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 copying 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 copying 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.

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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, KIIs, 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 amd 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.

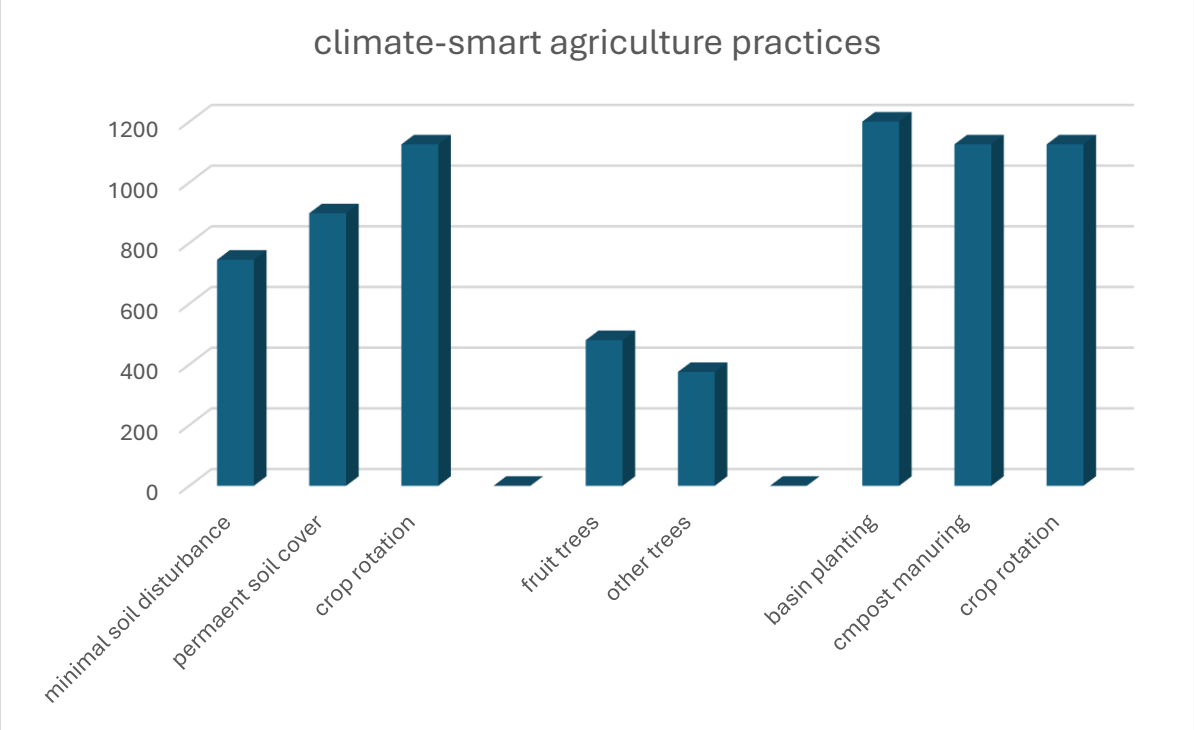
Smallholder farmers in Chimanimani have benefited from Caritas Mutare's extensive capacity building approaches, practical demonstrations, and ongoing technical back stopping and assistance in applying climate-smart agricultural practices. The research revealed that prioritizing capacity building and 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



