021).

2.1.3 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) helps to explain consumer acceptance and behavioural intentions regarding edible insect consumption (Bae & Choi, 2021; Lucchese-Cheung et al., 2020; Thu et al., 2023). TPB suggests a three-factor influence behaviour:

Table 1: Theory of Planned Behaviour (TPB)

No.	Factor	Description	Relevance to Edible Insects in Zimbabwe
1	Attitudes	Perceptions of whether consuming insects is beneficial or undesirable.	Cultural stigma often associates insect consumption with poverty, limiting market expansion.
2	Subjective Norms	Social pressures influencing dietary choices.	The influence of societal beliefs and traditional dietary habits affects consumer acceptance.
3	Perceived Behavioural Control	Individuals' confidence in adopting insect-based diets.	Education, marketing, and policy interventions can enhance consumer confidence and demand.

In Zimbabwe, cultural stigma often associates insect consumption with poverty, limiting market expansion (Ameixa et al., 2020; Tanga et al., 2021). TPB enables an examination of how social, educational, marketing, and policy interventions can influence public perceptions and enhance consumer demand for edible insect products (Thu et al., 2023).

2.2 The Role of Edible Insects in Food Security in Zimbabwe

As previously established by scholars including Kinyuru et al. (2015), edible insects have always been a fundamental component of human menus. In traditional Zimbabwean diets, they play an important role in providing a rich source of protein, essential micronutrients, and seasonal food options. According to Hlongwane et al. (2020), popular delicacies such as mopane worms (*Gonimbrasia belina*), crickets (*Acheta domesticus*), and stinkbugs (*Encosternum delegorguei Spinola*) are higher in protein than livestock, thus, making them valuable in addressing nutritional deficiencies and food insecurity. Kazembe et al. (2024) note how stinkbugs - *harurwa* - widely consumed across Southern Africa, are especially prized for their unique

flavour, high protein content, and micronutrient density. A seasonal delicacy traditionally harvested and consumed in Masvingo and Matabeleland, the stinkbug (*harurwa*) remains an important high-value food source in local communities. In addition, the mopane worms (*madora/amacimbi*), are particularly popular among communities with limited access to livestock (Selaledi et al., 2021). A ready source of dietary omega-3 fatty acids, iron and zinc, edible insects are thus the backbone of indigenous cuisine, providing a safety-net during seasons of food shortage (Zielińska et al., 2025; Hlongwane et al., 2021).

While rural communities continue to incorporate edible insects into their daily diets, urban markets have yet to fully embrace them beyond traditional consumption practices. As urbanisation and shifting dietary habits reshape food preferences, the underlying reasons for low urban consumption are yet to be sufficiently explored in the Zimbabwean context (Manditsera et al., 2018). Matandirotya et al. (2022) and Wade and Hoelle (2020) agree that further research into the commercialisation of edible insects is necessary to understand how they could be integrated into modern food systems while preserving cultural relevance.

Rooted in indigenous knowledge systems embedded in recipes and preparation methods often handed down from mother to daughter, edible insects are harvested, processed, and consumed to maximise their nutritional and economic value (R. Caparros Megido et al., 2024). The table below presents the traditional collection, preservation, and consumption methods of the most commonly consumed edible insects across Zimbabwe's provinces.

Table 2. Indigenous harvesting and preparation methods of commonly consumed insects in Zimbabwe.

Insect Order	English Name	Local Name (Shona / Ndebele)	Provinces Found	Consumption Stage	Seasonality	Collection Methods	Collectors	Processing for Preservation	Cooking Methods
Lepidoptera	Mopane Worm	<i>Madora</i> (Shona) / <i>Amacimbi</i> (Ndebele)	Matabeleland South & North, Midlands, Masvingo	Larval stage	Rainy season (December to April)	Handpicked from Mopane trees	Predominately Women & Youth	Degutted, boiled in salted water, sun-dried or smoked	Rehydrated for stews, fried, or roasted
Isoptera	Flying Termites	<i>Ishwa</i> (Shona & Ndebele)	Mashonaland East & West, Midlands, Manicaland	Winged adult stage	Early rainy season (after the first rains)	Attracted to light; collected by hand or traps	Families Especially Youth	Lightly fried to remove moisture; can be sun-dried	Roasted or fried as a crunchy snack
Hemiptera	Edible Stinkbugs	<i>Harurwa</i> (Shona) / <i>Umtshipela</i> (Ndebele)	Masvingo, Matabeleland South	Adult stage	Late dry season (August to October)	Shaken from trees into nets or containers	Predominantly Men	Boiled to remove secretions; sun-dried	Boiled or fried; used as seasoning or snack
Orthoptera	Locusts and	<i>Mhashu</i> (Shona)		Nymph and	Throughout	Caught by	Youth	Wings and legs	Fried, roasted,

	Grasshoppers	<i>/ Inkankane</i> (Ndebele)	Mashonaland Central, Manicaland, Matabeleland North	adult stages	the year, peaks during crop seasons	hand, nets, or traps		removed; sundried or smoked	often seasoned with salt or chilli
Orthoptera	Cricket	<i>Makurwe</i> (Shona) <i>Inyekuvhu</i> (Ndebele)	Midlands, Mashonaland West	Adult stage	Rainy season (November to February)	Collected by hand at night or early morning	Youth & children	Cleaned ; sometimes sundried for storage	; added to soups

2.3 Viability and Market Potential

Because they are low in production costs but high in demand, edible insect farming is considered economically viable. This is particularly true in areas where seasonal shortages drive up retail prices (Aigbedion-Atalor et al., 2024). This demand is confirmed by the higher price per kilogram of mopane worms as compared to the prices of beef or chicken (Babarinde et al., 2021; Chagwena et al., 2019; Siddiqui et al., 2023).

Despite this, edible insects' commercialisation remains informal and poorly structured, limiting scalability. Additional barriers to edible insects' production becoming a fully integrated agribusiness sector include supply chain constraints, lack of standardisation, and policy uncertainties (Ameixa et al., 2020). Moreover, studies in market expansion suggest that investment in processing technologies, branding, and packaging could enhance consumer trust and facilitate broader market penetration (Munson, 2021).

2.4 Environmental Sustainability and Climate Resilience

With a smaller environmental footprint due to their significantly lower emissions of greenhouse gases compared to traditional livestock such as cattle, pigs or poultry, edible insects also require far less water and feed (Szulc, 2023; Siddiqui et al., 2023). Magara et al. (2021) suggest that cattle production requires as much as six times more feed than cricket production, for instance, to produce an equivalent amount of protein.

However, caution must be taken when commercialising edible insects' production. While the wild harvesting of insects has long been a sustainable practice, large-scale farming poses potential ecological concerns, such as disrupting local insect populations and biodiversity (Hlongwane et al., 2021). More research is needed to develop best practices for insect farming that balance sustainability with production efficiency (Moruzzo et al., 2021).

2.5 Gender and Youth Inclusion in Insect Farming

Despite the acknowledged role of women and youth in the edible insects' business sector (Dokubo et al., 2023; Platta et al., 2024; Szulc, 2023), few studies have explored the undergirding systemic barriers limiting their full participation in and growth within this agribusiness sector. Women entrepreneurs in the edible insects' value chain are

casualties of discriminatory financial exclusion, as agricultural loans are typically structured for male crop and livestock farmers rather than women, let alone women in alternative protein production (Mrabet, 2023). Similarly, youth engagement remains low due to a lack of training, startup capital, and business development support (Aigbedion-Atalor et al., 2024). Addressing these gaps could inform gender-responsive agricultural policies promoting inclusive edible insect farming business models (Ameixa et al., 2020; Tanga et al., 2021).

By focusing on the economic feasibility of commercial edible insect farming from the viewpoint of the actors within its value chain, this study explores the intersection of gender, youth participation, and policy constraints in scaling up insect farming. In addition, this paper addresses administrators through policy recommendations to strengthen food safety regulations, financial access, and integration of the commercial value chain for edible insects. This research addresses these critical areas and contributes to agricultural innovation, sustainable food systems, and inclusive economic development in Zimbabwe.

The study focuses on Zimbabwe, where edible insects hold cultural significance, yet remain economically underdeveloped and where gender-inclusive market participation is underexplored. The research therefore, prioritises studies on the economic and nutritional viability of edible insects, policy analyses on market regulation and financial barriers, as well as social inclusion in gender and youth participation in the country. This narrow approach ensures that findings are directly relevant to Zimbabwe's food security and agricultural policy landscape.

By comprehensively analysing opportunities and challenges, this study offers evidence-based policy recommendations to support the sustainable development of edible insect farming in the country.

3.0 Methodology

3.1 Research Design

Adopting a phenomenological qualitative design, this study examined the personal experiences and perspectives of people making a living in Zimbabwe's edible-insect value chain. Following Pilarska (2021), this approach is especially effective in understanding how participants in a research study interpret their roles, navigate

challenges, and seize opportunities within a particular setting. Considering the scarcity of existing research on edible-insect farming in Zimbabwe, qualitative methods offer nuanced insights that quantitative approaches might miss (Morse & McNamara, 2013).

Using phenomenology allowed the researcher to deeply delve into and understand how people view edible-insect farming as a livelihood (Kazembe et al., 2024). It was particularly effective in uncovering the motivations, barriers, and future hopes of women and youth involved in this industry. The study also integrated aspects of ethnography by directly interacting with and observing insect traders, farmers, chefs, and agricultural extension workers in their work settings. To further strengthen validity, the researcher cross-referenced findings from participants coming from diverse geographic areas, and socioeconomic backgrounds.

3.2 Participants

This study included the following respondents: small-scale edible insect farmers, traders, consumers, a chef, and agricultural extension officers, all from multiple regions in Zimbabwe. Especially chosen for being involved in the edible insects' value chain, the respondents are actively involved in edible insect farming, market activities, or extension services. The research thus ensured diversity of insights into market trends, sustainability challenges, and policy-related obstacles.

3.3 Sampling Strategy

Following Chikonyani (2022), this study followed a purposive sampling strategy and so ensured the participation of key informants with experience and expertise in the edible insects' value chain. By such a selection, the method ensured that only participants most suitable in meeting the research topic were selected. In addition, snowball sampling was also employed and this enabled the study to delve more deeply into the edible insects' sector as participants voluntarily referred other individuals within the sector. In the end, this combination of the methods not only ensured diversity in representation, but also saw that both rural and urban voices were heard.

3.4 Data Collection Methods

Data were collected through semi-structured interviews, focus group discussions, and a case study to capture diverse views and specific contexts related to edible insect farming. Semi-structured interviews involved 20 participants, including farmers,

traders, a professional female chef, four consumers, and an agricultural extension officer. These interviews allowed follow-up questions while maintaining key themes covering economic benefits and barriers, cultural attitudes toward edible insects, market entry challenges, agricultural extension services, and culinary innovations involving insects. Including four consumers provided insights into their acceptance, preferences, and concerns about insect-based food products.

Additionally, the interviews with the agricultural extension officers offered valuable information about government support, availability of technical training, and potential policy initiatives to help young edible-insect farmers.

Three focus group discussions were held, consisting of groups of three, five, and six participants drawn from women traders, young entrepreneurs, and small-scale farmers.

These discussions facilitated group dialogue and experience sharing, especially on women's roles in insect farming and trading, shifting dietary and farming practices among different generations, and challenges related to accessing finance and market regulations. Participants shared their personal views on the cultural and economic importance of edible insect farming in Zimbabwe, helping to understand barriers and opportunities for market access and commercialisation.

A case study focused on a professional chef exploring innovative ways to market edible insects through new culinary approaches. The chef, a successful entrepreneur in the country, developed recipes such as gourmet dishes and cakes made with stinkbugs (*harurwa*), cricket flour bread, insect protein bars, and dishes containing mopane worms (*madora/amacimbi*). The case study examined the feasibility of integrating insects into everyday meals, consumer acceptance issues, food safety regulations, marketing and product development strategies, and the need for investment in production and distribution. Findings from this study offer insights into marketing insect-based foods in urban areas, combining traditional eating habits with modern culinary innovation to cater for the more sophisticated urban palettes.

Site visits were conducted at a traditional harvesting location to examine environmental sustainability practices, and at Mbare Musika, Harare's main urban market, to document business transactions, pricing, and interactions between consumers and edible insect traders.

An additional visit took place at the chef's food preparation facility, helping evaluate the market expansion potential within Zimbabwe's food industry and changing consumer acceptance of insect-based foods. Site visit data provided deeper context for interviews and focus group discussions, enabling thorough analysis of economic and cultural aspects of edible insect farming in Zimbabwe.

3.5 Data Analysis

Data analysis was conducted using thematic analysis as described by Braun and Clarke (2006) and Dawadi (2020). This included familiarising with the data, generating codes, creating themes, and refining identified themes. From this exercise, themes such as economic viability, gender roles, and policy constraints emerged from both inductive and deductive coding. NVivo 12 Pro software (QSR International, 2019) was used to systematically store and organise the data.

Trustworthiness of the findings followed Lincoln and Guba's (1994) guidelines, focusing on credibility, transferability, dependability, and confirmability. Triangulation, member-checking, and peer debriefing enhanced credibility. Detailed (thick) descriptions and participant selection from diverse groups supported transferability of the findings to other contexts. Audit trails and inter-coder reliability ensured dependability, and reflexivity through research journaling reinforced confirmability.

Participants provided informed consent, with guarantees of confidentiality and the right to withdraw. Data security was maintained through pseudonyms and restricted access. Ethical guidelines ensured minimal disruption to traders and farmers during fieldwork.

4.0 Results

This section presents the study's findings, organised around central themes emerging from thematic analysis of the 20 interviews, three focus group discussions and site observations. The participants' voices are synthesised here to reflect the diversity of experiences within the edible insect value chain in Zimbabwe. Findings are interpreted through the Sustainable Livelihoods Approach (SLA), the Gender and Development (GAD) framework, and the Theory of Planned Behaviour (TPB), as applicable.

4.1 Economic Viability and Market Demand

4.1.1 Income Generation Potential

Of the 20 participants, eighteen reported the farming of edible insects as offering significant potential for higher income than from livestock or conventional crops. Participants indicated that the sale of mopane worms (*madora/amacimbi*) and flying termites (*ishwa*) were particularly lucrative during seasonal scarcity. Participant 01 (a female trader at Mbare Musika, Harare) explained:

“Right now, [January] a cup of madora is \$2, but by October it’s \$5... It’s more expensive than beef or chicken because it’s seasonal.”

Figure 1: Sacks of dried mopane worms (*madora/amacimbi*) with a 5kg tin and cup used for at Mbare Musika market, Harare.



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Participant 02 echoed this observation, noting that edible insects were “more profitable than beans,” particularly when sold to urban and diaspora clients. Youth respondent Participant 03 stated:

“If I had \$500, I could order 10 buckets. Right now, I lose customers because I can’t meet bulk demand.”

Both agricultural extension officers (Participants 19 and 20) affirmed the sector's potential for income generation, particularly for small-scale rural producers. One observed:

“Insects grow fast, require less space and feed, and can provide a lifeline in arid zones where livestock can't thrive.”

These findings align with the SLA, which highlights livelihood strategies that maximise local resource use while minimising vulnerability to climate or economic shocks.

4.1.2 Urban and Diaspora Demand

Nine participants described increasing demand from both urban elites and Zimbabwean diaspora. Participant 01 stated:

“I have clients from the UK and South Africa—they buy in bulk. These insects remind them of home.”

Participant 02 noted that children and young adults in Harare now enjoy edible insects as snacks, suggesting a generational shift. This diversity in consumer interest challenges the assumption that insect consumption is confined to rural populations.

4.2 Gendered Participation and Market Access

4.2.1 Women's Dominance in Retail, Barriers in Bulk Trade

Thirteen participants (11 women and 2 male participants) identified women as central to edible insect retail and informal distribution. Participant 05, a vendor with 24 years of experience, stated:

“I do everything—from sourcing to selling. But I still can't grow. I just survive.”

Participant 06 lamented the lack of financial inclusion:

“Banks want pay slips and company papers—we don't have those.”

GAD's emphasis on systemic inequalities restraining women's agency economically is highlighted in these identified gendered barriers to capital, infrastructure and scale. Even though women are the backbone of the edible insects' trade in the country, they are excluded from both the control of the supply chain and access to formal credit.

Extension officer Participant 19 confirmed this gender imbalance:

“Women dominate the trade but have no voice in decision-making or policy advocacy.”

4.2.2 Youth and Gender Intersection

The GAD framework also explains how young women face dual exclusion: both by age and gender. The chef (Participant 18) explained:

“It’s mostly women and girls who gather and prepare insects in the rural areas. But they don’t see themselves as business owners because there’s no support to formalise what they do.”

Men, on the other hand, appeared less aware of these barriers. One male trader dismissed such gender concerns:

“If you have skills, gender isn’t an issue. It’s just business.”

This comment illustrates the gender blindness that GAD critiques, where structural inequalities are rendered invisible by dominant market norms.

4.3 Youth Engagement and Perceived Informality

Six youth participants (under 35) expressed mixed views concerning edible insect entrepreneurship. Four viewed it as innovative but lacked the financial and institutional support to commercialise it. Participant 03 said:

“I know there’s money in it, but starting is hard. No loans, no training, no business guidance.”

According to TPB, this reflects low “perceived behavioural control,” where youth recognise opportunity but lack confidence in overcoming institutional and financial constraints. Extension officer Participant 20 stated:

“Youth want modern, tech-driven ventures. Insects seem informal and unscalable unless we rebrand them.”

Participant 18 (chef) noted the role of subjective norms in shaping youth engagement:

“They avoid insect work because of stigma; it’s seen as poor people’s food.”

TPB provides a useful lens for understanding how perceived control, attitudes, and social norms converge to limit youth uptake in the sector.

4.4 Climate Change and Seasonal Constraints

All 20 participants expressed concern about the declining availability of edible insects due to erratic rainfall and environmental degradation. Participant 04 stated:

“We used to expect ishwa after the first rains. Now, the rains don’t come, and harvests are poor.”

