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Water governance and agricultural livelihoods: Navigating human-ecological systems and farmer strategies in Rural Zimbabwe

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Abstract: Water plays an important role in agricultural livelihoods and it is increasingly significant in regions where precipitation is low and variability is high such as in semi-arid and arid regions. In such regions, there is a pressing need to manage, allocate, and utilize water resources wisely in order to enhance the sustainability of communities. This study aims to assess how water governance systems relate to farmers' practices and rural livelihood in rural Zimbabwe with emphasis on Mutoko District, Mashonaland East. This was a qualitative exploratory study. Data was collected through semi-structured interviews, focus group discussions, and participant observations. The study consisted of a wide range of stakeholders including smallholder farmers, local authorities, and water management bodies. The study found that water resources management in rural Zimbabwe is a combination of both formal and informal processes. The study also revealed that effective implementation of policies has been deterred by lack of funding and political interference. It has also been established that to combat water shortage in the region, local farmers have engaged in growing drought-resistant varieties of crops, use of traditional water harvesting methods, and creating water conservation management associations. The paper concludes that there is a need to consider the human-ecological aspects, especially the influence of agriculture on the livelihoods of communities.

Keywords: *Agricultural livelihoods, Farmer strategies, Human-ecological systems, Rural Zimbabwe, Water governance.*

1. Introduction

Agricultural livelihoods exhibit a strong relationship with water governance, particularly in those regions practicing agriculture where water resources are particularly limited (Franks et al, 2013; Bernier et al, 2016). In several rural households in Zimbabwe, agriculture is one of the most practiced economic activities and means of earning a living (Mugambiwa, 2021). In rural Zimbabwe, farming is sustained within the human-ecological system as water is utilized for irrigation and it determines what crops a particular farmer will grow in that area (Mugambiwa, 2018). One of the challenges faced by the farmers is constant erratic rain patterns and fertile land erosion which negatively affects agricultural productivity. It is, therefore, beneficial to approach such issues holistically, considering the ecological factors and the framework in which water decision-making occurs. This paper investigates the ways in which farmer strategies and agricultural productivity are affected by the water governance mechanisms in rural Zimbabwe focusing on the Mutoko district of Mashonaland East province. Further, the paper evokes the interlinkages between farmer strategies and water governance mechanisms vis-à-vis the human-ecological systems in which they are embedded.

1.1. Background

Water governance in Sub-Saharan Africa includes a nexus of different formal and informal institutions (Nhemachena, 2007). The water governance structure that currently exists in Zimbabwe

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has its roots in the colonial era and it is embedded within the historical, socio-political, and economic aspects of the country. Moreover, like all of southern Africa, colonialism in Zimbabwe has produced a blended water governance paradigm where the state, society, and private sectors are capacitated to participate in the management of these resources (Zhou et al, 2011). In sub-Saharan Africa, water governance is also made difficult because of the presence of formal and informal relations which shape the management and distribution of the water (Chanza, & de Wit, 2016; Mugambiwa, 2021). The ruling elite in most Sub-Saharan African countries continues to introduce planning and management institutions or agencies that are appointed to regulate and supervise water resources (Mugambiwa & Makhubele, 2021). Local governance approaches of water involve a separate main dimension of the wider governance structure using horizontal integration (Abarzua and Glueckler, 2022). In most settings, non-formal systems of governance take the place of formal oversight and community-level structures can replace formal systems (Mugambiwa, 2020).

2. Literature Review

2.1. Agricultural Livelihoods and Human-Ecological Systems

Agricultural practices in rural Zimbabwe are conducted within integrated human-ecological systems with the spatial and temporal dimensions of water availability and quality limiting agricultural practices (Gwimbi, 2009; Gutsa, 2017; Mugambiwa, 2020). Farmers are required to make continual changes as a result of changing rainfall patterns, soil loss, and government changes. In rural settings, agriculture remains embedded in human-ecological systems, in which the various natural components, as well as human actions, ultimately affect the sustainability and the extent of operationality of farming systems (Kimani et al., 2014; Lwoga, et al., 2010; Madzwamuse, 2010; Mafongoya, & Ajayi, 2017). Agriculture is dynamic in rural Zimbabwe as it is economically important as well as a key contributor to food security. As such, it is important to comprehend the interlinkages between agriculture and human ecological systems vis-a-vis water governance while dealing with the consequences that they pose upon farmers. Human-ecological systems are of course constituted of physical attributes like climate, soil, and water. However, there are also social and economic systems that shape agricultural practices and livelihoods.

