

ADOPTION OF CLIMATE-SMART CONSERVATION AGRICULTURE IN IMPROVING FOOD SECURITY IN ZIMBABWE: THE CASE OF MARONDERA DISTRICT, ZIMBABWE

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Abstract

Climate change is negatively impacting the global community and local communities in the Southern African Development Community (SADC) region. Extreme weather events are occurring more frequently, posing a threat to human lives and well-being. Climate change-induced disasters have exacerbated the risks of hunger and under nutrition through reduced yields of agricultural crops. The detrimental effects of climate change are particularly seen in Zimbabwe. It is best to use climate-smart agriculture (CSA) in the smallholder agricultural sector, which produces the majority of the nation's food. Therefore, it is important to learn lessons from past events and manage risks effectively as part of an integrated set of interventions directed at mitigating the harmful impacts of disasters and risks. The research explores community adaptation and coping strategies in addressing the effects of climate change on food security using Marondera District as a case study. The research was conducted using the qualitative research methodology. Data were collected from a population of 50 people that included smallscale farmers, Agritex officers, extension officers, non-governmental organisation (NGO) representatives, village herdsman and the chief. Documentary research was analysed thematically. The research concludes that

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climate change has had a negative impact on food security. It affected all the four dimensions of food security, that is; food availability, food accessibility, food utilisation and food systems stability. In response, various projects aimed at ensuring community resilience to cope in the face of climatological hazards have been implemented by NGOs, government institutions and other actors, with community members being key stakeholder. The research recommends continued mobilisation of social protection interventions, building of resilient agricultural systems to make them more resilient to climate change and improving the management of the environment to ensure effectiveness in efforts to mitigate the impact of climate change on food security.

Keywords: *community resilience, climate-induced social injustices arid and semi-arid communal areas*

INTRODUCTION

Climate change is one of the most significant global challenges of our day. Its wide-ranging consequences affect many aspects of human existence, particularly for those whose primary sources of income are agriculture and natural resources. Communities in rural areas, where they depend mostly on farming, fishing and other traditional livelihoods, are seriously threatened by the changing environment. Food insecurity is escalating across sub-Saharan Africa (SSA) countries. In 2022, a minimum, 123 million people (12% of SSA's population) were projected to be acutely food insecure—suffering from high malnutrition and unable to meet minimum food consumption needs (IMF, 2022). In sub-Saharan Africa, combating poverty and ensuring the sustainability of agrarian livelihoods are confronted with additional challenges due to climate change. The agricultural sector in the region

continues to be the most significant industry , employing between 65 and 70%of the region's active population and providing livelihoods for 90%of the population (Sithole and Olorunfemi, 2024). The changes in weather patterns have caused reduced agricultural production, causing food insecurity among households, prompting the subsistence farmers to adopt strategies to counter these negative effects. As a result, farmers have started to practise crop diversification, water re-use and harvesting. The adoption of CSA practices has been widely recognised as a promising and successful alternative to minimise the adverse impacts of climate change. Climate variability and change are compounding the impacts of these multiple stressors on people's well-being and livelihoods. Climate-smart agriculture is a crucial approach to addressing the interconnected challenges of food security, climate change and rural development. It encompasses practices, technologies and policies that aim to: increase agricultural productivity – boosting yields and improving resource efficiency are essential to meet the growing demand for food in a world facing climate change; adapt to climate change – CSA helps farmers adapt to changing weather patterns, extreme events and other climate impacts by implementing resilient practices; mitigate climate change – by reducing greenhouse gas (GHG) emissions from agriculture and enhancing carbon sequestration, CSA contributes to mitigating climate change.

Climate-smart conservation agriculture (CSCA) is a cutting-edge method of farming that aims to improve food security while reducing the effects of climate change. This approach incorporates sustainable farming practices, which are essential in light of the world's environmental problems since they enhance soil health, boost biodiversity and maximise water utilisation. Climate change

has become a challenge, for days immemorial. Nearly 690 million people around the world are hungry today (FAO, 2020). The implementation of CSCA has accelerated globally as a result of growing awareness of the threats that climate change poses to food production. Food insecurity is exacerbated by traditional farming practices, which frequently result in decreased yields, water scarcity and land degradation. On the other hand, CSCA encourages methods like cover crops, crop rotation and reduced tillage, which not only increase output, but also strengthen resistance to climate change. The incorporation of CSCA into national policies and programmes has been further accelerated by the emphasis placed globally on the Sustainable Development Goals (SDGs). In addition to improving food security, CSCA supports more general environmental objectives including lowering GHG emissions and fostering biodiversity by coordinating agricultural practices with climate action and sustainability.