Participant 01 added:

“No trees, no madora. Deforestation is killing our trade.”

These climate change induced disruptions threaten long-term sustainability, reinforcing the SLA’s emphasis on environmental capital as a foundation for livelihood resilience. Both extension officers stressed the need to shift from seasonal harvesting to structured farming. One said:

“Without breeding programmes and controlled farming, edible insects will remain unreliable.”

4.5 Consumer Perceptions and Cultural Stigma

4.5.1 High Demand and Traditional Value

Seventeen participants reported growing demand across all socioeconomic groups. Participant 02 noted:

“Even the rich buy from us—they just don’t talk about it. It reminds them of their childhood.”

Participant 05 explained that clients see insects as “healthy and healing” food.

Figure 2: A winnowing basket with flying termites (*ishwa*) is strategically displayed in front of traditional grains at Mbare Musika market, Harare



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4.5.2 Stigma in Urban Contexts

However, TPB's construct of 'subjective norms' emerged clearly: urban stigma persists. The chef explained:

"Insects are seen as food for the poor. In low-density suburbs, people would rather eat imported meat."

This stigma creates tension between cultural heritage and modern identity. TPB helps us understand how these perceptions can limit consumer uptake despite nutritional and environmental benefits.

4.6 Infrastructure, Capital Constraints, and Policy Gaps

4.6.1 Inadequate Storage and Security

Twelve participants cited storage and infrastructure as limiting factors. Participant 01 noted:

"We leave our produce with guards. Sometimes it gets stolen. We need proper vending stalls."

Participant 05 discussed fumigation methods:

“With fumigated rooms, I can keep madora for two years. But I can’t always afford to rent them.”

4.6.2 Lack of Capital and Institutional Support

Women and youth were especially affected by lack of collateral, documentation, and business registration. Participant 06 stated:

“We’ve never even approached a bank. We know we don’t qualify.”

Both extension officers and some youth farmers confirmed the absence of formal policies, financial instruments, or food safety standards to support edible insect production and commercialisation. Participant 08, a youth harvesting *harurwa* explained:

“Right now, anyone can sell insects with no standards. There’s no guidance for processing or packaging. This holds us back.”

This absence of regulatory frameworks aligns with the GAD perspective, where informal economies (particularly those led by women) are often excluded from policy discourse and support.

These findings indicate the transformative potential of edible insects farming as a viable livelihood option in Zimbabwe. The participants’ reflections and experiences foreground such challenges as informality in business and the dilemmas of accessing markets as well as cultural and current stigmatisation in the sector. Such dynamics differ across men’s and women’s gender, age, and role on the value chain, calling for gender-and-age-specific interventions (as summarised in Table 3). These considerations shall serve as the basis for a more in-depth theoretical discourse in the next section.

Table 3: A Summary of Participants Themes and Contributions.

Theme	Participants (n=20)	Representative Roles	Key Insights
Income Generation	18	Traders, farmers, chef, extension officers	High margins during seasonal scarcity; greater profitability than meat or beans; challenged by inconsistent supply

Gendered Market Barriers	13 (mostly women)	Female traders, chef, extension officers	Women dominate retail but lack access to finance, cooperatives, and scaling opportunities
Youth Engagement & Stigma	6	Youth traders, chef, extension officer	Youth interested but constrained by stigma, lack of training, and perceptions of informality (TPB: low perceived control and negative norms)
Climate & Seasonality	20	All respondents	Rainfall variability and deforestation reduce insect availability; support needed for controlled farming
Consumer Demand vs Stigma	17	Traders, chef, diaspora clients	Traditional value remains strong, but stigma persists in urban/elite spaces; rebranding needed for mainstream adoption
Infrastructure & Capital Gaps	12	Traders, extension officers, chef	Inadequate storage, insecure vending areas, and lack of tailored loans; traders lack documentation for formal financing
Policy & Regulation Void	7 explicitly, 5 indirectly	Chef, extension officers, youth entrepreneurs	Absence of standards and safety regulations hinders formalisation; edible insects remain excluded from national agro-policy frameworks

5.0 Discussion

5.1 Integrated Framework for Climate-Resilient and Inclusive Edible Insect Farming in Zimbabwe

This study contributes to emerging scholarship that positions edible insect farming as a viable livelihood strategy in the face of worsening food insecurity, unemployment, and climate change. Building on previous research (Kelemu et al., 2015; van Huis, 2015), it confirms that Zimbabwe's edible insect sector holds untapped potential across economic, environmental, and nutritional domains. In addition, the findings expand upon earlier studies by foregrounding the gendered and generational dynamics that shape access to market opportunities, financing, and policy influence.

Edible insect farming in Zimbabwe presents a transformative opportunity for addressing food security, economic empowerment, and climate resilience. This study

points towards there being a strong market demand for edible insects, particularly mopane worms (*madora/amacimbi*), flying termites (*ishwa*), and crickets (*majuru*). Traders have highlighted that profits from selling these insects are higher compared to those from traditional agricultural products such as beans or other sources of protein such as dried kapenta (*Limnothrissa miodon*). Nevertheless, despite this clear economic potential, the edible insects sector remains informal, hindered by seasonal insect availability, limited financial support, and a lack of clear policies for market integration. These barriers prevent edible insect farming from evolving into an organised industry capable of growth and serving both rural and urban markets, thus missing the opportunity to significantly contribute to strengthening national food security.

The study's findings align with the Sustainable Livelihoods Approach (Chambers & Conway, 1992), thereby suggesting that edible insects present vital economic opportunities, requiring minimal initial investment and helping to diversify income sources for actors in the value chain. The study confirms Musundire's (2014) assertion that there is high profitability during challenging periods. Further to this, this study also corroborates that women heavily depend on the insect trade to sustain household incomes during crises. Moreover, the fact that 18 out of 20 participants saw insects as more profitable than traditional crops strongly supports formalising this sector into a viable business.

Women play key roles along the edible insect value chain, especially in harvesting, processing, and trading. Despite holding these roles, they face challenges such as limited access to credit, a lack of technical training, and the absence of structured markets. These barriers prevent women from scaling their enterprises effectively. This gendered exclusion confirms the earlier work by Ayieko et al. (2010), who highlighted the challenges of the informal nature of women's participation in insect harvesting in Kenya. However, unlike previous studies, this research explicitly connects these barriers to institutional blind spots in Zimbabwe's financial and agricultural policy systems, which fail to recognise women-led informal enterprises in this sector. Viewed through the GAD lens, this lack of structural support perpetuates women's marginalisation in value-added agricultural sectors.

Similarly, youth participation remains low, primarily due to the perception that insect farming is informal, seasonal and lacks consistent profitability. However, young entrepreneurs who have entered the sector recognise its potential, particularly in modern processing, branding, and agribusiness development. Expanding their engagement will require targeted interventions in training, financial support, and business development to position edible insect farming as a viable career path.

This perception gap aligns with the Theory of Planned Behaviour (Ajzen, 1991), particularly the constructs of “subjective norms” and “perceived behavioural control.” Unlike previous studies that broadly cite youth disinterest in agriculture (Geza et al., 2021; M Nthoesane & Teele, 2024; Baidoo & Maame Kyerewaa Brobbey, 2023), this study shows that youth are not inherently disinterested in insect farming, they are discouraged by its informality, low visibility in entrepreneurship support programmes, and peer perceptions that associate it with poverty. The chef’s observation that youth avoid the trade due to stigma supports this interpretation.

Edible insect farming offers significant environmental advantages in addition to economic benefits. Unlike traditional livestock production, insects require minimal land, water, and feed, making them an efficient, climate-resilient food sources. These findings corroborate van Huis et al. (2015) and Matandirotya et al. (2022), who identify edible insects production as low-carbon alternatives to livestock. However, this study expands upon these environmental arguments by linking them to the lived experiences of participants. All 20 interviewees attributed declining insect harvests to climate shocks and deforestation, a point rarely emphasised in commercialisation debates. This finding reinforces the SLA’s emphasis on natural capital and validates calls for semi-intensive farming as a sustainable response to climate volatility. However, cultural perceptions present a significant challenge. While rural communities continue to incorporate insects into their traditional diets, urban consumers often associate insect consumption with poverty and outdated customs. This inclination by urban consumers confirms earlier findings by Kinyuru et al. (2015). However, this study goes further by revealing a dual perception: insects are both stigmatised and nostalgically valued among urban consumers and diaspora clients. Such ambivalence suggests that urban market resistance is not absolute and may be shifted through branding and cultural repositioning, as supported by TPB’s focus on attitudinal change.

This study therefore, suggests that culinary innovation and branding can help reposition edible insects as premium, sustainable food products. The case study of the professional chef illustrates how modernising insect-based cuisine and integrating it into gourmet markets can increase consumer acceptance, expand commercial potential and introduce edible insects to new markets.

Despite these opportunities, the absence of food safety regulations, clear processing guidelines, and financial incentives remains a significant barrier to commercialisation. Without formal government recognition and structured market support, edible insect farming risks remaining an informal, small-scale activity with limited growth potential. While previous literature has called for regulatory frameworks (Kumar & Ogwu, 2025; Lähteenmäki-Uutela et al., 2021), this study adds granularity by documenting how traders' daily realities, such as lack of hygienic vending space or packaging standards, contribute to marginalisation. Participants' calls for processing regulation and secure vending infrastructure illustrate the practical bottlenecks that policy inaction perpetuates. Addressing these regulatory and financial gaps is essential for transitioning insect farming from a subsistence practice to a fully integrated agribusiness sector.

5.2 Barriers and Opportunities in the Edible Insect Sector

This study confirms the role of edible insects in providing nutritious, seasonally available food, especially in rural communities. In addition, edible insects promote diversity in diet as well as economic stability in the value chain actors' households. Despite its encompassing significant potential as a livelihood strategy, the sector remains informal. Unlike previous research by Simatele and Kabange (2022), which viewed informality as a form of external financial marginalisation, this study identifies it as a failure of formal policy structures contributing to the exclusion of actors within the edible insects' value chain in Zimbabwe from accessing the resources and institutional frameworks they need to thrive in their industry.

The exclusion of edible insect farming from agricultural financing, food safety regulations, and market development highlights the absence of a clear government vision, not merely a lack of market development. Women traders lament the lack of financial support and organised structures, which they identify as a barrier to their

accessing higher-value markets. Similarly, limited financing, training opportunities, and structured industry frameworks prevent youth from fully participating in the sector.

Consumer attitudes continue to influence market dynamics, with urban residents hesitant to consume insects due to an acquired cultural stigma as a result of colonisation and a lack of awareness of edible insects' nutritional benefits. However, emerging trends in health consciousness, local sourcing, and dietary shifts indicate that this stigma is gradually decreasing. This paradox of persistent cultural stigma alongside growing demand, builds upon Verbeke's (2015) observations, suggesting that emotional and cultural perceptions can shift when aligned with sustainability, health benefits, or local identity.

The increasing recognition of traditional foods and their health benefits, including edible insects, presents opportunities for urban market expansion. Culinary innovation has become a powerful tool in reshaping consumer perceptions. Effective marketing, product development, and contemporary preparation techniques can further enhance acceptance and demand. Nonetheless, large-scale commercialisation remains challenging without formal food safety regulations, clear production standards, and financial incentives. Official government recognition and support for structured markets are crucial in transitioning insect farming from informal practices into a formal, thriving industry.

5.3 The Sustainable Edible Insect Farming Framework

For Zimbabwe to fully harness the potential of edible insect farming, a comprehensive, multi-sectoral approach is required. This approach integrating insights from the Sustainable Livelihoods Approach (SLA), Gender and Development (GAD) theory, and the Theory of Planned Behaviour (TPB), should combine climate resilience, social inclusion, government support, and consumer education, transforming edible insect farming into a structured and profitable industry.

Central to this strategy is promoting controlled insect farming, shifting from traditional harvesting toward more efficient and sustainable methods of production. Integrating edible insect farming into circular agriculture would serve to enhance industry resilience by using organic waste to produce low-carbon food sources. Investing in climate-smart harvesting, processing, and preservation methods reduces post-harvest losses and improves product quality.

An industry model that fully integrates women is essential for equitable participation. Expanding women's access to financial resources through microfinance, savings groups, and government-backed credit schemes would enable them to scale up their businesses. Forming cooperatives and business training programmes would help women access formal markets and increase productivity. Enhancing women's leadership along the edible insect value chain, ensuring their involvement in decision-making and policy processes, would address barriers they currently face.

Youth participation is another crucial component. Establishing youth-targeted incubation hubs offering mentorship, business training, and seed funding supports young entrepreneurs interested in insect farming. Creating a National Youth Edible Insect Association could facilitate networking, advocacy, and knowledge exchange. Moreover, leveraging digital platforms for e-commerce, social media marketing, and brand development can open new market opportunities for insect-based products.

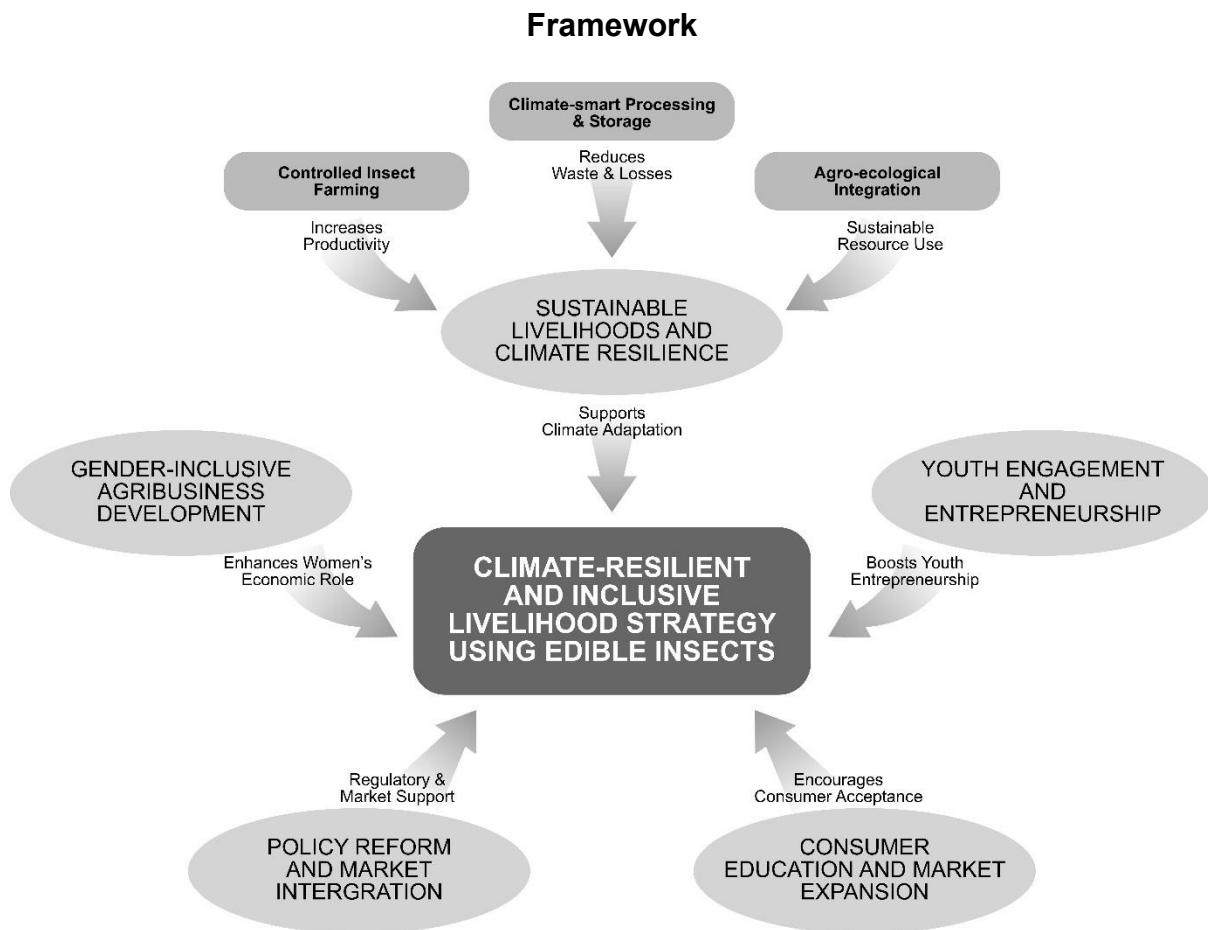
Policy reform and structured market integration are key to the industry's long-term sustainability. Developing clear food safety standards and production regulations helps protect consumers and builds market trust. Recognition of edible insect farming within government agricultural policies, along with financial incentives, will encourage investment. Private sector partnerships are also vital, driving commercialisation efforts through investment in edible-insect food processing and supply chain improvements.

Consumer education forms another cornerstone of this strategy. Culinary innovation should be actively employed to shift consumer perceptions positively. Introducing gourmet insect-based dishes, high-protein snacks, and value-added products can appeal to urban consumers. Nationwide public awareness campaigns will reduce stigma, educating consumers on the health benefits, cultural value, and environmental sustainability of edible insects. There is also potential for market expansion among Zimbabweans living abroad, who have indicated an interest in packaged edible insects to reconnect with their cultural heritage.

This study proposes the **Sustainable Livelihoods & Climate Resilience Edible Insects Framework** (see Figure 4) illustrating how edible insect farming can become a climate-resilient and inclusive livelihood strategy in Zimbabwe. The framework integrates controlled insect farming, climate-smart processing and storage, and agro-ecological practices to promote sustainable livelihoods and climate adaptation in the

country. Central to this strategy are gender-inclusive agribusiness development, youth engagement and entrepreneurship, supportive policy reforms, and comprehensive consumer education. By addressing each of these critical dimensions simultaneously, Zimbabwe can transition edible insect farming from informal survival activities into a structured, economically viable, and socially inclusive industry.