In any agricultural community particularly in rural Zimbabwe, farmers operate within changing weather patterns, including high temperatures and erratic rainfall which affect production (Mugambiwa & Rukema, 2019). Their abilities to handle such changes depend on their creativity, capacity, and technology. Some of these include crop and soil selection which are typical agricultural practices that have been carried down through generations (Mugambiwa, 2018). Human-ecological systems concepts advocate for the incorporation of management that is responsive to both ecological and socio-economic characteristics. Mugambiwa & Chitongo (2023) pointed out that many strategies of climate change mitigation are applied by local farmers, including improved water governance, better farming practices, and enhanced community resilience capacity among others.

2.2. Farmer Strategies in Water-Scarce Environments

In the presence of low availability of water resources, farmers make use of many ways in order to secure the wellbeing of their households (Wang et al., 2024). Some of the strategies that can be considered include shifting to the production of more crops, and adopting communal water-conserving technologies (Munang et al., 2013; Mutekwa, 2009). These strategies usually depend on higher governance arrangements such as water rights enforcement or the provision of infrastructure dedicated to water access. In the case of dry climates, many factors resist the impact of water deficiency even as the production levels are maintained (Nadi, 2014). High-end technologies such as drip irrigation and moisture sensors, are slowly being installed to help combat the problem of water wastage (Mugambiwa & Makhubele, 2021). Also, droughts compel the farmers to adopt crop diversification as an important strategy. They also adopt crop varieties that are resistant to drought or plant short-season crops. This is fundamental because it enhances the efficient use of these water resources, increases the level of food security, and reduces the level of economic threats.

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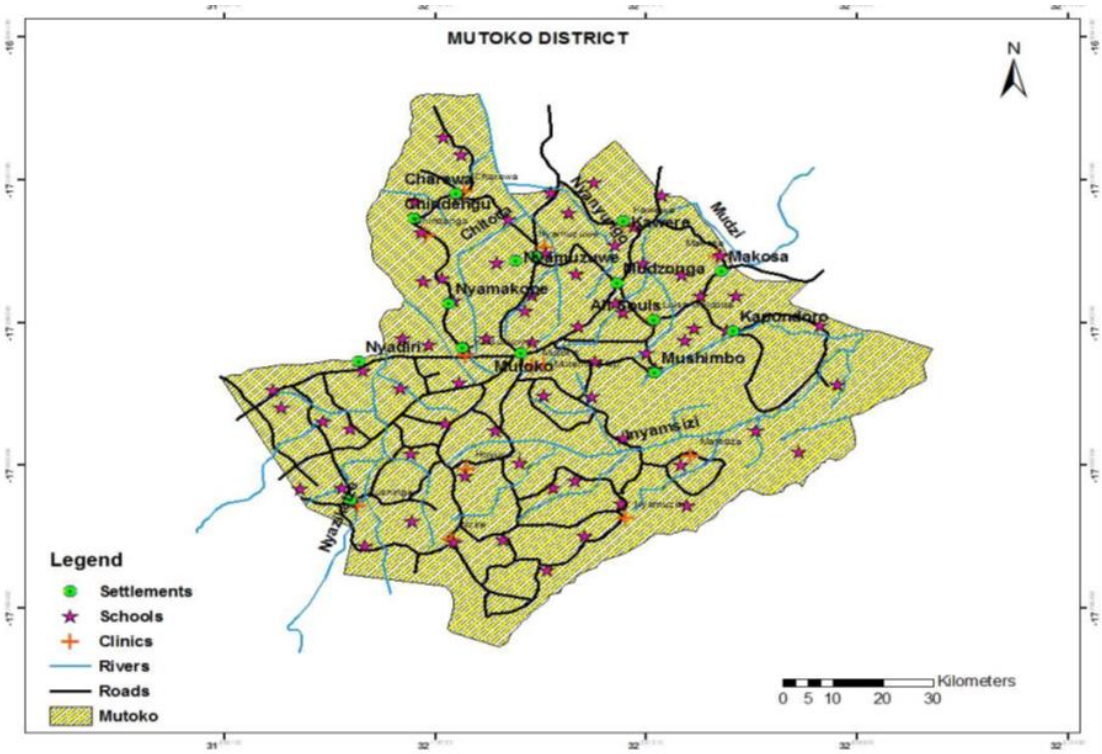