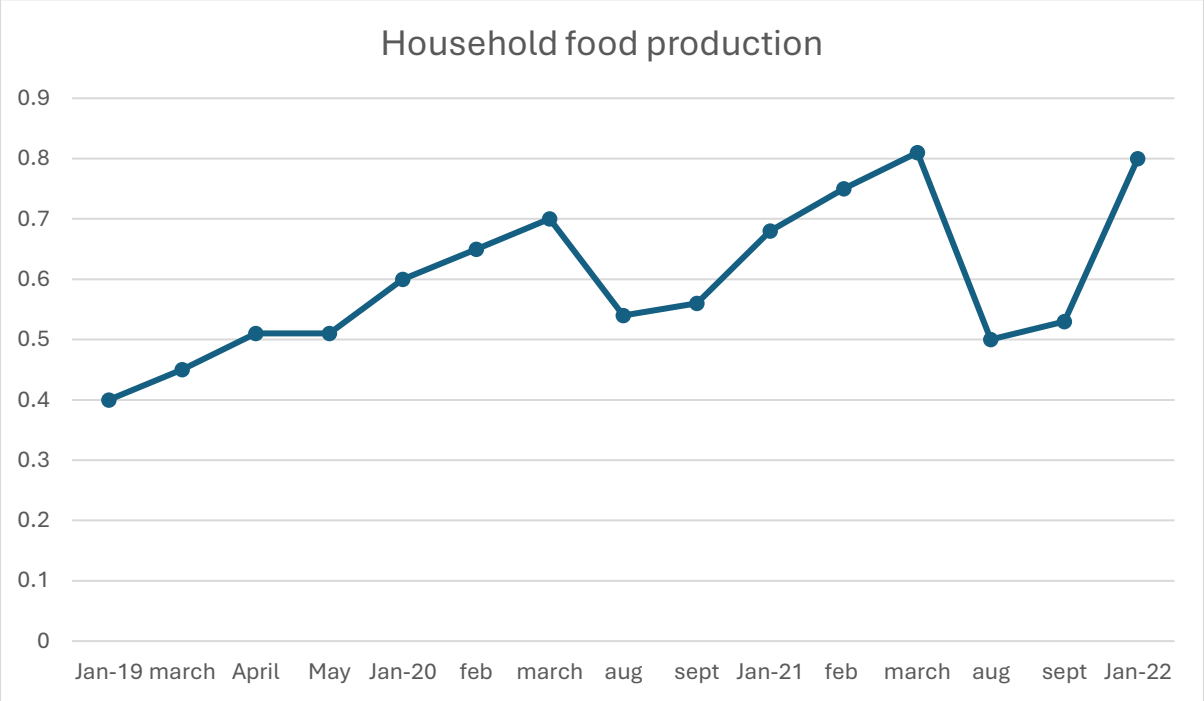
There are noteworthy implications for sustainable land use, resilience, cohesion and climate justice from the developed crop yields and efficiency seen in Chimanimani.

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 copying skills that result in social cohesion in the area. (Thierfelder et al., 2017).

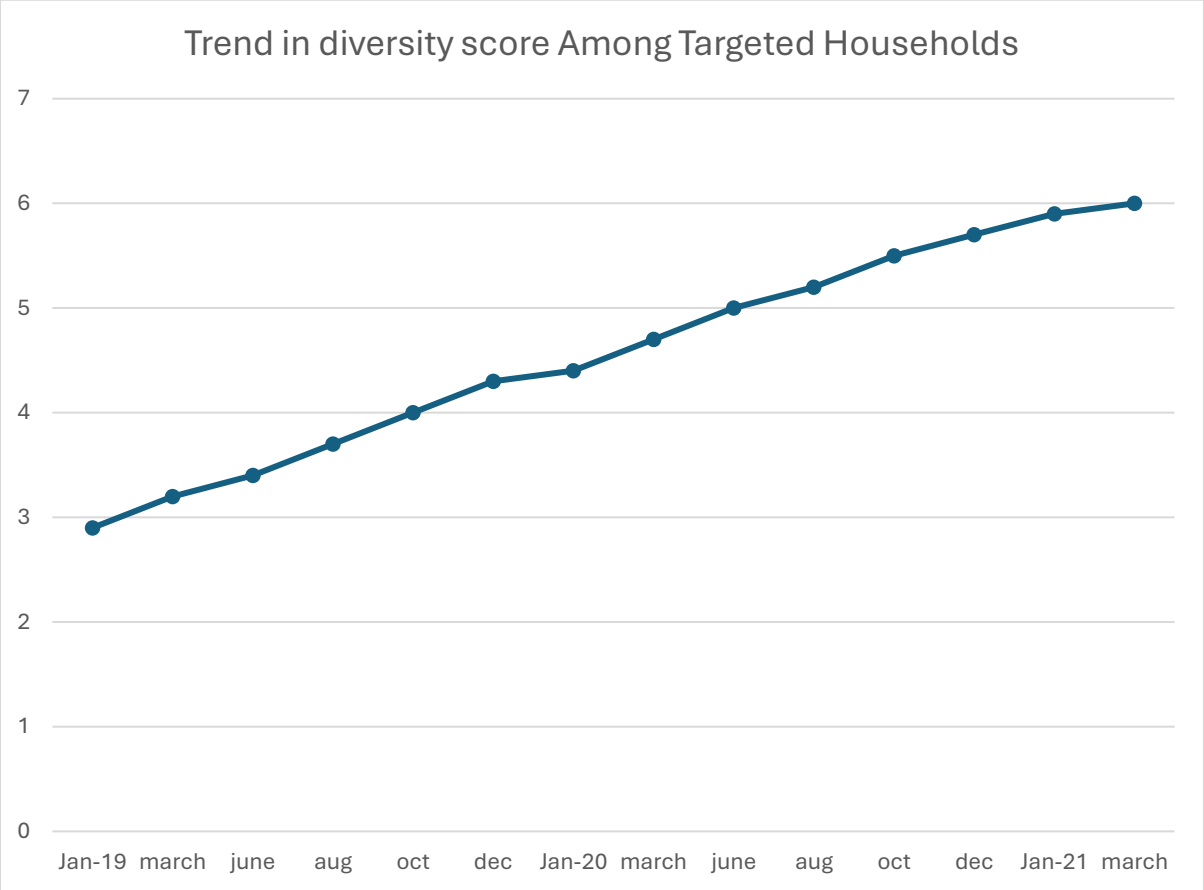
4.2.1 Increased Access to Nutritious and Diverse Foods