Figure 4: Sustainable Livelihoods & Climate Resilience Edible Insects



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5.4 Implications for Policy, Practice, and Future Research

The findings of this study emphasise the urgent need for regulatory frameworks that formalise edible insect farming, establish food safety guidelines, and integrate the sector into national food security strategies. Policymakers must prioritise the development of financing mechanisms and training programmes for women and youth entrepreneurs to ensure equitable access to market opportunities. The private sector can be crucial in commercialising edible insect-based foods by investing in product development, branding, and distribution channels.

6.0 Future Research

Future research should focus on scaling up edible insect farming through controlled breeding techniques, mechanised processing, and structured supply chains. Shifting

from traditional wild harvesting to semi-intensive and intensive farming systems could enhance production efficiency and ensure a stable, year-round supply of edible insects. Investigating how structured farming improves supply chain consistency and quality control would provide critical insights into making insect farming a commercially viable agribusiness. Furthermore, assessing the environmental impact of scaling up production would be necessary to ensure that sustainability remains a core component of edible insect farming.

Understanding consumer perceptions, particularly in urban areas, is crucial for expanding the market for insect-based foods. Research should explore how cultural attitudes, dietary preferences, and purchasing behaviours influence the acceptance of edible insects. A deeper analysis of consumer willingness to pay for processed or value-added insect products could guide branding, marketing, and distribution strategies. Additionally, studies on the effectiveness of culinary innovation and food product diversification in increasing consumer appeal could provide essential insights for industry players looking to reposition edible insects as premium, nutritious, and sustainable food options.

At the policy level, future research should investigate the best approaches for integrating edible insect farming into Zimbabwe's national food security strategies and agricultural sustainability frameworks. Studies could examine how policy reforms, food safety regulations, and government incentives could support the sector's transition from an informal trade to a structured, regulated industry. Research should also assess the potential for public-private partnerships in promoting insect farming and the role of development organisations in providing technical training, financial support, and infrastructure investment. Addressing these research gaps would provide a solid foundation for developing evidence-based policies and business strategies, positioning Zimbabwe as a leader in alternative protein production and climate-resilient agriculture.

7.0 Conclusion: A Call to Action

Edible insect farming offers a promising, climate-resilient, and inclusive pathway to tackle Zimbabwe's food security and livelihood challenges. This research highlights that insects like mopane worms (*madora/amacimbi*) and termites (*ishwa*) are not only nutritious and environmentally sustainable but can also generate substantial profits,

especially for informal traders, women, and youth. Yet, as findings show, this potential remains limited by the informality of the sector, climate-related uncertainties, lack of funding, and persistent cultural stigma around insect consumption.

To transform insect farming from a crisis-response strategy into a structured agribusiness industry, intervention is required at multiple levels as proposed in the Sustainable Livelihoods & Climate Resilience Edible Insects Framework. Policy reform is urgently needed to ensure integration into agricultural financing, establishment of clear food safety regulations, and product quality standards. Such policy changes will not only position insect farming within official agricultural programmes but also attract investment and business innovation.

Women, central to harvesting, processing, and trading, must receive financial and institutional support to scale their businesses, formalise their operations, and enter higher-value markets. Addressing gender disparities in access to credit, training, and cooperative groups strengthens women's economic participation and boosts overall industry growth.

These measures align with the Gender and Development (GAD) approach, highlighting that structural constraints, rather than women's individual capabilities, limit their advancement in agribusiness. Ensuring women's leadership roles, financial access, and inclusion in formal cooperatives is critical for achieving equitable industry development.

Similarly, youth engagement must be actively encouraged through structured training programmes, financial incentives, and entrepreneurship initiatives in insect farming, processing, and product innovation. Drawing on the Theory of Planned Behaviour (TPB), this study indicates young people's perceptions of stigma and informality reduce their willingness to engage, despite the economic opportunities. Public awareness campaigns, youth-oriented training centres, and digital platforms could significantly change these perceptions and stimulate youth-driven innovation in the sector.

Consumer education and culinary innovation will play crucial roles in reshaping perceptions and expanding market reach. Overcoming stigma and positioning insects as desirable, healthy, and sustainable requires targeted marketing, brand-building, and diverse product offerings.

This study suggests rising sustainability awareness and growing health consciousness, particularly among urban residents and Zimbabweans abroad, present new market opportunities. Food innovators and chefs will be essential in reshaping consumer acceptance through novel food products and high-end culinary experiences.

Integrating insect-based products into mainstream food industries, supported by clear food safety regulations and quality standards, will further legitimize the industry. For Zimbabwe to fully exploit this opportunity, a collaborative, evidence-based approach involving policymakers, researchers, entrepreneurs, agricultural workers, and communities is essential.

Such an approach, built on the Sustainable Livelihoods Approach (SLA), will position insect farming as both a climate-resilient food source and an inclusive economic development tool. By enacting cohesive policies, investing in inclusive infrastructure, and consistently educating the public, Zimbabwe can become a leader in promoting alternative protein sources, ensuring food security, climate resilience, and economic equality for all.

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Climate Change Financing for a Just Transition in Africa: Avoiding ‘A race to the bottom scenario’.

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Abstract

The article deploys the theory of stupidity to unpack the concept of the ‘race to the bottom’ scenario. The article argues that stupidity has incentives, and not inherently a mental defect. In the context of Africa’s response to the climate change funding crisis, “the race to ruin” entails a downward spiral scenario which results in anthropocentric extractivism in poor African countries. By competing in lowering standards so as to remain competitive in attracting foreign investment, African states are competing for environmental ruin and social dislocation. While the immediate effect of the scenario may boost economic activity, the long-term consequences can be disastrous. The article uses documentary analysis to argue that Africa’s response to the climate change crisis has been mixed and at worst characterised by ruin and dislocation. This scenario underscores the need for African states to balance economic competitiveness with the need for ecocentrism and sustainable practices. The article proposes that Africa must of necessity take a united stand against neo-imperialistic and green washing solutions for climate justice to be achieved on the continent. Additionally, it emphasizes the necessity of responsible practices in the adoption of financing models that are underpinned by a resolute commitment to good governance.

Key words: Climate change, anthropocentric extractivism, ecocentrism, sustainable development

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1.1 Introduction

Developing nations, which are highly vulnerable to climate change impacts, require substantial financial investments for transitioning to low-carbon economies (Maria *et al.*, 2023). This transition must be "just," by ensuring that it does not exacerbate existing inequalities or create new ones (Mattar *et al.*, 2021). For Africa, a critical challenge lies on how to mobilise international climate financing models which promote equitable outcomes and avoids a "race to the bottom," where countries compete to lower environmental and social standards to attract investment. This necessitates careful consideration of the types of financial instruments used, the governance structures in place, and the integration of social justice principles into climate policy.

The notion of a 'just transition' entails a fair and inclusive shift towards low-emission and climate-resilient smart economies. McCauley *et al.* (2022) note that a 'just transition' encompasses distributive, procedural, and restorative justice dimensions. Distributive justice relates to the fair distribution of the costs and benefits of climate policies that ensures vulnerable groups are not disproportionately burdened. Procedural justice on the other hand involves inclusive and participatory decision-making processes while restorative justice addresses historical injustices of past environmental harms by the rich countries of the North (Sharman, 2022). So, the issue becomes who owes who between the North and South for the just transition?

The principle of 'just transition' is crucial in framing global climate response strategies and resonates well in Africa. Despite contributing less than 4% of global greenhouse emissions, Africa disproportionately bears the devastating brunt of climate change impacts (Winkler *et al.*, 2021). For the continent to achieve a just transition, substantial financial resources are required through global financing mechanisms that are based on equity, inclusivity and sustainability. Based on the 2015 Paris Agreement which emphasised the 'Polluter-Pays Principle', developed countries as duty bearers, have a moral obligation to compensate financially, the less developed countries, in adapting and mitigating the vicissitudes of climate change. Yet, in practice, Africa faces significant challenges in accessing adequate and fair financing, raising concerns about a potential "race to the bottom" scenario in the continent.

In the context of Africa, 'the race to the bottom' scenario entails a risk of the continent being locked into a vicious cycle of dependency and underdevelopment. This situation

involves poor African nations competing or being forced to accept insufficient or exploitative financing arrangements from rich polluting nations as 'green washing' strategies. These 'green washing strategies' are deceptive and ultimately not in the best interests of the African continent. So, the article argues that, in the absence fair and inclusive transformative approaches to climate financing, Africa remains a victim of a race to the bottom scenario which undermines the 'just transition' principle. There is therefore, an urgent need for global accountability and innovative strategies that promote local empowerment and sustainable responses for climate change financing mechanisms in the continent

1.2 Africa's Unique Climate and Development Challenges

Africa is particularly vulnerable to climate change, with the continent facing some of the most severe impacts despite contributing less than 4% of global emissions (Beakman and Reeler, 2021). The continent's vulnerability to changing climate is due to an array of factors encompassing historical, geographic, socioeconomic and infrastructural. The vast majority of Africa's population depend on climate sensitive livelihoods that are already strained by erratic rainfall patterns, prolonged droughts and floods (Morake *et al.*, 2021). Additionally, Morake *et al.* (2021) note that South-eastern African coastal regions, such as those in Mozambique and Madagascar, are facing increased threats of rising sea levels and more frequent tropical cyclones which endanger both infrastructure and livelihoods. Lowitt (2021) posits that Africa has warmed by more than 1 degree Celsius since 1900, with an increase in heat waves and hot days, with dire consequences for the poor and vulnerable key populations. Rising temperatures have caused numerous consequences upon the African continent through El Nino induced droughts, heatwaves, diseases and the depletion of water levels. For example, the depletion of inflows from the Zambezi River in Southern Africa has affected electricity generation for Zimbabwe and Zambia with severe impacts on livelihoods and development (Dube & Nhamo, 2019). These increased extreme weather events, associated with Africa's geographic positioning, are threatening human health, food and water security, and socio-economic development of the continent.

In addition to environmental challenges, Africa's vulnerability is further compounded by her economic dependence on natural resource-based industries like agriculture,

forestry, and fisheries which are directly prone to climate variability. For instance, the United Nations (UN) (2024) observes that millions of people in East Africa have been pushed into hunger and poverty through severe droughts which have disrupted crop yields and exacerbated food insecurity. For instance, water scarcity due to droughts has significant implications for agriculture, industry and domestic consumption. El Nino induced droughts in the southern African region have caused environmental and livelihood havoc that is affecting agricultural activities, leading to reduced crop yields, famine, disease and health issues. The International Panel on Climate Change (IPCC, 2022) avers that warmer temperatures and changing rainfall patterns are increasing the spread of diseases like malaria, dengue fever, yellow fever, cholera, typhoid amongst others. For example, countries like Zimbabwe and Zambia were recently affected by cholera and typhoid due to poor water quality, especially in urban areas.

The economic fragility of the continent is worsened by widespread poverty. It is estimated that nearly 40% of sub-Saharan Africa's population live in extreme poverty which creates a vicious cycle of vulnerability and underdevelopment in the region (Abdullahi *et al.*, 2024); Berthélemy, 2021). Financial constraints and widespread poverty limit the ability of households and governments to recover from climate shocks undermining adaptation and mitigation efforts.

Furthermore, it has been noted that poor governance and infrastructure pose significant challenges to Africa's adaptation and mitigation efforts. Mwije (2013) observes that poor governance, including corruption, political instability and fragile institutions contribute immensely to the continent's inability to respond effectively to climate shocks and disasters. He notes that weak governance structures and corruption contributes significantly to the risk of a "race to the bottom" resulting in climate finance funds being diverted to private interests and environmental regulations poorly enforced. The weak institutional and governance structures are a key contributing factor to environmental injustice in Africa. This creates opportunities for unsustainable and inequitable projects to be approved and implemented. These challenges results in the weakening of institutional responses to climate change thereby hampering effective policy implementation or ability to secure climate funding.

In addition, the United Nations Office for Disaster Risk Reduction Report (2024) notes that infrastructural deficits like poor transportation and communication networks, water

management systems, and energy infrastructure compromise disaster response capacity and efforts. Thus, countries with fragile political and economic institutions, like Somalia, Sudan and South Sudan, have experienced internal displacements and refugee crisis due to devastating environmental issues which could have been managed. These factors, combined with rapid population growth and unplanned urbanization, exacerbate stress on already scarce resources thereby increasing the continent's exposure to climate risks.

So, ultimately these unique climate and development challenges confronting Africa highlight the urgent need for tailored and equitable climate financing mechanisms that are inclusive in building resilience among vulnerable communities. Africa's plight in the fight against global greenhouse gas emissions underscores the need for collaborative global effort, including financing, in addressing these challenges realising the disproportionate burden the continent bears.

1.3 Drivers of the "Race to the Bottom" in African Climate Finance

The concept of a "race to the bottom" describes a socio-economic concept in which individuals, companies or states compete in reducing the utility of a product or service in response to perverse incentives (Qatley, 2024). It is a reductionist gamble that results in a situation where entities or countries compete to achieve the lowest standards, costs or regulations, often at the expense of the environmental, social or labour standards (Qatley, 2024; Albert, 2020). In climate financing the race to the bottom entails a potential scenario where corporates or countries, in an effort to attract investments, lower environmental standards or engage in competitive devaluation of climate commitments thereby undermining global efforts to combat climate change (Madsen, 2009). In the context of Africa's response to the climate change crisis, the race to the bottom is particularly concerning, as it can undermine efforts to achieve a just transition to a low-carbon economy.

Bokpin (2017) argues that the intense competition to attract foreign direct investment (FDI) and climate finance, which African nations often face, leads to a weakening of environmental and social regulations in order to attract investors. The competition and pressure for FDI is often exacerbated by the conditionalities attached to some climate change investments thereby disregarding their social or environmental impacts. Thus, the relaxation of environmental standards to attract investment may ultimately

compromise the recipient countries' abilities to mitigate and adapt to climate change. The South African Department of Environmental Affairs (DEA) (2011) posits that a concerning trend in Africa is the weakening of environmental regulations, which can have severe consequences for the continent's ecosystems, biodiversity and human well-being. Lowitt (2021) argues that the weakening of environmental regulations poses a major barrier to African economic growth and development. For instance, the influx of Chinese and Russian mining companies in Africa has given rise to human rights violations and environmental injustices across the continent.

Another critical driver to the 'race to the bottom' relates to capacity deficits. African nations lack institutional capacities to fully assess the environmental and social risks of proposed projects resulting in failure to negotiate favourable terms that protect their interests. This can result in the acceptance of projects that are ultimately detrimental to their sustainable development goals. Makgetla (2021) submits that lack of capacity and resources by many African countries for implementing and enforcing environmental regulations as critical in Africa's inability to negotiate meaningfully in international climate fora. Despite the presence of sound legal frameworks for environmental protection, African countries have had operational challenges in implementation and enforcement of these laws due to resource constraints as well as inadequate skills. Furthermore, corruption and governance issues have also undermined the effectiveness of environmental regulations and enforcement (Fanning *et al.*, 2022). This has resulted in African ruling elites prioritising personal gains at the expense of prudent environmental stewardship.

Bracking & Leffel (2021) posit that international climate change financing mechanisms are increasingly relying on market-based approaches, such as blended finance and debt-based financing mechanisms. They (ibid) argue that the reliance on market-based approaches to climate financing has a tendency of shifting power towards market actors which negates the efficacy of good climate finance governance. Such approaches may ultimately prioritize financial returns over social and environmental outcomes thereby leading to investments that do not align with the principles of a just transition. Hence, there is need for strong public oversight and regulation for ensuring that market-based climate finance promotes equity and sustainable development. Thus, in the face of climate change challenge, there are potential risks of African

countries engaging in a 'race to the bottom' through prioritising short-term economic gains over long-term sustainability and environmental protection (IPCC, 2022).

Additionally, Cahill and Allen (2020) submit that external factors such as multinational corporations and foreign governments may exert pressure on African countries to weaken environmental regulations to facilitate investment and economic opportunities. Some examples include Chinese investment in infrastructure. China's Belt and Road Initiative (CBRI) has led to significant investments in African infrastructure, including roads, railways and ports. While this has brought economic benefits, it has also raised concerns about debt traps, environmental degradation and labour exploitation. For an example, Maseko (2021) asserts that international oil companies, such as Shell and Chevron, have significant influence over Nigeria's oil industry, often at the expense of environmental and social concerns. This has led to accusations of exploitation and neglect of local communities. The DEA (2011) posits that while external actors may bring benefits, such as investment and technical assistance, it is essential that African sovereignty and developmental needs are prioritised.

Fanning *et al.* (2022) submits that the exploitation of natural resource is a significant risk of a race to the bottom by African countries. As countries compete to attract investment and promote economic growth, they may be tempted to relax environmental and social regulations, leading to the exploitation of natural resources and undermining sustainable development. Some of the risk of exploitation includes environmental degradation, including deforestation, pollution and habitat destruction, social impacts. The exploitation of natural resources can have negative social impacts including displacements of communities, human rights abuses and increased poverty. For example, the Democratic Republic of Congo's mining sector has been plagued by corruption, environmental degradation, and human rights abuses, as foreign companies exploit the country's rich mineral resources. Glazebrook & Opoku (2018) also notes that Ghana's gold mining sector has been criticised for its disregard for environmental and social impacts, including deforestation, water pollution and displacement of communities.

IPCC (2022) notes that the neglect of climate resilience is a significant risk of a race to the bottom by African countries. As countries compete to attract investment and promote economic growth, they may be tempted to neglect climate resilience and

adaptation measures leaving them vulnerable to the impacts of climate change. Cahill and Allen (2020) posit that some of the risks of neglecting climate resilience include increased vulnerability to climate related disasters. African countries are already experiencing the impacts of climate change, including more frequent and severe droughts, floods and heat waves. Climate-related disasters can have devastating impacts on livelihoods and economic opportunities, particularly in rural areas where communities are heavily dependent on natural resources. For example, Mozambique has significant coal reserves, and the government has prioritised coal mining as a key driver of economic growth. However, the mining activities have led to the deforestation, water pollution, and displacement of local communities. The government has been criticised for failing to enforce environmental regulations and prioritising the interests of foreign mining companies over the needs of local people. Ghana is one of the largest gold producers in Africa, and the mining industry has been a significant contributor to the country's economy. However, the industry has also been linked to environmental degradation, water pollution, and human rights abuses, (Tuokuu, *et al.*, 2025).