Figure 1.
Map of Mutoko District.

3. Methods and Materials

3.1. Study Area

Mutoko district is located in the Mashonaland East province (MEP) of Zimbabwe. The district spans an area of 4,092.5 square kilometers, as reported by Mvumi et al. (1988). According to the 2012 population census, the district's population is 146,127 people (Moyo, 2016). Mutoko was designated as an administrative station in 1911 and is situated 143 km away from Harare, the capital city of Zimbabwe. The district derives its name from Chief Mutoko, a local leader, and is predominantly inhabited by the Buja ethnic group. The district consists of a growth point, communal spaces, resettlement farms, and small-scale commercial farms. The population density in the growth point is 198 people per square kilometer, while the communal areas have a density of 46 people, resettlement farms have a density of 23 people, and small-scale commercial farms have a density of 10 people (Bhatasara, 2016). Mutoko Rural District (MRD) is comprised of twenty-nine (29) wards, each containing six (6) villages. Each village is home to approximately one thousand (1000) individuals or eighty (80) to one hundred and twenty (120) families. Certain villages are equipped with Village Development Committees (ViDCos) that are accountable to the Ward Development Committee (WaDCos). Additionally, every village is overseen by a village headman who assumes the responsibility of managing the district daily. At the ward level, the district is represented by a counselor who is elected by the people. The council is led by a Chief Executive Officer (CEO) (Mvumi et al. 1998).

3.2. Research Design

A qualitative exploratory research design was employed. The study is located within the interpretivist paradigm, whose objective is to understand farmers' subjective experiences of operating water governance systems and the prospects of their agricultural livelihoods. Purposive sampling was used to select thirty (30) participants including small-holder farmers, local leaders, water management

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officials, and NGO representatives. Semi-structured interviews, focus group discussions, and participant observation were employed as data collection tools. The focus groups involved smallholder farmer groups who discussed common trends in irrigation practices among them. Interviews conducted by use of semi-structured questionnaires included questions involving different stakeholders like farmers themselves, local community leaders, watershed management authorities as well as environmentalists who represent NGO interests. The questions sought views on issues regarding access to fresh waters, irrigation practices, and the effect of laws governing these resources. Participant observation was applied to allow the researcher to witness how the community interacts with one another in matters related to water management. Data was analysed using thematic analysis in order to identify key issues that relate to water governance, agricultural practices, and farmer strategies. It mainly focused on identifying patterns and associations that explain how farmers deal with governance systems and adapt themselves towards ecological and socio-economic transformations.

4. Findings and Discussion

4.1. Water Governance Structures

The study established that water governance in rural Zimbabwe is characterized by a combination of formal and informal systems. Formal institutions like government agencies and local governments participate in regulating the use of water; however, community-based informal institutions have more direct bearing on the day-to-day use of water. Often, such kind of fragmented governance structures bring about conflicts over the use of water especially in times of drought thereby affecting agricultural productivity. This study finds that there is a complex interplay between formal and informal water governance structures in rural Zimbabwe. This has implications for agriculture as each type influences this sector differently. For instance, formal institutions including state departments responsible for water and local committees are mandated to prescribe norms and set up infrastructure whilst their efficiency is sometimes hindered by low funding levels, weak technical capacity, or political interference. Therefore, some policies on water become unevenly implemented hence leading to disputes regarding its allocation and sharing among farmers due to different rights to this resource being granted formally. To that effect, participants had this to say;