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 beneficiation 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

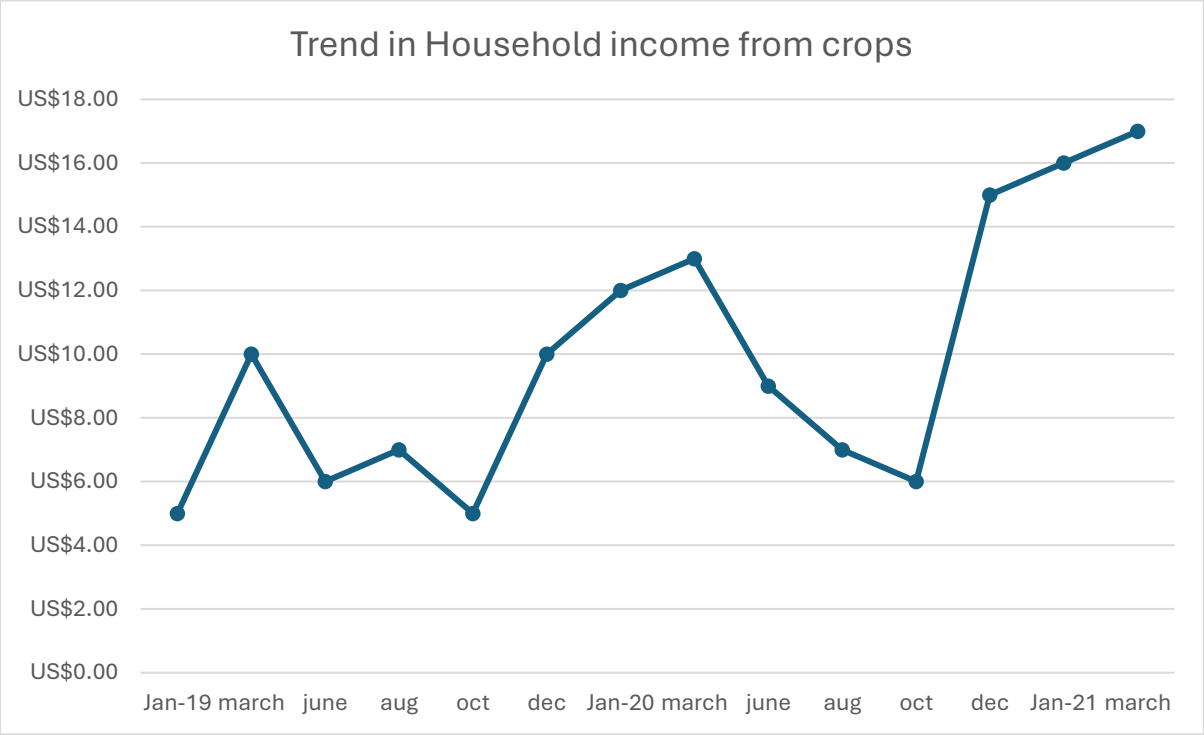
Smallholder farmers' economic security has developed as a consequence of the climate-smart farming exercises improved agricultural efficiency and income source broadening. 83% said they were able to save money through the Village Savings and Loan Associations (VSLAs), which are supported by the project, 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 od 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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