1.4 Assessment of Africa's Response to the Climate Change Crisis.

The question that begs answers is why African leaders participate in this competition for inanity? Can it be an issue of ignorance or complicity? It is within this context that the theory of stupidity has been deployed to interrogate the competition to ruin. According to Cipolla (2011) the theory of stupidity examines how rational actors, operating within a defective system, can collectively produce suboptimal and even harmful outcomes. In this context, the "theory of stupidity," describes how cognitive biases within institutions and policy-making processes leads to systemic failures arising from flawed incentives and limited information. In essence, the theory of stupidity argues that stupidity is essentially a sociological and rather than an intellectual defect. Similarly, Bonhoeffer (1940) (in Barret, 2000) argues that there are incentives for stupidity and actors can actively participate to maximize short-term benefits at the expense of rationality. This theoretical framework has been deployed to unpack motives for the race to the bottom in Africa, which are driven by greed and self-enrichment rather psychological or mental imbalances. Despite the potential benefits of global climate finance to Africa, it can inadvertently contribute to the

continent's exploitation and underdevelopment through flawed governance and corruption which undermines people and planet sustainability.

Indeed, the continents' efforts to address climate change have been inconsistent and often prioritised short-term economic gains over long-term social and environmental justice. This has led to a scenario where African countries compete to press the self-destructive mode button in order to attract investment and financing, often at the expense of environmental and social standards. Lowitt (2021) argues that the consequences of this approach are far reaching and devastating with Africa becoming increasingly dependent on global climate financing. Resultantly, this creates a culture of dependency which undermines domestic resource mobilisation and solutions to the climate crisis. Moreover, the focus by African countries to attract foreign investment at all costs has led to a culture of anthropocentric extractivism with negative effects on development.

Lowitt (2021) submits that the resulting anthropocentric extractivism has had disastrous consequences for local communities and the environment. The exploitation of natural resources has led to environmental and social dislocation, deforestation, pollution and habitat destruction that is threatening livelihoods, biodiversity and ecosystems. The DEA (2011) notes that the unbridled pursuit for Africa's natural resources by foreign players has led to human rights violations, including labour abuses, internal displacements, and violence against local communities. Examples of human rights abuses in the pursuit of natural resource extraction includes Congo's Coltan Mines. The Democratic Republic of Congo's Coltan mines have been linked to child labour, forced labour, and violence. Militias and rebel groups have violently taken control of mines and have been using the proceeds to fund their activities which has spurred conflict in the region. The South African Marikana Platinum Mine incident in 2012 is also a case in point, where police killed dozens of miners who were agitating for better wages and working conditions. The incident has highlighted the poor labour conditions and disregard for human rights issues in South Africa's mining industry.

1.5 Towards a Theory of Climate Finance Justice for Africa

The clarion call for Africa to avoid the race to the bottom entails a fundamental shift in mindset and approach to the climate financing paradox. Instead of African leaders viewing climate finance as a means to attract investment at any cost, the continent

should embrace a vision of climate finance justice, where climate investments are aligned with social equity goals in building resilience to climate change impacts. This requires effective governance build on strong leadership and a commitment that prioritizes the long-term well-being of people and the planet.

By adopting a "theory of stupidity" lens, those mandated with policy making, both public and private, must identify and address the systemic failures leading to suboptimal outcomes. Africa must leverage global forums like United Nations Conferences of Parties (COPs) for marshalling collective action to tackle the climate change financing crisis (Atwoli *et al.*, 2021). Atwoli (ibid) avers that fundamental and equitable changes to African governance are needed to reverse the current trajectory and instead, strive for a climate finance system that truly benefits Africa. Mattar *et al.*, (2021) also suggest that African policymakers should pursue climate financing frameworks that are broad-based, recognizing diversity and intersectionality, for a just transition in Africa. This calls for policy reforms that are geared towards equitable climate financing that ensures funding reaches those who need it most to avoid social and environmental dislocation. Such policies must promote transparency, and ensure accountability in the use of climate funds.

African countries are also called upon to strengthen a collective approach in seeking innovative climate financing mechanisms. Regional economic communities must collaborate in pooling resources, knowledge sharing, and joint climate projects implementation. Such a collective approach will help strengthen Africa's negotiating power and resource mobilization efforts at global climate finance negotiations, like the COPs. This calls for African countries to adopt innovative and collaborative financing mechanisms, that leverage on green bonds and public-private partnerships. These financing mechanisms must be geared towards helping in attracting investments while at the same time maintaining environmental stewardship. There is therefore a powerful and timely call for African countries to unite against neo-imperialistic and green washing solutions that undermine climate justice in the continent.

Africa will require significant capital mobilisation, through harnessing both public and private resources to achieve a just transition. The Just Energy Transition Partnership (JETP) and other global and continental partnerships through the African Development Bank (AfDB) Climate Action Plan are crucial platforms for Africa to leverage on for just

transitions to low carbon and smart economies. At country level, resources can be mobilised by strengthening regulation, and institutional arrangements, public-private partnerships and adopting innovative business financing models for climate adaptation and mitigation. IPCC (2022) postulates that the just transition has significant replications for all social partners. Therefore, a just transition in Africa will require collective action, shared vision and a high degree of trust among all parties. This will ensure that climate investments in Africa do not prioritize profits over people and the continent, which are the key pillars of sustainable development.

1.6 Conclusion

The urgency surrounding climate change and its financing calls on Africa to strategically reposition herself on the global arena. A fundamental shift in mindset and approach is vital in avoiding a "race to the bottom" in climate financing for Africa. Future policy directions for climate financing in Africa must of necessity include strong and robust governance structures based on inclusive and transparent decision-making processes essential for just transitions. This includes strengthening regulatory frameworks, promoting accountability, ensuring public participation in climate finance decisions, and combating greed and corruption.

A just transition for Africa must ensure the support and protection of vulnerable communities throughout the process by integrating social justice into climate solutions. Instead of viewing climate finance as a means to attract investment at any cost, African countries should embrace a vision of climate finance based on social and environmental justice. This calls for probity in scrutinizing foreign climate investments so that they align with sustainable development goals, promote social equity, and build resilience to climate change impacts. To avoid the pitfalls of the race to the bottom, Africa requires effective governance systems built upon strong leadership, and a commitment to prioritizing the long-term well-being of the African people and continent.

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Cultivating Resilience: Climate-Smart Agriculture Innovations and sustainable land use in Chimanimani district of Manicaland Zimbabwe

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Abstract

Climate-smart agriculture has emerged as an innovation, offering an alternative viewpoint on sustainable farming and community development, agroecology, biodiversity and conservation in the face of increasing macroclimate change risks and shocks. This research evaluates the transformative impact of the Community Food Nutrition Security and Health Promotion Programme (CFNSHPP) using a comprehensive methodology informed by a solid theoretical foundation, to attain the research results. The research utilised a convergent parallel mixed-methods approach, incorporating focus Group Discussions (FGDs), qualitative Key Informant Interviews (KII), and survey. The principles of agroecology and the sustainable livelihoods framework served as the underpinning theoretical framework for the study. The researchers sampled at least 40 farmers in Chimanimani, 10 KIIs and stakeholders to document the perspectives and real-life experiences, creating a clear picture of their journey toward climate justice, resilience and coping strategies. The research revealed that, there has been a significant shift, with smallholder farmers implementing a range of climate-smart agriculture (CSA) techniques, approaches and methods like integrated crop-livestock eco systems, biodiversity, conservation agricultural ecosystems, and agroforestry. It revealed that smallholder farmers experienced increased crop yields and soil health, new revenue streams and increased household food security, as innovative and tangible results. The study highlights the role played by social capital and community-based institutions in boosting farming communities' resilience and coping strategies. The study identified the need for robust monitoring and assessment protocols, capacity building in Climate smart agriculture, social cohesion approaches and restricted access to agricultural inputs as hampering the attainment of food security by the farmers. The research revealed that policymakers and development professionals need a roadmap that highlights the importance of growing CSA programs, fortifying supply chains, and promoting community-driven strategies. This study provides optimism by asking stakeholders across Sub-Saharan Africa to adopt climate-smart agriculture as a strategy for attaining climate justice, food security, and sustainable development. The Caritas Mutare model is a prime example of how resilience and modernization driven by the community can change lives in the face of changing weather patterns.

Keywords: *Climate-smart agriculture, agroecology, sustainable livelihoods, community resilience, Diverse foods, Food security, Innovations, Sustainable land use*

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1.0 Introduction

Weather changes have key consequences for food security and agricultural efficiency, particularly in susceptible regions like Sub-Saharan Africa. The adverse consequences caused by climate change, such as persistent droughts, unpredictable rainfall patterns, and extreme weather events, have had a significant impact on Zimbabwe, a nation heavily dependent on smallholder agriculture (Rurinda et al., 2020). These complications have led to the development of innovative agricultural practices that improve agricultural output and enhance climate changeability resilience, justice and social cohesion. Climate-Smart Agriculture (CSA) is a promising solution to enhance agricultural productivity, build social cohesion, strengthen resilience and copying strategies and reduce greenhouse emissions thereby maintaining the biodiversity and ecosystems in place (Lipper et al., 2014). Two fundamental doctrines of this paradigm - agroforestry and agroecology - have gained traction among Zimbabwean communities. Food security, social cohesion, environmental degradation, sustainable development and climate change adaptation are interrelated issues that are addressed by these strategies (Mango et al., 2018).

Agroecology promotes the integration of traditional ecological knowledge, comprehensive agriculture system management and biodiversity preservation. This approach utilises regional resources and customs for the intensification of agricultural productivity, social cohesion and resilience. According to Altieri (2002), agroecological techniques can meaningfully increase crop yield and soil health while at the same time fostering biodiversity, climate adaptation and ecosystem preservation. Agroecological techniques like crop rotation and intercropping, have shown to increase food security and climate resilience, have been embraced by farmers in Zimbabwe (Mango et al., 2018). The deliberate incorporation of fruit trees and wild shrubs into livestock operations or farming systems is known as agroforestry. Among the many benefits of this approach are improved soil fertility, reduced erosion, and a variety of income sources (Mbow et al., 2014). In Zimbabwe, practices for instance planting fruit trees in corn fields help farmers weather economic recessions by varying their plies of livelihoods with various sources of income and providing extra nutrition.

Climate-smart agriculture programs have been greatly aided by government-led initiatives that have followed the notion of Zimbabwe being an agriculture led economy, address SDG1 on poverty and hunger and in line with the National development strategy 1. To develop food security in the face of weather changes, Zimbabwe's Command Agriculture program, mechanization program, Fast track land reform, pfumvudza/Intwasa, Presidential Input Support Scheme (PISS), aimed to boost food production through government assistance and subsidized inputs. Even though these initiatives have shown promise, they usually run into issues with long-term resilience and sustainability (Zhou et al., 2017). Since zero tillage techniques can improve soil health and reduce erosion, the government has supported them, which supports sustainable agricultural practices (Hikwa et al., 2016).

The Community Food Nutrition Security and Health Promotion Programme (CFNSHPP), implemented by Caritas Mutare in Zimbabwe's Chimanimani district has taken the principal role in championing climate-smart agriculture and sustainable land use practices for sustainable development, food security and social cohesion in the area. A faith-based development group, Caritas Mutare has made a significant impact on local communities, helping to scale and execute climate justice, biodiversity conservation, food security and sustainable agriculture projects. Caritas Mutare assists communal farmers in adjusting to climate change through engaging in programmes that increase food security and establish sustainable livelihoods.

This study examined the program interventions and actual outcomes of Caritas Mutare's CFNSHPP, highlighting the ways in which agroforestry and agroecology techniques enhanced the resilience, improve social cohesion, conserve biodiversity and increase productivity of agricultural systems in the Chimanimani region. The study focused on the project objectives of sustainable development looking at conservation of biodiversity, increase food security and change in income levels per household and climate justice that focused on resilience building, sustainable land use and copying strategies. According to FAO, 2018, "sustainable agricultural practices can serve as a foundation for food security and nutrition, particularly in the face of climate change." The research captured the experiences and lessons learned from Caritas Mutare's CFNSHPP, and offered significant perceptions for scholars, legislators and

lawmakers, and development specialists working on climate-smart agricultural and sustainable land use programs in Sub-Saharan Africa.

2.0 Theoretical Framework: Agroecology and Sustainable Livelihoods

The sustainable livelihoods and agroecological frameworks serve as the theoretical foundation underpinning this study informing the methodological approach. According to Altieri (2002) The integration of traditional ecological knowledge, biodiversity conservation, and the optimization of natural processes to boost resilience and productivity form a holistic approach to sustainable land use that can result in conservation of biodiversity, increased food security, and climate change resiliencies that can build social cohesion and result in sustainable development. "Agroecology is based on the idea that a cultivated ecosystem is analogous to a natural ecosystem in terms of the functions and services it provides," as stated by Altieri (2002). The framework for sustainable livelihoods offers a comprehensive perspective on how people and communities navigate the intricate network of physical, natural, social, economic, and environmental concerns that affect their capacity to preserve and improve their well-being (Scoones, 1998). According to Scoones (1998): "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living."

The study is informed by how smallholder farmers have adopted agroecological practices to create sustainable livelihoods and boost their resilience to climate change, which is particularly significant in the context of climate-smart agriculture (Mango et al., 2018). In Sub-Saharan Africa, where smallholder farmers constitute 75% of farmers and communal areas, they remain the most susceptible to the effects of climate change, this is particularly important because they continue to play a vital role in ensuring food security and sustainable land use (Scoones 2001).

2.1 Agroecology and Climate-Smart Agriculture

Climate-smart agriculture includes crop diversification, soil health management, and tree-livestock integration (Lipper et al., 2014). According to Lipper et al. (2014), "Climate-smart agriculture aims to achieve food security and broader development goals under a changing climate and increasing food demand." These practices improve farming systems' ability to adapt to the effects of climate change against

increasing agricultural output (Mbow et al. 2014). According to (Rusinamhodzi et al., 2011; Thierfelder et al., 2017), implementing agroecological techniques like conservation agriculture and agroforestry can boost crop yields, enhance soil fertility, and lessen susceptibility to shocks brought on by climate change. "Conservation agriculture-based cropping systems can improve maize and cotton yields by 20-120% related to conservative practices in sub-Saharan Africa," Rusinamhodzi et al. With the aim of creating context-specific climate-smart agriculture practices that appeal to smallholder farmers, it is important to combine traditional ecological knowledge with local innovations (Mango et al., 2018). "The combination of traditional and innovative practices has shown promise in enhancing the resilience of smallholder farming systems in the face of climate change," state Mango et al. (2018).

2.2 Sustainable Livelihoods and Community Resilience

The sustainable livelihoods framework emphasizes how important it is to understand the diverse assets, methodologies, and results that affect individuals' and communities' capability to preserve and develop their well-being (Scoones, 1998). Scoones (1998) emphasizes that "a livelihood is sustainable when it can cope with and recover from stresses, shocks and maintain or enhance its capabilities and assets." According to Mango et al. (2018), this framework propositions a helpful lens through which to examine how smallholder farmers have used their human, social, financial, natural, and physical assets to create resilient livelihoods. Studies in sub-Saharan Africa have shown that smallholder communities can become resilient and be able to cope to climate-related shocks and stresses by integrating traditional and innovative practices, diversifying livelihood strategies, and bolstering community-based institutions (Scoones, 2009; Mango et al., 2018).

"Smallholder farmers have engaged in diversified income sources by increasing their plies of livelihoods through engaging in off-farm activities, such as selling fruits, manure and composite selling natural remedies to farm management, small-scale businesses and wage labour, to supplement their agricultural earnings and mitigate the impacts of drought and erratic rainfall," Ajayi et al. (2011). The implementation of climate-smart agriculture and the creation of sustainable livelihoods in Sub-Saharan Africa have significantly aided by social cohesion and capital which takes the form of community networks and group action (Mbow et al., 2014). "Community-based

organizations play a crucial role in supporting smallholder farmers in adopting agroecological and agroforestry practices, which improve smallholder farmers food security, biodiversity, conservation of ecosystems, social ecology and resilience to climate change," Kiptot et al. (2014).

According to Scoones, (2009) a broad methodology to understanding the sophisticated connection between climate-smart agriculture, sustainable land use, and community resilience in Sub-Saharan Africa is provided by the incorporation of agroecological principles with the sustainable livelihoods' framework. The practical examples from the region of Sub Sahara Africa establish how smallholder farmers can build resilient and sustainable livelihoods in the face of climate change by utilizing their special resources and local expertise.

3.0 Methodology

3.1 Research Approach

A Phenomenological approach provided a comprehensive analysis of smallholder farmers' lived experiences traversing the challenges of climate change and employing climate-smart agriculture practices in Chimanimani, Zimbabwe (Creswell 2015). The research adopted a mixed-method approach to triangulate the data and give a comprehensive understanding of the research problem (Creswell & Creswell, 2018).

3.2 Research Design

According to Creswell & Creswell, 2018, a convergent parallel mixed-methods design was utilised in this study by the researchers. The objective of this design is to provide an exhaustive understanding of the research problem by concurrently collecting and valuing both qualitative and quantitative data (Creswell & Creswell, 2018). In order to provide a complete understanding of the phenomenon and experiences being studied, qualitative and quantitative data were combined and given equal priority during the interpretation phase.

3.3 Research Methodology

The study combined quantitative and qualitative data collecting and analysis tools to accomplish its goals. The qualitative component employed direct observations, 4

Focus Group Discussions (FGDs), and 10 KIIs to acquire a thorough understanding of farmers' viewpoints, lived experiences, and decision-making procedures when putting climate-smart agriculture practices into practice. A semi-structured survey employed a questionnaire that reached to 40 smallholder farmers. The study analysed of secondary data sources, including project reports, monitoring and evaluation records, and pertinent scholarly and governmental publications, were part of the quantitative component that helped contextualize and triangulate the data.