> "*The water committees were formed with the hope to help us access water for irrigation, but we always see people with connections being in such committees. For smallholder farmers like us, it is really hard to get water and as a result, affecting our yields from the crops.*"
>
> **(Participant 1: Focus group discussion -Farmer)**
>
> "*Water governance here has its good and bad side. In as much as there are structures put in place to avoid discrimination of some parts and healthy competition, the lack of support and bad governance means that some of the potential beneficiaries, especially the farmers are excluded.*"
>
> **(Participant 2: Key informant interview- Local Agricultural Extension Officer)**
>
> "*We use indigenous methods of water management; however, these have been interrupted from the inception of formal water governance. Whereas the aim was or is to enhance the distribution of water and the farmers' needs. In practice, it has at times further compromised the farmers' needs.*"
>
> **(Participant 3: Key informant interview- Village Head)**

The participants illustrate a difficult and often tense nexus between the water governance structures and agriculture in the rural context. The first quote is from a small-scale farmer from the Mutoko District, which captures the problems stemming from governance structures that are predominantly built within networks. Many of these farmers are left high and dry especially the minority farmers, who have only limited access to the irrigation water that is critical to their crop production, and incomes. The experiences of the farmer highlight the typical generic issues of resource allocation inequities within water governance systems where the resources are mainly a factor, leaving such inequalities unchecked and the attainment of sustainable agriculture efforts achieved with difficulties.

Further, as indicated by a local agricultural extension officer, governance frameworks in the district are always put in place to avoid water conflicts. However, in most situations, this is not always the case

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since corruption and shortage of resources constrain these measures. This is the so-called gap between good policies and bad practices where good ideas on governance are thwarted at the implementation level. Institutions such as the one highlighted by the agricultural officer entail that water governance policies must be made and implemented with effective regulation and control so that the poorest and most needy farmers benefit from the systems.

One of the participants, a village headman presents a society and cultural perspective on water management. Daily routines of the people with respect to the use of water are undermined with the introduction of official governance strategies showing the contradiction between modern governance systems and traditional systems. Although formal arrangements may be made for better participation in the management of water, the functions that have supported communities for the ages may sometimes be neglected. The headman's sentiments emphasize the necessity of considering traditional practices in their integration with formal processes of river basin management. This integration can act in a way that supports rather than undermines agricultural systems and practices within those governance frameworks, leading to more sustainable and resilient agrarian societies.

Figure 2.
A submersible solar-powered river waterhole and hand-dug well irrigation system in Matedza village.

Figure 1 depicts a solar-powered submersible irrigation system for river waterholes in Matedza village. The farmer utilises a river waterhole that he consistently excavates to collect water for the specific purpose of irrigation. In order to siphon water, the technique necessitates the farmer to place a submersible solar pump in either the river waterhole or a hand-dug well. When the water levels in the river waterhole decline, the farmer digs to a greater depth, as shown in one of the images in Figure 1. The technique is a successful adaptation approach utilised by the farmer, as it is implemented after the cessation of rainfall and the subsequent drying of the river. Typically, around this time, farming activity in most villages would have come to a halt as farmers prepare for the upcoming rainy season in preparation to begin farming. Moreover, the system's widespread adoption is a consequence of the social networking among small-scale farmers in the region. Ellis and Bahiigwa (2003) advocate for the utilisation of social networks in the context of climate adaptation as a valuable tool. The argument was that social networks are responsible for the increased awareness and utilisation of adaptation options.

The term "social capital" is used by social scientists to describe this concept, which is widely recognised as a public benefit that is intended to facilitate the exchange of information and resources among individuals. During the process, farmers who are engaged in the process channel the capacity to learn and facilitate innovation. I was taken to a farm where the system was most effective during the data collection process by another farmer who was testing the system. The farm's innovation was remarkable, and the farmer was at liberty to demonstrate the system's functionality. In the same vein, Adger (2003) maintains that social capital is a critical asset that is employed to establish a

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comprehensive adaptive capacity to climate change. This form of networking is not facilitated by governments or other authoritative bodies; rather, it is facilitated by ordinary community members who are engaged in daily agricultural activities. The farmers' engagement can be interpreted as self-organised facilitation, which is more sustainable and effective than those that are subject to adaptation mechanisms imposed by external entities.