3.4 Sampling

3.4.1 Quantitative Sampling

The study focused on the Chimanimani district, where the Community Food Nutrition Security and Health Promotion Programme (CFNSHPP) was implemented by Caritas Mutare. 45 smallholder farmers who were selected through a multi-stage selection process participated in the semi-structured household survey, were selected from a project register of 346 participants. the research utilised. a total of 90 participants including 6 staff members from Caritas Zimbabwe. Project data was used to classify all farmers who had taken part in the CFNSHPP program. To ensure a wide representation of gender, age, and socioeconomic status, 45 farmers were then chosen at random from the list using a straightforward random sample technique.

3.4.2 Qualitative Sampling

32 focus group discussion participants, 12 key informants, 6 project staff members, who were beneficiaries of the CFNSHPP program were selected using purposive sampling technique. These farmers were designated to epitomize a diverse assortment of socioeconomic status, age, and gender. The study utilised KIIs and FGDs with other stakeholders in addition to farmer interviews. 8 to 10 communal farmers, community members, including local leaders, extension agents, and representatives from community-based organizations, attended the focus group discussions. 5 to 6 representatives from non-governmental organizations (NGOs) government agencies, and academic institutions that focus on climate-smart agriculture and sustainable lifestyles participated in key informant interviews.

3.5 Data Collection techniques

3.5.1 Quantitative Data Collection

The quantitative data gathering procedure involved allotting a semi-structured survey to 45 selected smallholder farmers in Chimanimani district. The survey tool was intended to gather data on farmers' demographics, agricultural practices, implementation of climate-smart agriculture measures, and alleged effects on crop yields, income, and household food security. The questionnaire tool was pre-tested with a small group of farmers to make sure the questions were appropriate and comprehensible, and it was reviewed as required.

3.5.2 Qualitative Data Collection

The following qualitative data collection tools were used in this study:

1. In-depth interviews shed light on farmers' perspectives, experiences, and selections concerning climate-smart farming practices.
2. In-depth group discussions supported in examining common struggles, experiences, and community dynamics.
3. Firsthand observations provided information about the adoption, implementation and overall results of climate-smart agriculture in Chimanimani district.

3.5.3 Phases of Fieldwork

The research was made up of three stages of fieldwork:

1. The reconnaissance phase: this was made up of founding a relationship with the community, defining important stakeholders, and concluding the research design and data gathering tools instruments and approach to analysis.
2. Data collection phase: The chosen participants were subjected to semi-structured household questionnaire surveys, KIs, FGDs, and direct observations during this phase.
3. Validation phase: To ensure the accuracy and applicability of the study findings, the preliminary findings were shared with the community and other interested parties for comments and confirmation.

3.6 Data Analysis

3.6.1 Quantitative Data Analysis

Descriptive and inferential statistics were used to analyse the quantitative data from the semi-structured household surveys (Creswell & Creswell, 2018). In order to give a numerical synopsis of the farmers' demographic profile, farming methods, and the results of the climate-smart agriculture interventions. This involved calculating means, frequencies, and cross-tabulations of the research participants.

3.6.2 Qualitative Data Analysis

Thematic analysis was utilised to interrogate the qualitative information collected from the FGDs and KIIs. This was done to find recurrent themes, patterns, and narratives that speaks to the goals of the study and its objectives. The transcripts were meticulously coded and transcribed by research assistants. A systematic comprehension of the intricate and diverse experiences of the smallholder farmers in Chimanimani as they dealt with the difficulties posed by climate change and adopted climate-smart agricultural practices was made possible by the integration of the quantitative and qualitative data.

3.7 Ethical Considerations

The study adhered with the strictest ethical procedures throughout the research process. Every participant asked their informed consent, and anonymity. The research upheld confidentiality rigorously. To safeguard the research against ethical standards, the study procedure was scrutinized and accepted by the appropriate ethical standards institutional review board. Distinct care was taken to make sure that the smallholder farmers and stakeholders involved in the study were not harmed or overburdened by the research process or results.

4.0 Findings

The main goal of this study was to evaluate how the CFNSHPP meaningfully impacted the resilience, biodiversity, conservation and food security of subsistence of smallholder farmers in the target communities. 4 major thematic areas appeared from the project's results analysis:

1. Adoption of Climate-Smart Agriculture Practices for conservation and biodiversity
2. Improving Food Security and Sustainable Livelihoods,
3. Increasing Social Capital, cohesion and Community Resilience,
4. Difficulties and Lessons Learned, and
5. Policy and Practice Implications.

4.1 Adoption of Climate-Smart Agriculture Practices for conservation and biodiversity

Smallholder growers in Chimanimani were exposed to a diversity of climate-smart agricultural systems through the CFNSHPP project. The techniques included integrated crop-livestock systems, agroforestry, and conservation agriculture. The Caritas Mutare team's wide-ranging capacity building innovations, practical demonstrations, and ongoing technical back stopping and assistance, the farmers witnessed that these methods were adopted. Conservation agriculture, which placed an importance on permanent soil cover, crop rotation, and little soil disturbance, were extensively incorporated by farmers. According to the research findings, this innovative methodology meaningfully improved soil fertility, lessened erosion, and reinforced the agricultural system's resistance to climate change. This resulted in sustainable land use, biodiversity and conservation of ecosystems. The farmers observed an increase in income, plies of livelihoods social cohesion and general well-being of life.

"I used to struggle with maize and sorghum harvests in the past, but from the time when I adopted conservation farming, my yields have increased by double, and I'm able to feed my family throughout the year," a farmer shared.

The addition of agroforestry procedures, such as embedding nitrogen-fixing shrubs and developing fruit tree orchards, was another important element of the CFNSHPP. Farmers underscored the numerous benefits of these approaches, such as better-quality soil health, superior food, dietary and nutrition security for households, and the opportunity of making extra cash from the sale of additional fruits and tree products.

Land use, conservation of ecosystems, climate change mitigation and biodiversity in Chimanimani have considerably improved as a result of farmers' adoption of climate-smart agriculture practices. Conservation agriculture, which gives prominence to permanent soil cover, crop rotation, and little soil disturbance, have been adopted by Chimanimani farmers. According to Thierfelder et al. (2018), this approach has been shown to improve soil fertility, reduce erosion, and improve cropping systems' resilience and conservation. The approach of minimizing soil disturbance and preserving permanent soil cover, assists the soil absorb carbon and lessens the effects of climate change, improve biodiversity and conservation of the ecosystem (Powlson et al., 2016). Sustainable long-term land use in the area is improved resulting in food security conservation of ecosystems and sustainable land utility by reducing erosion and improving soil health.

Agroforestry structures have been acknowledged for their capability to increase soil fertility, retain water, and provide a diversity of food and income sources for smallholder farmers (Mbow et al., 2014). The introduction of trees and shrubs into agricultural systems can also aid in carbon sequestration because the woody biomass and roots of these plants store a lot of carbon (Albrecht and Kandji, 2003). The planting of nitrogen-fixing shrubs, the establishment of fruit tree orchards, and the adoption of agroforestry practices have all had a positive impact on land usage and climate change mitigation.

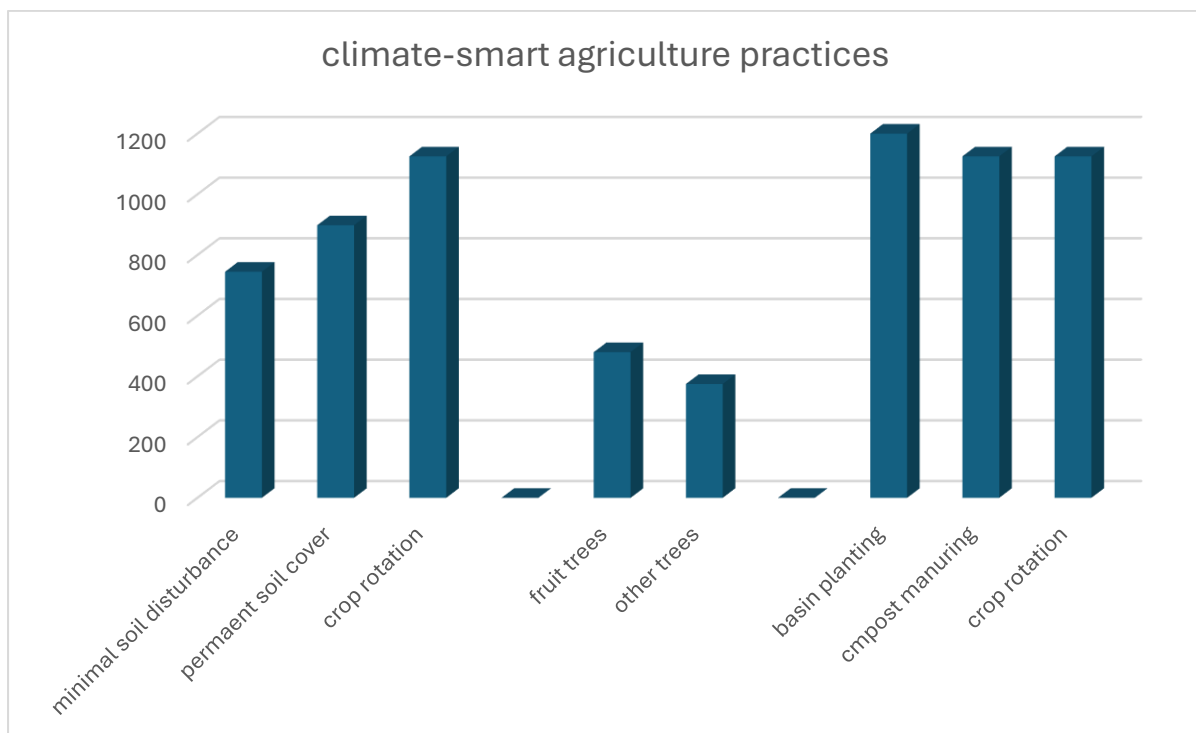
Smallholder farmers in Chimanimani have benefited from Caritas Mutare's extensive capacity building approaches, practical demonstrations, and ongoing technical back stopping and assistance in applying climate-smart agricultural practices. The research revealed that prioritizing capacity building and continuous engagement with farmers, is essential to the successful implementation of sustainable land use practices (Neufeldt et al., 2013). The region's land use and climate change mitigation have improved with the adoption of climate-smart agriculture practices like agroforestry, agroecological models and conservation agriculture (Powlson et al., 2016). These methods could support the long-term sustainability of agricultural systems, biodiversity, conservation and the livelihoods of smallholder farmers in Zimbabwe by improving soil health, increasing resilience, social cohesion to climate variability, and aiding in carbon sequestration.

4.1.1 Improved Crop Yields at the Household Level

Crop productivity and household yields have considerably improved as a result of smallholder farmers' implementation of climate-smart agriculture systems thereby improving household food security by 32%, conservation by 40% and increase biodiversity by 5%. The research revealed that farmers who adopted conservation agricultural methodologies, crop yields improved by at least 72%. Conservation agriculture practices like crop rotation, permanent soil cover, and minimal soil disturbance have increased farmers' harvests by 72% (CFNSHPP, 2022).

Agroforestry practices, such as wild fruits, fruit tree orchards, assisted farmers diversify their crops and improve their general efficiency and sustainable land use. The research revealed that 480 fruit trees—bananas, pawpaw, oranges, mangoes, and lemons—planted in the micro-irrigation ecosystems improved the household's nutritional intake by 65% per household (CFNSHPP, 2022).

Figure 1: Trend of Adoption of the Conservation Farming Basic Principles



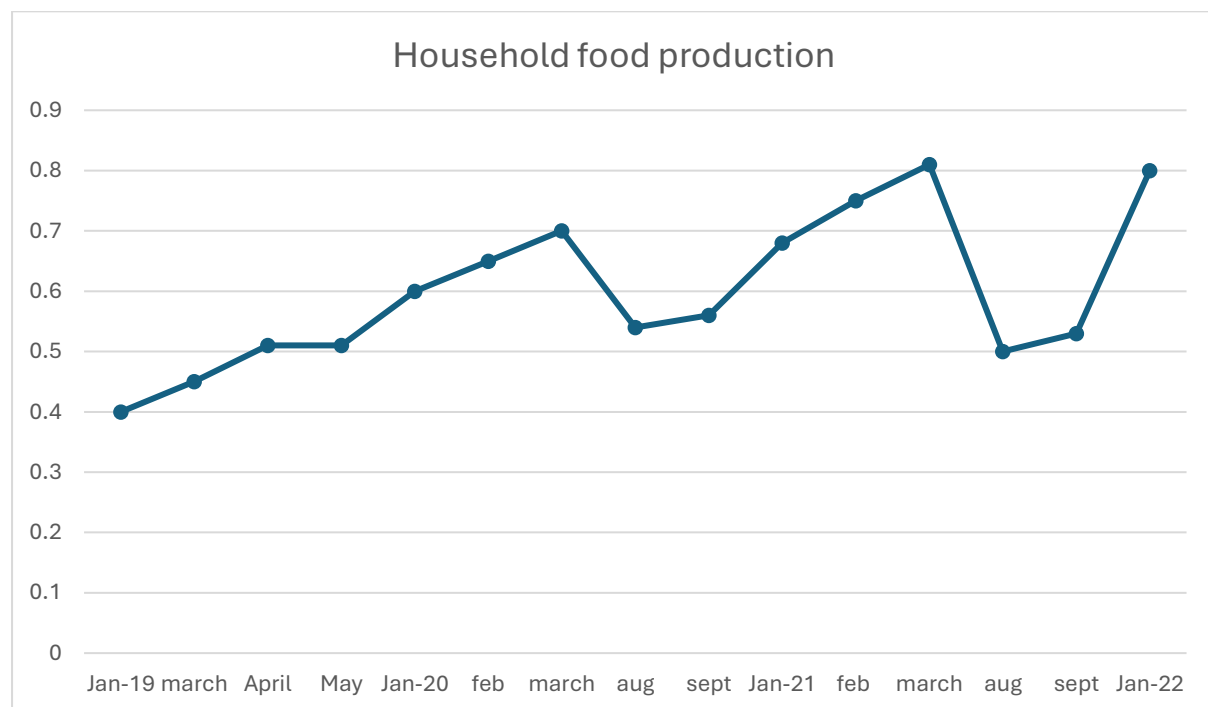
There are noteworthy implications for sustainable land use, resilience, cohesion and climate justice from the developed crop yields and efficiency seen in Chimanimani.

Climate-smart agriculture procedures can decrease the pressure on land resources, biodiversity, conservation and encourage sustainable land use practices (Powlson et al., 2016). The food security and plies of livelihoods of smallholder farmers which were at risk due to extreme weather events and changing rainfall patterns brought on by climate change are conserved and the ecosystem is maintained (Thierfelder et al. 2018).

4.1.2 Stability of Food Supplies

The implementation of crop selection divergence, revenue source diversification, and climate-smart agriculture practices has given Chimanimani's smallholder farming families a reliable and dependable source of food. The study discovered that farmers' cropping structures are more robust to climate inconsistency and life-threatening weather events, like droughts, thanks to the acceptance of conservation agricultural practices. A farmer stated that

"in the past, droughts regularly wrecked our produces, but now we can rely on a steady source of food during the year, even throughout periods of climate pressure" (CFNSHPP, 2021).



The graph reveals that food supply gradually increased from 0.4 to 0.8 during the rainy seasons whilst the dry spells were lower at 0.5. This revealed that project participants were producing more yields than before the initiation of the project. The incorporation of agroforestry methods, like creation of fruit tree orchards, promoted diversification of the farmers' crop assortments and added to the constancy of their food supplies. The research reveals that 480 fruit trees planted in the micro-irrigation schemes, comprising lemons, oranges, bananas, pawpaw, and mangoes, have provided supplementary sources of nourishment and earnings for the households (CFNSHPP, 2022). This broadening of agricultural production assisted to decrease the farmers' exposure to the influences of climate change, improve biodiversity, conservation as they can rely on a broader range of crops, farming methods, preservation techniques and income sources (Mbow et al., 2014).

The execution of micro-irrigation approaches has been critical in enlightening the targeted families' diet source stability. A stable source of food has been guaranteed even throughout the dry spell. The research revealed that at least 54 farmers contributing in the micro-irrigation schemes, have been able to yield a range of crops during the year, comprising beans, maize, vegetables and wheat (CFNSHPP, 2022). This is particularly vital for climate change because the reliability of rain fed farming may be susceptible to the rising unpredictability of rainfall patterns (Thierfelder et al., 2017).

4.2 Enhancing Sustainable Livelihoods and Food Security

The execution of climate-smart farming had the consequence on farmers' livings, source of income, supply of food, utilisation and food security. Farmers were able to intensify agricultural productivity and increase the diversity of nutrient-dense food supplies and meals by utilising the scheme's provision to set up micro-irrigation programs and encourage crop diversity. The practice of micro-irrigation systems has been critical in improving the consistency and reliability of food sources for the targeted families. One farmer said,

"Before the project initiative, we were utilising rain-fed agriculture, and our yields were wrecked by droughts. Thanks to the micro-irrigation scheme, we can now grow a variety of crops, including vegetables, wheat, and beans, all year round, ensuring my family a nutritious diet (CFNSHPP, 2022).

The plies of livelihoods, income sources and food availability, accessibility and utilisation of farmers were impacted by the employment of climate-smart agriculture. The research revealed that 80% farmers were competent to begin micro-irrigation programs and encourage crop variety, whilst 20% of farmers did not establish micro irrigation schemes. This resulted in improved farming productivity and improved the diversity of nutrient-dense availability and accessibility. In order to intensify the usage, reliability and consistency of food provisions for the households in Chimanimani, micro-irrigation schemes grew market gardening initiatives, vegetables, legumes and staple foods that are essential to food security and biodiversity. One farmer stated,

"We can grow our crops all year round and we can no longer depend on practicing rain-fed agriculture in our communities. The persistence of droughts and changing weather patterns can no longer affect our produce as we can now harvest water from the perennial rivers in our community. Households can grow and establish a variety range of crops and their sources of income and plies of livelihoods have significantly improved. (CFNSHPP, 2022).