The fragmented nature of water governance in rural Zimbabwe presents a lot of problems for efficient resource management (Mugambiwa & Makhubele, 2021). Formal institutions, whose role is to set rules and guidelines, and develop infrastructure, often lack the capacity or resources needed to enforce policies and adequately respond to the needs of their localities. This void has seen an upsurge in informal modes of governance that are characterized by extensive use of traditional practices and community-based management approaches. Notwithstanding being more responsive to the local conditions these informal systems are ineffective due to their lack of formal recognition and support. Consequently, coexistence sometimes leads to conflicts and inefficiencies hence necessitating integrated governance frameworks that would harmonize formal regulations with local practices. However, they demonstrate the ingenuity and resilience that rural communities possess but also show the weaknesses inherent in existing support mechanisms. Some strategies include traditional water management methods, crop diversification, and collective action among others which enable farmers to cope with water scarcity. Nevertheless, effectiveness is limited by poor infrastructure, inadequate technology transfer facilities as well as insufficient financial resources for this purpose. From these difficulties, it can be deduced that while farmers have adapted quite effectively on matters concerning water scarcity, they still need external help so as to transition into more sophisticated sustainable techniques which could enhance their productivity level. Consequently, what is required here includes policy options or interventions aimed at ensuring enhanced resilience towards water-related challenges among farming communities.

4.2. Farmer Strategies for Navigating Water Scarcity

Different strategies are employed by farmers in rural Zimbabwe to combat water scarcity. This includes the adoption of drought-resistant crop varieties, utilizing traditional rainwater harvesting techniques, and crop diversification. Additionally, collective action such as the formation of water associations has been found to be critical in resource governance at community levels. However, inadequacy in infrastructural development coupled with inconsequent support from formal institutions undermines the effectiveness through which these mechanisms achieve their objectives. Resilience and innovations under harsh environmental circumstances have made rural Zimbabwean farmers come up with various coping mechanisms to minimize the effects of water shortage. One such step includes the use of traditional water management systems like rainwater harvesting and small-scale reservoir construction. These methods help in capturing and storing rain during the rainy season for use in irrigation during dry periods. Some participants had this to say;

> *"This is the time of year when we go to the river and drill shallow wells in the bed along the river to look for water beneath. It's hard work, but that's the only way we can keep some things alive when the river goes dry."*
>
> **(Participant 4: Focus Group Discussion- Farmer)**
>
> *"Instead of planting maize, we are now planting millet, sorghum, and other crops that can handle unpredictable rain. These plants don't need a lot of water, and they can still produce harvests even if other plants can't because of insufficient rain."*
>
> **(Participant 5: In-depth Interview- Irrigation Scheme Participant)**
>
> *"We have created local water associations to deal with the fact that the community doesn't have a lot of water. We have a system where farmers are given set days to water their crops so that every farmer has a chance to water, even if it's only a little."*
>
> **(Participant 6: Key Informant interview- Community Leader)**

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The narratives provided by the participants illustrate the adaptive strategies farmers have devised to address water scarcity, a prevalent issue in agricultural communities. The initial quotation from a small-scale farmer in the district highlights the antiquated, expensive, and labor-intensive methods employed to obtain water during periods of drought (See Figure 1). This approach is outdated as it enhances a farmer's use of surface water sources by accessing relatively shallow wells dug near streams or rivers. Nevertheless, this method is only efficient and feasible to a limited extent due to the necessity of strenuous manual work and the presence of underground water. The remark from a member of an irrigation scheme highlights the recent advancement in the method of cultivating drought-resistant crops in response to the scarcity of water. To mitigate the risk of crop loss caused by erratic rainfall, farmers can opt to cultivate drought-tolerant crops like millets and sorghums, as opposed to the moisture-dependent maize (Hisali et al., 2011). This method not only enables farmers to continue harvesting crops during water shortages, but also demonstrates their adaptability to the evolving environment.