This entails that there is sustainable land use in the area that is resulting in improved biodiversity, conservation of ecosystems and increased food security in the area. 75% of the households were able to sell their extra produces, purchase small ruminants, and save money that was not possible before the project started. Only 25% of the research respondents were still at the same level and could not save, purchase livestock or sell their surplus produce in the study area. (CFNSHPP, 2022). This multiplicity of revenue sources helps households become less susceptible to the impacts of climate change thereby becoming more resilient and building coping skills that result in social cohesion in the area. (Thierfelder et al., 2017).

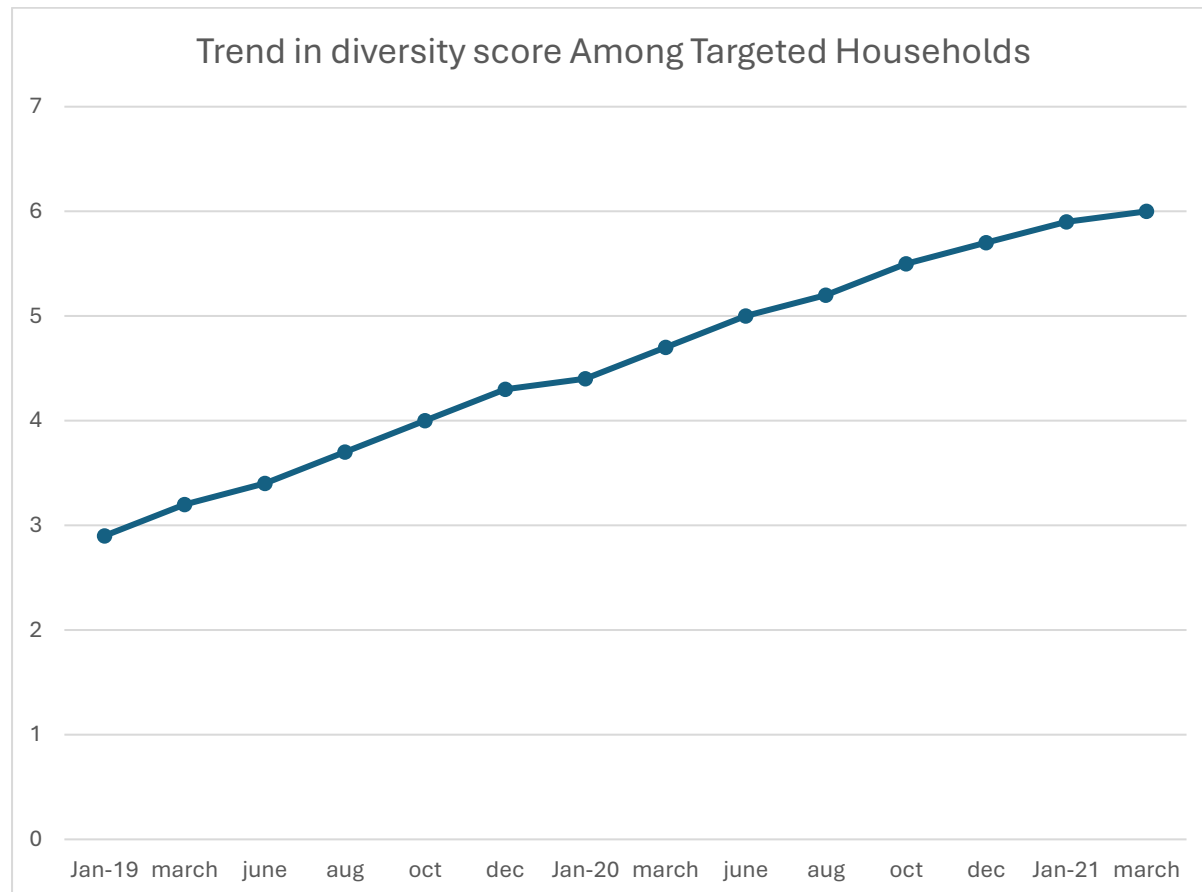
4.2.1 Increased Access to Nutritious and Diverse Foods

The support for crop broadening initiatives and micro-irrigation schemes permitted smallholder farmers to increase the variety of nutrient-dense foods available, accessible and affordable to households. Improving availability and accessibility of a range of nutrient-dense foods for the households was achieved by the project through the micro irrigation programme. One participant stated,

"the community did not have sufficient access and availability of nutritious food and we were dependent on rain fed agriculture for our produce. This scheme has given us access to a variety of food and our utilisation has changed with value addition and benefication now added. (CFNSHPP, 2022).

The study showed that the 54 households in the micro-irrigation programs were able to yield a extensive diversity of crops all year long, (CFNSHPP, 2022). The small farmer households now have access to a superior variety of food collections thanks to the farming production's divergence, which has enhanced nutritional variety and dietary needs. The enhancement in dietary variety within the farmer households is depicted in Figure 2. The average dietary diversity score rose from 2.9 out of 8 food groups in the baseline assessment to 6 out of 8 food groups (CFNSHPP, 2022). This important development in dietetic diversity can be ascribed to the project's provision for the acceptance of climate-smart agriculture practices, including the creation of micro-irrigation structures and the promotion of crop diversification.

Figure 2: Trend in Dietary Diversity Score among Targeted Households



According to the figure above dietary score increased steadily throughout the project from a score of 2 to around 7 at the end of the project. This reveals that there was improved food security in the area and there was more sustainable land use in the area.

Food availability, affordability, accessibility and quality have enhanced overall well-being and health outcomes are better managed in the area. According to the study, Pamela, a minor with acute undernourishment, improved after receiving food rations and nourishment support from the established crop varieties and micro irrigation schemes. Integrating agroforestry procedures, like planting fruit tree orchards, has helped farmer households vary their crop selections and made vitamin and mineral sources available. 480 fruit trees planted in the micro-irrigation schemes have given the households easy access to vital nutrients (CFNSHPP, 2022).

4.2.2 Improved Household Incomes

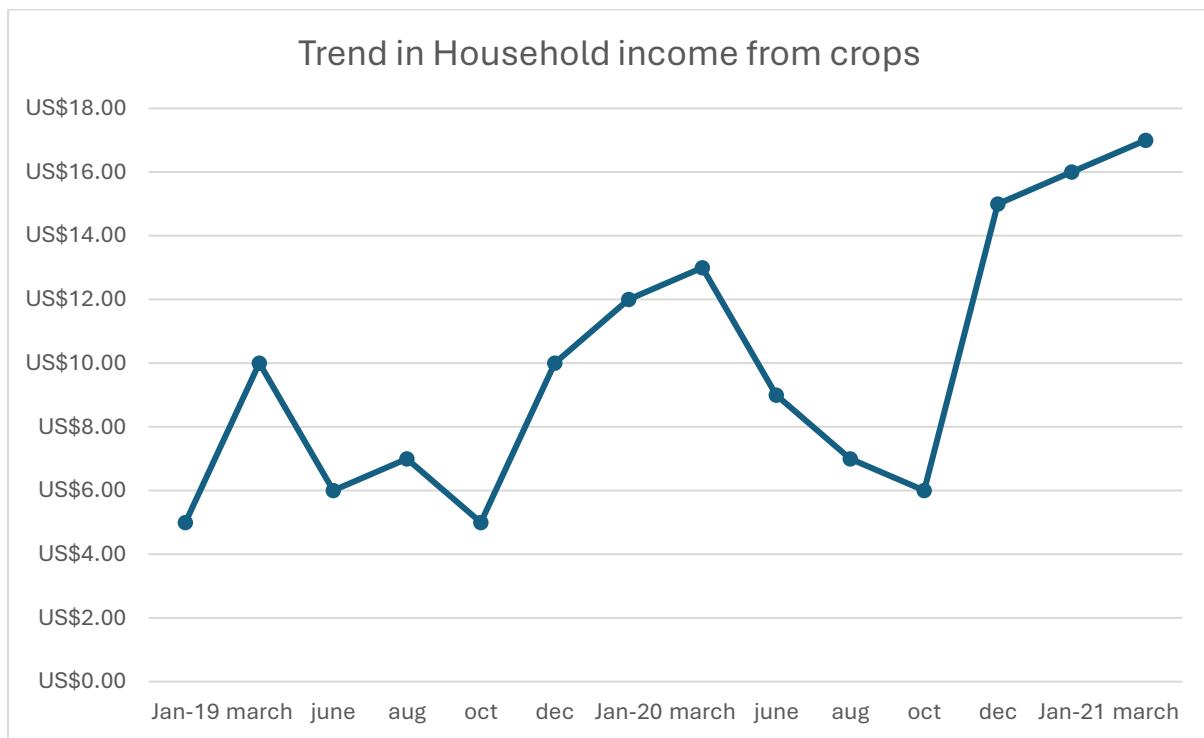
Smallholder farmers' economic security has developed as a consequence of the climate-smart farming exercises improved agricultural efficiency and income source broadening. 83% said they were able to save money through the Village Savings and Loan Associations (VSLAs), which are supported by the project, sell extra crops, and even invest in small livestock. Only 17% of the research respondents were still not able to do much in improving their food security status and conservation of ecosystems. The application of micro-irrigation agendas has been key in levitation of the farmer households' capability to produce income and intensification of agricultural efficiency. 54 farmers were able to yielded significant surpluses of vegetables, wheat, beans, and maize, which they were able to sell to make extra money As one farmer shared,

"The diversification, variety of our crops and improved access to better markets have allowed us to increase our income, food choices and invest in activities that further improve our livelihoods."

The addition of small ruminants, like indigenous chickens, have added to the change of income sources for the farmer households. The study revealed that 300 households received a total of 2,100 indigenous chickens, for household consumption, sell locally, and earn an average income of \$35 per household (CFNSHPP, 2022). The use of

compost made up of chicken manure in the conservation farming practices has contributed to enhanced crop produces, improving the household's food accessibility, availability, utilisation and income-generating capacity. The respondents improved their household income from crop sales and small ruminants is depicted in Figure 3. The graph specifies that there is a notable proliferation in the number of households with a variety of revenue streams, including the sale of small livestock and excess crops. The farmer households' overall financial well-being has increased and their susceptibility to the impacts of weather change has decreased thanks to this diversification of income sources.

Figure 3: Trends in Household Income from Crop Sales and Small Livestock



According to the graph above the income has been fluctuating but experienced a steady increase towards the end of the project. This means that respondents were more comfortable with the climate smart agriculture techniques and their adoption. The community thus was more included towards the end of the project to adopt sustainable land use and resilience techniques.

4.3 Strengthening Community Resilience and Social Capital

The importance on community-driven approaches and the development of social assets was essential in improving social cohesion, conservation of ecosystems,

biodiversity and communities' resilience to climate change. The development program facilitated the establishment of farmer groups, water point committees, and natural resource management teams, empowering the establishment of robust community-based organizations and networks. This resulted in increase in biodiversity, conservation efforts and management of natural resource management. Adger (2003) asserts that societal assets - defined as the systems, customs, and faith that enable collective action - has a key influence on a society's capacity to acclimatize to biodiversity management, conservation efforts and environmental change. The formation of farmer support groups, water point committees, and natural resource management teams offers credibility to this concept because these community-based groups have provided platforms for cooperative capacity building and learning, resource allocation, and collective decision-making.

One participant said,

"there is a lot of harmony social capital and networking among the community members resulting in improved social cohesion. We can now manage our natural resources, flora and fauna in this community."

The findings of Mbow et al. (2014), who highlight the significance of collective determinations in decision making and farmer-to-farmer information involvement in inspiring smallholder farmers to embrace climate-smart agriculture practices, are consistent with this sentimentality.

The establishment of community-based systems and structure that are owned and run by communities has improved ownership of community biodiversity and ecosystems, communities' ability to react to climate change-induced shocks and stressors. During the recent droughts and cyclones, the community systems and structures like farmer organizations and water point committees achieved coordination of assistance efforts, consolidate resources, and safeguard impartial delivery of food and other essentials. This is consistent with the concept of "community resilience," which Berkes and Ross (2013) define as the capability of a public to familiarize to and recuperate from shocks such as natural tragedies.

4.3.1 Building Social Cohesion through Sustainable Land Use

Integrating environmental information and customs into policymaking procedures can be central to more impartial and ecological conclusions when indigenous societies have superior control over the authority of natural resources, biodiversity and conservation management (Meinzen-Dick et al., 2002). This notion is in line with the CFNSHPP's livelihood of the creation of natural resource management teams, farmer associations, and water point committees, all of which have reinvigorated teamwork and cooperative decision-making concerning the sustainable utilisation of land and water-based resources.

"The farmer groups, water points and natural resource groups have completely transformed our lives. We've been able to voice our concerns and hold local officials accountable for helping us adapt to the changing climate."

This sentimentality demonstrates in what way the project has amplified social assets capital and the capacity of the communities to plan for biodiversity, conservation of ecosystems, resource governance and climate adaptation. It highlights the numerous ways in which community-based systems and structures have nurtured sustainable land use practices and enhanced social cohesion. The farmer groups, water points committees and natural resource management which allow smallholder farmers to exchange best practices, what works and knowledge on climate-smart agriculture techniques. This approach resulted in practices like agroforestry, conservation farming, and ecosystem restoration, facilitating biodiversity, conservation of ecosystems and peer-to-peer learning. The application of sustainable land use approaches has resulted in a collective effort to knowledge-sharing, which has reduced communities' vulnerability to climate-related shocks and pressures.

The establishment of community-based systems and structures has improved the communities' aptitude to advocate for transparency and accountability and hold indigenous administration officials answerable for assisting climate adaptation determinations. This is in line with the philosophies and ideologies of climate justice, which underscore the significance of sanctioning sidelined groups to contribute in decision-making procedures and holding duty-bearers answerable for speak to the inconsistent effects of climate change (Adger et al., 2006). In Zimbabwe, where climate change is escalating pre-existing susceptibilities and inconsistencies.

According to Mubaya et al. (2012), community-based systems and structures are fundamental in assisting smallholder farmers regulate to the effects of climate change, such as amplified drought and unpredictable rainfall configurations. Programs for ecological development and climate justice resilience can take motivation from Chimanimani villages' accomplishments in encouraging community cohesion and invigorating societies. It has been conceivable to inspire sustainable land use practices and nurture social cohesion within societies by placing a robust prominence on community-driven approaches and the development of social assets capital.

4.3.2 Effective Food Utilization

The holistic methodology to sustainable agriculture has made nutrient-dense foods more manageable and allowed farming communities to make healthier use of assets.

"We've realized a noticeable development in the dietary multiplicity and nutritional position of families," said a key informant from the local government. A superior diversity of crops is being grown by farmers, who are intentionally and ingeniously integrating them into their meals.

The families have remained capable to use food competently thanks to the project's all-inclusive approach, which incorporated behaviour adaptation intrusions, nutrition edification, and the reassurance of climate-smart agricultural practices. This stratagem is in line with the connotation of increasing the food source and improving households' capability to attain, consume, and resourcefully use nutrient-dense foods Gillespie et al. (2012).

Smallholder farmers are now able to integrate nutrient-dense foods into their mealtimes and differ their food régimes thanks to a variety of crop production, conservancy, and preparation systems and procedures. This has helped to progress nutritional consequences and proliferation of nutritional multiplicity. Second, the project's nourishment edification and behaviour adaptation programs have been helpful to community members, especially women. This has resulted in abilities and understanding that they need to essentially and positively select, prepare, and consume foods. The project conducted nutrition counselling sessions, recipe-sharing sessions, and cooking demonstrations to promote awareness of the prominence of balanced diets and the best feeding practices for both pregnant women and children.

The households' enhanced nutritional position serves as indication of the progressive influence of CFNSHPP's food use initiatives. The study found that the incidence of stunting among children under five years old decreased from 32% at baseline to 22% at the end of the project, and the percentage of underweight children decreased from 12% to 7% (CFNSHPP, 2022). These conclusions show how efficiently the project has permitted the farming communities to employ the nutritious foods they have been able to harvest and purchase. The CFNSHPP's holistic approach to sustainable agriculture, which combined the promotion of climate-smart practices with nutrition education and behaviour modification interventions, has significantly increased the targeted farming communities' effective use of nutrient-dense foods.

5.1 Sustainable Land Use and Climate Justice: Lessons from the Chimanimani Communities

5.1.1 Community-Driven Approaches to Natural Resource Governance

The emphasis on community-driven methods and the expansion of social assets capital has frolicked an important part in promotion of sustainable land use practices and improving social cohesion within communities. The establishing of farmer organizations, water point committees, and natural resource management teams has encouraged knowledge sharing, collaboration, and collective action in the management of land and natural resources. These groups have offered platforms for integrating traditional ecological knowledge and customs into local land use decision-making processes (Meinzen-Dick et al., 2002). the farmer organizations have made it possible for smallholder farmers to embrace climate-smart agriculture practices like agroforestry and conservation farming, as well as to share knowledge, which has improved the sustainability of local land use practices (CFNSHPP, 2022).

5.1.2 Empowering Marginalized Communities for Climate Resilience

The expansion of community-driven natural resource management systems and structures has given societies power to express their apprehensions and hold local government representatives responsible for their climate adaptation efforts. This is in line with ideas of climate justice, which highlight the importance of giving marginalized groups a voice in decision-making and holding accountable those responsible for reducing the disproportionate impacts of climate change (Adger et al., 2006). In Zimbabwe, where climate change is intensifying pre-existing vulnerabilities and

disparities, the community-driven approach to sustainable land use and natural resource management has proven particularly relevant. The project's accomplishment of enhancing community participation in resource governance and climate adaptation planning provides crucial data for developing equitable and effective policies and programs for the country's climate change adaptation.

5.1.3 Towards Integrated and Inclusive Climate Solutions

The holistic method to sustainable agriculture, which joined the establishment of climate-smart practices with the reinforcement of community-based systems and structures, has numerous important remunerations. The project's impact highlights the importance of comprehensive, inclusive climate solutions that prioritize the empowerment of marginalized communities. As the global community continues to grapple with the anxieties of climate change, Zimbabwe and other sub-Saharan African nations can take advantage of the lessons learned from the CFNSHPP by designing and implementing more equitable and effective development initiatives.

5.2 Challenges and Lessons Learned

The CFNSHPP tackled numerous challenges notwithstanding its significant accomplishments, which deliver significant lessons for imminent climate-smart agriculture initiatives in Zimbabwe and the wider SADC region. Sometimes the limited availability of agricultural supplies, like organic fertilizers and drought-resistant crops, hindered farmers' capability to fully implement climate-smart agriculture practices. Increasing the availability and affordability of essential agricultural supplies will require strengthening relationships with input suppliers and looking into innovative financing options.

5.3 Conclusions

The CFNSHPP has positioned a high importance on community-driven approaches and the development of social asset capital in order to support sustainable land use practices and improve social cohesion. The creation of systems and structures like farmer groups, water point committees, and natural resource management teams has strengthened communities' aptitude to regulate to the trials posed by climate change by fostering information sharing, collective action, and collaborative decision-making concerning land and natural resource management. The project's success in

empowering communal farmers to implement climate-smart agriculture practices and water point committees to safeguard impartial and sustainable access to water resources has had a direct impact on local ecosystems and the standard of living of the targeted households.

It has been vital to incorporate customary ecological knowledge and accustomed norms into community-based decision-making processes in order to guarantee the long-term sustainability of conservation techniques and land use practices. The CFNSHPP's holistic approach to sustainable agriculture, which combined the promotion of climate-smart practices with the establishment of community-based organizations and networks, has, all things considered, greatly and in many ways benefited the Chimanimani region. The project's impact on food, dietary and nutrition security, community resilience to climate change, and sustainable land use can positively impact future development interventions in Zimbabwe and other sub-Saharan African nations.

5.3.1 Implications for Policy and Practice

The findings of the CFNSHPP project have substantial insinuations for policymakers and practitioners working in rural development and climate-smart agriculture in Zimbabwe and the broader SADC region. The project's success in encouraging the widespread use of climate-smart practices and nurturing the standard of living and resilience of smallholder farming communities emphasizes the need for additional funding and support in this area.

Legislators must prioritize developing inclusive policy frameworks that support the growth of community-based systems and structures for sustainable natural resource management, strengthen agricultural input supply chains, and embolden the adoption of climate-smart agriculture. More funding and technical assistance should be allocated to scaling up successful models like the CFNSHPP in order to ensure that the benefits reach a superior number of smallholder farmers.

6.0 Recommendations and Conclusions

The results of the study validate the huge prospective of climate-smart agricultural techniques to develop the resilience and standard of living of smallholder farming

communities. Impressive results have been obtained from the project's comprehensive approach, which included the introduction of innovative agricultural techniques, the development of sustainable income-generating activities, and the reinforcement of community institutions.

The following suggestions can be made to guide policy and practice in the grounds of climate-smart agriculture and rural improvement based on the study's major thematic findings:

1. Growing Adoption of Climate-Smart Farming Techniques: Chimanimani's smallholder farmers have reported high adoption rates and noticeable benefits, underscoring the need for additional funding and support to spread the use of climate-smart farming practices like conservation agriculture and agroforestry across Zimbabwe and the wider SADC region. To reach more smallholder farmers, policymakers and development partners should prioritize the replication and adaptation of the CFNSHPP model.
2. Strengthening Agricultural Input Supply Chains: smallholder farmers and input suppliers must fortify their ties, and creative financing options must be investigated to increase the accessibility and affordability of these vital resources.
3. Fostering Community-Based Institutions and Social Capital: The CFNSHPP's emphasis on community-driven tactics and the development of strong social capital was one of the greatest elements of its initiatives to improve the resilience of the Chimanimani communities. The establishment of community-based organizations, like farmer associations and natural resource management teams, must be a top priority for policymakers and development experts in order to ensure the long-term sustainability of conservation, biodiversity and climate-smart agriculture initiatives.
4. Improving Monitoring and Evaluation Frameworks: The CFNSHPP project made it clear that more trustworthy monitoring and evaluation systems are required to more accurately capture the long-term impacts of climate-smart agriculture interventions on household resilience and community well-being. It

will be crucial to create tailored monitoring frameworks that incorporate mixed data to direct future program design and adaptation.

In conclusion, the CFNSHPP in Chimanimani, which is run by Caritas Mutare, has shown how combining climate-smart agriculture, livelihood diversification, and community empowerment can improve smallholder farming communities' ability to withstand the influences of climate change. The CFNSHPP's lessons and best practices can be a useful guide for replicating and scaling up similar initiatives, helping to develop more sustainable and equitable food systems as the Chimanimani communities and others in the SADC region continue to struggle with complex challenges posed by a changing climate.

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Human-Wildlife Conflict in Gachegache, Zimbabwe: Climate Change, Water Scarcity, and Sustainable Community Conservation Strategies.

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Abstract

This study explored the relationship between climate change, water scarcity, and human-wildlife conflict (HWC) in Gache Gache, Zimbabwe, with a focus on sustainable community conservation strategies acknowledging the inseparable link between ecological systems and human livelihoods. Wildlife migration patterns have become increasingly unpredictable, leading to intensified competition for resources and heightened conflict. While community-based conservation strategies provide a foundation for coexistence, their effectiveness remains limited by inconsistent implementation, financial constraints, and a lack of local ownership. Governance structures continue to be a significant barrier, as weak institutional support and inefficient resource allocation hinder progress in conservation efforts. Greater community engagement, adaptive governance, and sustained investment in conservation initiatives are essential for fostering long-term human-wildlife coexistence. Addressing these challenges requires a shift towards more inclusive decision-making processes, where local communities are active stakeholders rather than passive recipients of externally driven conservation policies. A holistic approach that integrates ecological sustainability with social and economic empowerment will be critical in mitigating human-wildlife conflict and ensuring resilience in conservation efforts. HWC, evaluate the effectiveness of community-based conservation (CBC) strategies, and examine the role of governance, resource allocation, and community engagement in HWC mitigation. A qualitative research design was employed, utilizing semi-structured interviews and focus group discussions to gather data from key stakeholders, including community members, conservation officers, and policymakers. Thematic analysis was used to interpret the findings. The study concludes that while CBC strategies have shown potential in reducing HWC, their effectiveness is hindered by governance challenges, limited financial resources, and inadequate local participation. Climate-induced water scarcity continues to exacerbate conflicts as wildlife encroaches into human settlements in search of resources. To address these challenges, the study recommends strengthening conservation governance, increasing financial and technical support for community initiatives, enhancing local participation in conservation decision-making, and integrating HWC mitigation into broader climate adaptation policies. A holistic and adaptive approach is essential for fostering long-term coexistence between human populations and wildlife in Gache Gache.

Key Words: Human-Wildlife Conflict, Climate Change, Water Scarcity, Sustainable Community Conservation, Community-Based Conservation (CBC)

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1.1 Introduction and Background

Human-wildlife conflict (HWC) is a pervasive issue that manifests globally, often resulting from the intersection of expanding human populations and wildlife habitats. The International Union for Conservation of Nature (IUCN) highlights that such conflicts are becoming more frequent and severe due to habitat loss and fragmentation, leading to increased encounters between humans and wildlife. Climate change further exacerbates these conflicts by altering resource availability and species distributions, intensifying competition between humans and wildlife. For instance, changes in temperature and precipitation patterns can shift the habitats of various species, bringing them into closer contact with human settlements (Abrahms et al., 2023). This global trend underscores the need for comprehensive strategies that address both conservation and human livelihoods.

In the African context, HWC is particularly pronounced due to the continent's rich biodiversity and the proximity of human communities to wildlife habitats. The World Bank reports that encounter between humans and wildlife often lead to crop raiding, livestock predation, and property damage, adversely affecting livelihoods and exacerbating poverty. Climate-induced water scarcity further intensifies these conflicts, as both humans and wildlife compete for diminishing water resources. For example, prolonged droughts have been linked to increased incidents of elephants raiding crops in search of food and water (Gaynor et al., 2021). Efforts to mitigate HWC in Africa have included the development of community-based conservation programs, which aim to involve local communities in wildlife management and benefit-sharing. However, the effectiveness of these programs varies, often hindered by limited resources and inadequate governance structures.

Zimbabwe, located in Southern Africa, faces significant challenges related to HWC, particularly in regions adjacent to protected areas. The Gache Gache area, situated near Lake Kariba, has experienced increased incidents of human-wildlife interactions, especially involving elephants and other large herbivores. These interactions often result in crop destruction and pose threats to human safety. The Zimbabwe Parks and Wildlife Management Authority (ZimParks) has implemented measures such as community education programs and the establishment of wildlife corridors to mitigate

these conflicts. However, the effectiveness of these interventions is often limited by resource constraints and varying levels of community engagement. In 2024, the Zimbabwean government announced plans to cull 200 elephants to address food insecurity among vulnerable populations, a decision that sparked considerable controversy. Critics argue that such actions may undermine conservation efforts and fail to provide long-term solutions to the underlying causes of HWC (Le Monde, 2024). This situation underscores the need for sustainable and community-centred approaches to HWC management.

At the local level, communities in Gache Gache are directly affected by the consequences of HWC. Crop losses due to wildlife incursions threaten food security and livelihoods, leading to negative perceptions of wildlife conservation among local residents. Efforts to mitigate these conflicts have included the use of deterrent methods such as chili fences and the promotion of alternative livelihoods to reduce dependence on agriculture. However, challenges persist, including limited access to resources, inadequate support for implementing mitigation measures, and insufficient involvement of local communities in decision-making processes. Research indicates that successful HWC mitigation requires a holistic approach that integrates ecological, social, and economic considerations (Mekonen, 2020). This underscores the importance of developing strategies that not only address the immediate impacts of HWC but also promote long-term coexistence between humans and wildlife.

This research aims to examine the interplay between climate change, water scarcity, and HWC in Gache Gache, Zimbabwe. Through assessing current community-based conservation strategies and their effectiveness, the study seeks to identify sustainable solutions that align ecological conservation with the socio-economic needs of local communities. Through this analysis, the research will contribute to the development of informed policies and practices that promote harmonious coexistence between humans and wildlife in the context of environmental change.

1.2 Statement of the Problem

Despite ongoing conservation efforts, human-wildlife conflict (HWC) in Gache Gache, Zimbabwe, remains a significant challenge due to climate-induced water scarcity, which forces wildlife into human settlements in search of resources. Mekonen (2020)

argues that competition for diminishing water sources intensifies conflicts, leading to crop destruction, livestock predation, and threats to human safety. Existing mitigation measures, such as wildlife corridors and deterrents, have shown limited effectiveness due to inadequate community involvement and resource constraints. Without sustainable, community-driven conservation strategies, HWC will continue to threaten both biodiversity and local livelihoods. This study examines the effectiveness of current interventions and explores alternative approaches to foster long-term coexistence.

1.3 Research Objectives

1. To assess the impact of climate-induced water scarcity on human-wildlife conflict (HWC) in Gache Gache, focusing on wildlife movement and resource competition.
2. To evaluate the effectiveness of current community-based conservation strategies in mitigating human-wildlife conflict (HWC) and promoting sustainable coexistence in Gache Gache.
3. To examine the role of governance, resource allocation, and community engagement in shaping the success of human-wildlife conflict (HWC) mitigation efforts in Gache Gache.

1.4 Research Questions

1. How does climate-induced water scarcity influence human-wildlife conflict (HWC) in Gache Gache by increasing competition for essential natural resources?
2. How effective are existing community-based conservation strategies in reducing human-wildlife conflict (HWC) and fostering sustainable coexistence in Gache Gache?
3. What is the impact of governance, policy implementation, and resource distribution on the success of human-wildlife conflict (HWC) mitigation strategies in Gache Gache?

2.0 Theoretical Framework

This research employed two interrelated theoretical frameworks: Adaptive Co-Management (ACM) and Social-Ecological Systems (SES) theory. These frameworks provide a comprehensive lens to understand the dynamic interactions between human communities and wildlife, particularly under the pressures of climate-induced water scarcity. Adaptive Co-Management (ACM) is a collaborative approach that combines the iterative learning processes of adaptive management with the collaborative governance structures of co-management. According to Armitage et al. (2009) ACM is a process that emphasizes shared decision-making, flexibility, and learning among stakeholders to manage natural resources effectively. Key elements of ACM include stakeholder collaboration, iterative learning, and adaptability to changing environmental conditions. In the context of this research, ACM is pertinent as it encourages the involvement of local communities in conservation efforts, promoting shared responsibility and knowledge exchange to mitigate HWC. This aligns with the research objective of evaluating the effectiveness of community-based conservation strategies in reducing HWC and fostering sustainable coexistence.

The Social-Ecological Systems (SES) theory, posits that humans and ecological systems are intricately linked, forming complex and adaptive systems (Berkes and Folke (1998)). It emphasises the interdependence between social and ecological components, highlighting the need for integrated management approaches. SES theory's main assumptions include the concepts of resilience, adaptability, and the recognition of feedback loops between human and ecological systems. In this research, the SES theory enables an in-depth examination of how climate-induced water scarcity impacts both human and wildlife behaviours, thereby influencing HWC dynamics. This perspective supports the research objective of analysing the influence of environmental factors on HWC in Gache Gache.

Integrated the ACM and SES theories provides a holistic framework for this study. ACM offers a practical approach to resource management through stakeholder collaboration and adaptive strategies, while SES theory provides a conceptual understanding of the interconnectedness between human and ecological systems. Together, these frameworks facilitate a comprehensive analysis of HWC by considering both governance structures and ecological dynamics. This integrated

approach is essential for addressing the research objective related to the role of governance, policy implementation, and resource distribution in HWC mitigation. Critiques of ACM highlight challenges such as power imbalances among stakeholders and the potential for conflicts arising from differing interests (Plummer and Armitage, 2007). Similarly, SES theory has been critiqued for its complexity and the difficulty in operationalizing its concepts in empirical research (Binder et al., 2013). Despite these limitations, the application of these theories is justified in this research due to their comprehensive perspectives on human-environment interactions. Through acknowledging and addressing these critiques, the research aims to apply these frameworks thoughtfully, ensuring a balanced analysis that considers both theoretical insights and practical constraints.

Drawing from the above, in this research, ACM will inform the evaluation of current community-based conservation strategies, assessing the extent of stakeholder collaboration and adaptability in management practices. SES theory will be utilized to analyse the interactions between social and ecological variables, such as how water scarcity influences wildlife behaviour and, consequently, HWC incidents. This dual-theoretical approach will enable a comprehensive understanding of the multifaceted nature of HWC in Gache Gache, leading to more effective and sustainable mitigation strategies.

3.0 Research Methodology

The research methodology for this study was structured to provide a comprehensive and systematic approach. The chosen methodology aligned with the study's objectives through ensuring a rigorous and context-sensitive exploration of the issue while maintaining ethical integrity and scientific validity. An interpretivist research philosophy, which emphasizes understanding social phenomena from the perspectives of those involved, was utilised. According to Creswell (2020), the interpretivist paradigm was particularly suited to qualitative research as it allowed for an in-depth exploration of human experiences, behaviours, and interactions. Given that this study sought to understand how communities in Gache Gache perceived and responded to HWC under conditions of water scarcity, the interpretivist approach was appropriate. It enabled the researcher to capture the lived experiences of affected individuals and

explore the socio-ecological dynamics shaping conservation practices. Unlike positivist approaches, which prioritized objective measurements, the interpretivist paradigm valued context, meaning, and subjective interpretations, making it well-suited for analysing complex human-environment interactions.

In line with this philosophical orientation, the study employed a qualitative research design, which was ideal for exploring social and ecological phenomena in depth. Flick (2022) argued that qualitative designs facilitated a holistic understanding of issues that could not be adequately quantified, such as attitudes, beliefs, and behavioural patterns. Since HWC is influenced by a range of socio-economic and environmental factors, a qualitative design allowed for flexibility in data collection and analysis, ensuring that emerging themes and contextual insights were adequately captured. Unlike quantitative approaches that relied on numerical data, qualitative research provided rich, descriptive accounts that were essential for understanding community-based conservation efforts. To operationalize this qualitative design, the study utilized a case study approach, the specific case study being Gache Gache. Yin (2021) contended that case study research was particularly effective in examining contemporary real-life phenomena within their natural settings. Given that HWC is shaped by localized environmental and socio-political conditions, a case study approach allowed for a detailed exploration of the interplay between climate change, water scarcity, and conservation strategies. This method enabled the study to generate context-specific insights that could inform broader conservation policies in Zimbabwe and beyond.

The target population for this research comprised local community members, conservation officers, policymakers, and non-governmental organizations (NGOs) involved in wildlife conservation in Gache Gache. According to Patton (2020), a diverse target population enhances the validity of qualitative research by ensuring multiple perspectives are represented. In this research, community members provided first-hand accounts of HWC experiences, conservation officers offered insights into management strategies, and policymakers contributed perspectives on governance and policy frameworks which ensured a well-rounded analysis of the issue. For the selection of participants, the study employed purposive sampling, a non-probability sampling technique that allowed for the deliberate selection of individuals with relevant

knowledge and experience. According to Bryman (2019), purposive sampling is particularly useful in qualitative research and in this research, it ensured that participants who possessed the necessary expertise to provide meaningful contributions were selected. Given the focus on community-based conservation, key informants included village leaders, farmers, and conservation practitioners with direct involvement in HWC mitigation efforts. This approach ensured that the data collected was rich, relevant, and directly aligned with the research objectives. The sample size for this study was 20 participants.