The community leader emphasised the necessity for farmers to collaborate in the administration of the scarce water resources at their disposal. Through the use of cooperative groups and rotational irrigation, individuals are able to effectively distribute the limited water available for their crops. This water usage system acknowledges the challenges posed by water scarcity and emphasises the importance of cooperation and support among individuals for their survival. Additionally, it demonstrates the inherent collectivist mindset of individuals in agricultural communities, where resources are allocated and decisions regarding their administration are made collectively to effectively tackle issues. This strategy exemplifies how indigenous knowledge systems can enhance the sustainability of water management in arid agricultural areas, enabling more efficient mitigation of water scarcity.

Moreover, crop diversification has emerged as one of the significant strategies used by farmers to reduce vulnerability to water scarcity. By cultivating diverse crops, they spread their risks as well as improve chances of getting good harvests even in case of uncertain availability of water. In particular, this involves the adoption of drought-resistant crop varieties and short-season crops that are more suited to variable climate conditions and therefore require less water for successful growth. It also helps in managing water resources better, reducing poverty levels, and malnutrition rates, and ensuring economic stability. Sustainable agricultural productivity under adverse conditions requires flexibility in choosing appropriate crops among other management practices.

Figure 3.
A submersible solar-powered borehole irrigation system in Matedza village.

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Figure 3 illustrates a solar-powered borehole that is employed to siphon water for irrigation purposes. A few smallholder farmers employ this method, which is one of the most effective. A small number of farmers are employing the system due to its high cost. The farmer in the image in Figure 3 disclosed that he rotates a variety of crops such as potatoes, onions, maize, beans, and tomatoes throughout the year. This study has established that water scarcity is effectively managed through collective action and community-based approaches. Water associations or community groups are often formed by farmers so that they can interact regarding sharing scarce resources; resolve conflicts that may arise pertaining to it and undertake projects for common benefit such as communal irrigation schemes. This is an attempt at ensuring there is fairness especially when it comes to accessing these Water resources as well as enhancing teamwork among farmers (Goddard et al., 2010). However, the effectiveness of these community-based initiatives depends on the strength of local social networks and governance structures that govern them. Other challenges persistently face them such as weak infrastructures coupled with limited external support. Inefficiently developed and maintained water management systems and technologies as a result of limited access to water can be inefficient and this makes it hard for farmers to get water. Additionally, there is a lack of funds and technical support that is required in order for the farmers to install advanced water-saving devices and strategies.

The study found that farmers in the district have adopted effective tactics used to fight water scarcity and environmental challenges but their sustainability is threatened by gaps witnessed in water governance and growing pressures on human-ecological systems. To mitigate these challenges, there has to be a more integrated approach that ensures sustainable water management recognizing the place of both formal and informal governance structures, supporting farmer-led initiatives as well and boosting the resilience of human-ecological systems (Mugambiwa, 2021). Thus, policies can be formulated or interventions designed which suit specific circumstances related to such areas thereby ensuring sustainable agricultural livelihoods in rural Zimbabwe under these changing environments together with economic conditions.

4.3. The Role of Human-Ecological Systems in Shaping Livelihoods

Agricultural livelihoods are influenced significantly by human-ecological interactions. Soil erosion coupled with decreasing rainfall has compounded problems faced by farmers due to environmental changes. To this end, adaptive practices have been adopted by the rural people which take into account peculiar ecological circumstances such as modifying planting dates or using soil conservation methods among others. Nevertheless, wider governance issues especially the absence of water resources and agricultural inputs often restrict these changes. It is clear from the research that human-ecological systems are essential in defining how agricultural livelihoods are shaped in rural Zimbabwe, and this happens through the on-farm relationship between environmental conditions and human undertakings. It also reveals that local ecosystems' health, and stability coupled with water availability plus soil fertility enhances farmers' well-being. An example is where regions have relatively stable and predictable water sources that promote agriculture for instance through irrigation as they can rely on consistent supplies of water. Participants had this to say;

> "*Our way of living is closely associated with the land and rivers. If the earth is rich and the river flowing, enough food can be grown. But if the land is old and dry and there are no water sources, everything is a battle*".
>
> (Participant 7: Focus Group Discussion- Farmer)
>
> "*It is possible to say that 'we have found out that when we grow trees and look after the forests, soil and water sources are safeguarded'. So our crops grow better, and we have the ability to collect additional fruits and firewood, that can be sold to help the families.*"
>
> (Participant 8: Focus Group Discussion- farmer)
>
> *"The natural environment here is vital to our existence. Wetlands protection and grazing areas management safeguards our livestock and crop production. Abandoning these natural services will lead to the destruction of everything that sustains us*".