The sample size for this study was determined based on the principles of qualitative research, which prioritize depth and richness of data over numerical representativeness. Unlike quantitative research, where large sample sizes are required for statistical generalization, qualitative research seeks to provide deep insights into specific phenomena through detailed accounts and thematic exploration (Creswell, 2020). The decision to use a sample size of 20 participants was guided by the concept of data saturation, which occurs when additional participants no longer provide new insights (Guest et al., 2020). Qualitative research emphasizes the importance of selecting participants who are most knowledgeable about the phenomenon under study. Patton (2020) asserts that purposive sampling allows researchers to target individuals with relevant experience and expertise, ensuring that the data collected is meaningful and directly applicable to the research objectives. The selection of 12 participants for structured interviews and eight for focus group discussions (FGDs) was deliberate, allowing for both individual perspectives and collective community insights. Mason (2019) argue that qualitative research sample sizes typically range from 15 to 30 participants, depending on the complexity of the study and the diversity of perspectives needed. In smaller case studies, a sample size of 10–20 participants are often sufficient to capture key themes while maintaining feasibility in terms of data collection and analysis (Boddy, 2016).

The decision to have 20 participants in this study aligns with these recommendations, ensuring a balance between comprehensive data collection and manageability. Additionally, Guest et al. (2020) found that data saturation in qualitative studies is often reached within the first 12 interviews, with diminishing returns thereafter. Thus, the

sample size for this study was appropriate for capturing the necessary depth of information without unnecessary redundancy.

Data collection was conducted through semi-structured interviews and focus group discussions (FGDs), which allowed for an in-depth exploration of participants' experiences and perspectives. Kvale and Brinkmann (2020) argued that semi-structured interviews provided a balance between flexibility and structure, enabling researchers to probe deeper into emerging themes while maintaining consistency across interviews. FGDs, on the other hand, facilitated collective discussions that revealed shared experiences, community dynamics, and divergent opinions on conservation strategies. The combination of these methods ensured a comprehensive understanding of HWC in the research area. Thematic analysis was used to analyse the data. Thematic analysis allows the identification of patterns and recurring themes within the responses. According to Braun and Clarke (2021), thematic analysis was a robust method for systematically organizing and interpreting qualitative data. In this regard, thematic analysis enabled the researcher to categorize findings into key themes and through iterative study, allowed for continuous refinement of themes as new insights emerged.

The research religiously adhered to research ethics to ensure the protection and dignity of all participants. Informed consent which according to Resnik (2020), is a fundamental research principle that ensure participants are fully aware of the research's purpose, risks, and benefits was obtained from all participants before data collection. Additionally, confidentiality and anonymity were maintained to protect the identities of participants, particularly those discussing sensitive conservation or policy-related issues. Ethical safeguards, including voluntary participation and the right to withdraw at any stage, were upheld to ensure compliance with ethical research standards.

3.1 Response Rate

The study targeted two key groups; structured interview participants and focus group discussion (FGD) participants. Among the 12 participants selected for structured interviews, 10 took part in the study, while two were unavailable or declined to

participate. Additionally, all eight participants invited for the FGD actively participated, ensuring a complete dataset from this group. The response rate for the study is presented in the table below:

Table One: Response Rate

Category	Targeted Participants	Actual Participants	Response Rate (%)
Structured Interviews	12	10	83.3%
Focus Group Discussion	8	8	100%
Total	20	18	90%

A response rate of 90% is considered highly satisfactory for qualitative research, as it ensures the inclusion of diverse perspectives while minimizing gaps in the data. According to Creswell (2020), achieving a high response rate strengthens the credibility of qualitative studies by ensuring that the findings accurately reflect the lived experiences of the target population. Given the relatively small sample size of this study, the participation of 18 respondents provided sufficient data saturation, reducing the likelihood of missing critical insights related to HWC. The high response rate, particularly the full participation in the FGD, contributed significantly to the richness of the data. Bryman (2019) asserts that focus group discussions enhance qualitative research by capturing collective views and stimulating deeper discussions that may not emerge in individual interviews. The structured interviews also yielded valuable in-depth narratives, providing a comprehensive understanding of the challenges faced by the local community. However, the absence of two interview participants, while minimal, may have slightly limited the diversity of individual perspectives. Nevertheless, the broad representation across the two data collection methods ensured that the study's objectives were met.

4.0 Presentation, Analysis and Discussion of Findings

4.1 Impact of Climate-Induced Water Scarcity on Human-Wildlife Conflict (HWC) in Gache Gache

The findings from interviews, focus group discussions (FGDs), and document analysis revealed that climate-induced water scarcity significantly exacerbates HWC in Gache Gache through increasing competition for essential natural resources. Interview participants frequently highlighted the depletion of water sources as a primary factor forcing wildlife into human settlements. One participant lamented:

With the rivers drying up earlier each year, elephants have no choice but to come into our villages looking for water and food

In the same vein, another participant echoed,

Wild animals no longer respect the park boundaries because their usual water points dried up, and they come straight to our homes.

Another participant emphasized:

We used to have water in our boreholes all year round, but now they dry up faster, and we have to share with animals

Similarly, one participant observed this:

Water scarcity is making the situation worse; even predators like lions now roam near villages more frequently

A conservation officer had this to add:

The increasing dryness of the landscape has caused unexpected animal movements, leading to more conflicts between communities and wildlife

Focus group discussions confirmed this observation, with community members agreeing that prolonged droughts have intensified conflicts. One FGD participant highlighted the following:

Before, we only saw wild animals near our farms occasionally, but now they are here almost every week

Another participant added this:

Even the hippos, which used to stay in the lake, are now coming further inland searching for water, making fishing more dangerous

Another participant made the following lamentations:

There are more cases of cattle being attacked near drying waterholes because wild animals now come there too

In similar vein, another participant stressed this:

This situation is not normal; it has worsened over the past five years

These findings align with studies by Gaynor et al. (2021), who argue that climate change-induced water scarcity disrupts wildlife movement patterns, thereby increasing interactions with humans.

In addition, document analysis further reinforced these findings. An analysis of the ZIMPARKS Annual Report 2021 reveals a direct correlation between water scarcity and rising human-wildlife conflict incidences in such areas as Gache Gache. The report highlighted that “*severe droughts in the Zambezi Valley and surrounding areas have led to a 35% increase in reported human-elephant encounters between 2019 and 2021*” (ZIMPARKS, 2021, p. 18). It further emphasizes that declining water levels in Lake Kariba have disrupted traditional wildlife migratory routes, pushing animals into human-occupied areas. The report concludes that “*inadequate water provisioning within protected areas has led to increased foraging in agricultural lands and settlements*” (p. 22), clearly pointing to water scarcity as a conflict driver. Similarly, the National Climate Policy of Zimbabwe (Ministry of Environment, Water and Climate, 2017) underscores the environmental risks posed by climate variability and reduced water availability. It identifies Gache Gache as one of the critical ecological zones vulnerable to climate-induced stress. The policy warns that climate change is projected to increase the frequency and intensity of droughts in low-rainfall zones, a characteristic of Gache Gache exacerbating resource-based conflicts between humans and wildlife (p. 34). This document supports the SES theory by acknowledging that ecological stressors disrupt both natural and human systems.

Moreover, a report by the Centre for Natural Resource Governance (CNRG, 2020) titled “*Climate Change and Resource Conflict in Zimbabwe’s Rural Districts*” provides a focused case study on Mashonaland West Province. It states that seasonal drying of boreholes and rivers in Nyaminyami District has resulted in elephants accessing communal water points (CNRG, 2020, p. 15). This pattern is described as an “*emerging human-security crisis linked to poor adaptation strategies at the community*

and institutional levels” (p. 17). The report recommended urgent investment in climate-resilient water infrastructure to mitigate these rising tensions.

4.2 Effectiveness of Community-Based Conservation (CBC) Strategies in Mitigating HWC

The study found that community-based conservation (CBC) strategies have had mixed success in mitigating HWC. Interview participants acknowledged that certain measures, such as chili fences and beehive barriers, have been effective to some extent. One interviewee made this statement:

Chili fences work for small animals, but elephants are intelligent; they sometimes just knock them over and continue eating our crops

Another interview participant highlighted the following:

Beehives help in some places, but maintaining them is expensive, and not everyone can afford to replace broken hives.

Furthermore, another interviewee made these remarks:

We have tried using noise deterrents at night, but the animals are no longer scared like they used to be

A participant who was an environmentalist made this comment:

Some people are reluctant to adopt conservation measures because they do not see immediate benefits

To this effect, a conservation officer stated the following:

More funding is needed to expand CBC efforts, especially in areas where conflict is escalating.

Findings from FGDs also yielded divergent perspectives. Some participants supported the use of deterrents, with one stating:

We have seen fewer baboons in areas where beehive fences were placed

However, others were sceptical, with one participant making the following argument:

These methods are temporary; the real solution is to create better water access points within the park so that animals do not need to come here

Another participant adding this:

Not everyone benefits equally from these conservation strategies, and this causes tensions among us

Furthermore, another participant said this:

Unless the government supports these efforts more seriously, we will continue losing crops and livestock.

From document analysis, reports analysed indicated that while CBC strategies have shown promise, inconsistent implementation and limited funding have hindered their success. The WWF Zimbabwe Report (2021) titled *"Community-Led Conservation Practices in Northern Zimbabwe"* highlights both the successes and challenges of CBC strategies. It documented the deployment of over 150 beehive fences in selected villages, reporting that *"the number of elephant crop raids dropped by 40% in areas with well-maintained deterrent systems"* (WWF, 2021, p. 11). However, the report also emphasized issues of sustainability, noting that without regular financial support and capacity-building, most of these conservation efforts degrade within 12 to 18 months (p. 14). It attributed this to the lack of technical support and unequal access to conservation benefits among community members. An evaluation by the Zimbabwe Environmental Law Association (ZELA, 2022) titled *"Assessment of Wildlife-Based Land Use Models"* discusses the weaknesses in the implementation of CBC under the CAMPFIRE program. The report points out that areas such as Gache Gache, elite capture and limited benefit-sharing have led to a decline in community trust towards conservation initiatives (ZELA, 2022, p. 19). Additionally, it provides that *"The mismatch between policy intentions and practical implementation continues to widen as donor fatigue and political interference undermine local empowerment"* (p. 23). These findings reveal structural barriers to effective CBC deployment.

Furthermore, the Southern Africa Trust (2020) also produced a regional conservation policy brief titled *"Community Engagement and Wildlife Conflicts in the Zambezi Basin"*. It concludes that although CBC methods are incorporated into national policies, actual implementation in Zimbabwe suffers from fragmented institutional support. The decentralisation model is underfunded, and (areas such as Gache Gache) lack the technical know-how and logistical support to sustain conservation practices (Southern Africa Trust, 2020, p. 8). The brief advocates for an integrated approach that includes both ecological investment such as construction of water points in parks and social investment like training and inclusive decision-making.

4.3 Governance, Resource Allocation, and Community Engagement in HWC Mitigation

The study revealed that governance structures and resource allocation play a crucial role in shaping the success or failure of HWC mitigation efforts. Interview participants expressed frustration over inadequate support from local authorities. One respondent made the following assertion:

We report our losses, but the compensation process is slow, and sometimes we receive nothing at all

Another interviewee quizzed the issue of financing conservation arguing the following:

The government talks about conservation, but where the money for proper fences or better security patrols is?

Another participant made this lamentation statement:

Community voices are rarely considered when making conservation decisions, and this makes people less willing to cooperate

Another participant made this observation:

There is too much bureaucracy; even when solutions are proposed, they take years to be implemented.

Furthermore, a conservation officer added this:

We do our best with limited resources, but more government support is needed."

FGDs echoed these frustrations, with participants citing weak policy enforcement and lack of community involvement in decision-making. One participant made this argument:

Policies are made in offices, but we, who live with the animals, are not consulted on what works best

Another participant added this:

If the government really cared, they would help us build stronger defences instead of just telling us to live with the animals

In addition, another participant made this statement:

We need financial assistance to invest in stronger protective measures like reinforced granaries and secured livestock enclosures.

Furthermore, a participant also made these remarks:

Without proper laws and enforcement, all these conservation efforts will not last

Coming to document analysis findings, the findings reinforced interview findings. The Zimbabwe National Development Strategy 1 (NDS1) 2021–2025 acknowledges the importance of environmental governance and community involvement in sustainable development. However, under the Environment and Natural Resources Management pillar, the report heightened that although frameworks exist for community engagement, actual implementation is patchy due to bureaucratic inertia and underfunding. Furthermore, the document made this conclusion; *“delays in compensation for wildlife-induced losses demotivate affected communities from actively participating in conservation programs”* (p. 68). These institutional weaknesses echo concerns raised by local respondents in the primary data. Another important source, the African Wildlife Foundation (AWF) Report (2020) titled *“Enabling Policy Environments for Human-Wildlife Coexistence in Southern Africa”*, critiques Zimbabwe’s centralized approach to wildlife governance. The report makes this argumentation; *“Too often, community inputs are only symbolic, and real decisions are made at provincial or national levels”* (AWF, 2020, p. 10). In the research area, this top-down approach leads to policy resistance and informal conservation practices that lack legal recognition. In this regard, the AWF recommends building transparent feedback loops between local communities and government departments to enhance trust and compliance.

Furthermore, the UNDP Zimbabwe (2021) project evaluation titled *“Mainstreaming Biodiversity into Rural Livelihoods”* which assessed donor-funded conservation programs in Mashonaland West provided that; while donor-funded projects initially improve community capacity, sustainability falters once external support is withdrawn (UNDP, 2021). The report also observes that communities are more engaged and responsive when they see tangible benefits and have institutional representation in conservation planning. The evaluation warns that weak inter-agency coordination between ZIMPARKS, Rural District Councils, and civil society actors continues to delay adaptive interventions. These governance gaps resonate with critiques from Plummer and Armitage (2007) regarding institutional power imbalances in adaptive co-management systems.

4.4 Discussion of Findings

The findings of this study confirm that climate-induced water scarcity profoundly impacts human-wildlife conflict. This aligns with the social-ecological systems (SES) theory, which emphasizes the interdependence of human and ecological systems (Berkes & Folke, 1998). Depleted water resources force wildlife into closer contact with human settlements, thereby increasing the frequency of conflict. These results corroborate existing literature identifying climate change as a primary driver of human-wildlife interactions (Gaynor et al., 2021). As water sources become scarcer, both humans and animals are forced to compete over dwindling resources, leading to increased cases of crop destruction, livestock predation, and direct confrontations with wildlife (Nyhus, 2016). These interactions create significant socio-economic challenges for communities, which further complicates conservation efforts (Lindsey et al., 2021).

Moreover, the study highlights the mixed effectiveness of community-based conservation (CBC) strategies, reinforcing the Adaptive Co-Management (ACM) framework's assertion that conservation must be flexible and responsive to community needs (Armitage et al., 2009). While strategies such as beehive fences and chili deterrents have shown promise, their success is often hindered by financial constraints and inconsistent implementation. The study revealed that some community members view these strategies as short-term fixes rather than sustainable solutions. This is a challenge also noted by Plummer and Armitage (2007), who argue that co-management approaches require robust institutional support and continuous adaptation to emerging challenges. Without adequate funding and capacity building, community conservation efforts may become ineffective in the long term (Lindsey et al., 2021).

Additionally, governance and resource allocation emerged as critical factors influencing the success or failure of conservation initiatives. Weak institutional frameworks, slow response times, and bureaucratic inefficiencies have led to community distrust in conservation authorities. Many participants expressed frustration with delayed or inadequate compensation schemes, which discourage active participation in conservation programs. This finding aligns with wider critiques

of conservation governance, which emphasise that effective resource management necessitates policy frameworks, practical enforcement and local engagement (Redpath et al., 2017). According to Taylor et al. (2022), strengthening governance structures and ensuring community representation in decision-making processes are essential for improving conservation outcomes.

Another key theme emerging from the findings is the need for increased community engagement in conservation efforts. The study found that many local residents feel excluded from decision-making processes, which reduces their willingness to cooperate with conservation authorities. This issue is particularly significant in light of the SES theory, which emphasizes the need for integrated social and ecological management (Berkes et al., 2003). Without active involvement from local communities, conservation efforts are less likely to be successful, and these communities are more likely to take retaliatory action against problematic species (Dickman, 2010). Enhancing local participation, fostering partnerships between communities and conservation organisations, and ensuring equitable distribution of the benefits of conservation initiatives can improve cooperation and long-term sustainability (Lindsey et al., 2021).

5.0 Conclusion

Climate-induced water scarcity has exacerbated the conflict between humans and wildlife in Gache Gache, disrupting livelihoods and biodiversity. Although community-based conservation efforts have been implemented, they remain limited in effectiveness due to governance challenges, resource constraints and insufficient local participation. Without a more adaptive and inclusive approach that integrates local knowledge, equitable resource distribution and stronger institutional support, this conflict will persist and threaten long-term conservation and community well-being. To achieve sustainable coexistence, there must be a paradigm shift towards policies that prioritise ecological resilience while addressing socio-economic needs. This will ensure that conservation efforts are effective, equitable, and sustainable for future generations.

6.0 Recommendations

- ✓ **The Parks and Wildlife Authority should** strengthen conservation governance by increasing patrols, enforcing wildlife protection policies, and ensuring that compensation schemes for affected communities are timely and transparent.
- ✓ **Development partners should** provide financial and technical support for community-based conservation programs, ensuring the long-term sustainability of initiatives such as beehive fencing and alternative livelihood projects.
- ✓ **The Gache Gache community should** actively participate in conservation efforts by forming local conservation committees, adopting sustainable farming practices, and working collaboratively with authorities to mitigate human-wildlife conflict.
- ✓ **The Government of Zimbabwe should** integrate human-wildlife conflict mitigation into national climate adaptation policies, prioritizing water resource management and infrastructure development to reduce competition between wildlife and human populations.
- ✓ **NGOs should** facilitate capacity-building programs that equip local communities with the knowledge and skills to implement effective conflict mitigation strategies and advocate for their conservation rights.

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