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(Participant 9: Key Informant Interview- Environmentalist)

The first narrative is attributed to an elderly farmer from Mutoko District and relates to how the health of natural resources soil and water directly determines the type of economic activities that rural communities engage in. The farmer's concern over the correlation between the presence of water and rich soil and the prosperity of agriculture, as well as the adverse effects of drought and infertile land leading to poverty, highlights the significant reliance of rural communities on the well-being of their ecosystems. It is worth noting that the public participates in these activities mostly for potential income, provided that the environment is well-maintained. Another participant demonstrates the contribution of ecological practices integrations in farming to the environmental and economic aspects. While actively farming, this farmer also practices the recycling of firewood as well as tree planting and deforestation, which supports the crop yield.

The results point out the importance of integrating water governance considering linkages between human and ecological aspects. Water scarcity coping strategies among rural Zimbabwean farmers exist although they have not been fully implemented due to the broader governance context (Gandure et al., 2011). Enhanced local governance capacities, infrastructural development, and equitable distribution of water resources are necessary for agricultural livelihoods and sustainability (Gbetibouo, 2008). The findings from this study reveal the linked human-ecological systems within which water governance structure, farmer strategies, and agricultural livelihoods in rural Zimbabwe are shaped. The fact that these communities thrive even when faced with water scarcity and other environmental challenges can be attributed to the complex interplay between formal and informal governance systems as well as the adaptive strategies used by farmers. Nonetheless, gaps or limitations exist within these systems as evidenced by this study thereby suggesting needs for more integrated or sustainable ways of managing water resources as well as developing agriculture.

Further, livelihood sustainability depends on the adaptability of human-ecological systems. The ecological characteristics of the study area closely relate to farmers' land management practices. For instance, some practice agroforestry which involves the integration of trees into their farming system with the aim of enhancing soil quality, reducing erosion, and improving water retention. Not only do these practices benefit the environment but also provide additional sources of revenues such as fruits or timber thereby diversifying livelihoods. Such integrative approaches are necessary for sustaining a balance between human needs and ecological sustainability, especially in areas that are prone to environmental stressors. However, findings also show that these human-ecological systems are vulnerable to external pressures including climate change and population growth. These systems have been stressed by increasing temperatures, erratic rainfall patterns, and depletion of natural resources making it difficult for traditional farming practices to be sustainable. To ensure sustainable livelihoods, this paper argues for support as well as improvement in resilience capacities within human-ecological systems. Interventions aimed at promoting sustainable land/water management, resource access improvements, and stronger local governance frameworks need to be put in place. Designing policies and programs that can enable the long-term viability of agricultural livelihoods requires an improved understanding of how humans interact with ecological processes. This is an all-inclusive way to address complex challenges faced by rural communities in Zimbabwe while ensuring that people's lives continue improving under changing environmental situations.

6. Conclusion

The findings of this study revealed that rural areas of Zimbabwe remain significant if there is good water governance and if agriculture is practiced sustainably. Regardless of the difficulties involved in water sourcing for farmers, the governance frameworks and the environment are a great challenge to the future of farming practices. Good governance should ensure that development policies such as water resource management plans are consistent with traditional cultures and beliefs. These structures are meant to engage all levels of rural sub-national governments and societies, including the use of external factors such as aid to improve water provision and management. Further, the paper emphasised the

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significant role of human-ecological systems in determining agricultural outcomes in light of escalating external environmental impacts. Lastly, the paper recommends the need to devise actions that support adaptation in ecosystems and their inhabitants in response to the cumulative impacts of climate change in rural areas coupled with the depletion of natural resources.

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