The concept of climate-smart agriculture was introduced in 2010 by the Food and Agriculture Organisation (FAO) of the United Nations to face climate change in the agricultural sector (FAO, 2010). It is an integrated approach to farming to address the problems of climate change in the farming system (Ramamasy and Baas, 2007). It can help improve crop yields for enhancing food security by using environmentally friendly techniques (FAO, 2010; World Bank, 2011; Ho and Shimada, 2019). Climate change is an unequivocal and consolidated major threat to sustainable development with multiple adverse impacts on the environment, food security, human health, economic activities, natural resources and physical infrastructure and there can be no contestation or denial of this fact (Rome, 2018). Food security is difficult to

achieve and maintain at the international and provincial levels in developing and underdeveloped nations due to the serious harm done to the agricultural production systems (Thottadi and Singh, 2024). Simultaneously, a growing number of individuals globally, particularly young people, are advocating for climate change action. As a result, it becomes increasingly important to address how to attain food security while simultaneously mitigating climate change and cutting GHG emissions. However, the industry has a great deal of potential to help achieve global climate targets (FAO, 2019a). It is, therefore, imperative to change agri-food systems, which include forestry, fisheries, aquaculture, agroforestry and agriculture. Integrated, multi-sectorial methods that are inclusive, pro-poor and gender-transformative and use synergies like those between climate change adaptation and mitigation, should be used to achieve this transformation. According to the review, CSA adoption frequently results in higher farm incomes and production. As a result, crop yields, productivity, revenue, profitability and the efficiency of technical and resource utilisation all increase (Zheng, Ma and He, 2024).

Crop yields and productivity, revenue and profitability and the efficiency of technical and resource utilisation all rise as a result (*ibid.*). Climate-smart agriculture is therefore being embraced globally as an approach to transform and protect the agriculture sector. Policy imperatives for CSA include the need to increase food yields, feed a growing population of nine billion by 2050, mobilise investments in farmers and reduce GHG emissions (WB, 2010). According to scientific data, the world's climate is primarily changing negatively (Marin, 2010; CGIAR, 2012). Because its effects take time to manifest, climate change has been referred to

as a silent crisis (Maponya, 2010). In this regard, climate change and its resultant impacts, specifically on food security and people's livelihoods, has become a critical and active area of research globally over the decades. Studies have been undertaken to quantify the extent of impacts and the dynamics of climate change on water resources, food security, ecosystems (Thompson, Mendoza and Devito, 2021) energy and human health and have revealed that climate change is a significant factor to consider in holistic planning for community resilience and adaption, fostering global progress towards achieving the United Nations Sustainable Development Goals, Agenda 2030 and the Paris Agreement goals (Kawamoto and Kanie, 2020).

Climate change adversely affects families, communities and the economy in general, and is also argued to be one of the major drivers of environmental change facing many countries, particularly those in the developing south, (Samset *et al.*, 2018). The Long-Term Adaptation Scenarios flagship research programme (LTAS) (2013) reviewed that greater variations in temperature, precipitation and extreme weather conditions associated with climate change combine to trigger environmental changes. This affects rural areas, which are characterised by heavy dependence on climate-sensitive economic sectors, such as agricultural productivity (Unganai, 2009). In the same vein, Handl (2012), explains that the shifting weather patterns associated with climate change threaten food production. In this regard, environmental researchers such as Dyson (2018) have warned that if no action is taken promptly to respond to these impacts

associated with climate change, specifically on food security, the consequences will be more difficult and costly (*ibid.*).

The length of growing seasons, agricultural yields and areas that are historically suitable for agriculture, are all changing and declining as a result of climate change. In other cases, the same seasons have brought about dry spells and floods. All seasons see a decrease in rainfall. Other possible changes include rising temperatures, shifting or decreasing river flows and the ability of various water sources to hold water (Moyo *et al.*, 2012). There is a clear signal from the scientific community that temperatures will increase globally due to climate change and this is likely to adversely impact agricultural productivity significantly. Climate-smart agriculture is, therefore, being embraced globally as an approach to transform and protect the agriculture sector. Policy imperatives for CSA include the need to increase food yields, feed a growing population of nine billion by 2050, mobilise investments in farmers and reduce GHG emissions (World Bank, 2010). Agriculture is the predominant economic industry in many countries and is key to meeting the basic needs and livelihoods of 70% of the world's poorest people (The Global Commission on the Economy and Climate (GCEC), 2014). Thus adaptation, mitigation and food security (the three pillars of CSA) will have important implications for the world's poorest farmers. Adopting CSA practices is environmentally feasible as it reduces GHG emissions and improves soil quality. An integrative strategy encompassing diverse CSA practices portends an optimised avenue to chart a trajectory toward agri-food systems fortified against climatic change (Zheng, Ma and He, 2024).

The impacts of climate change on agriculture and rural communities has become increasingly evident, posing significant challenges to food and income security. Farmers are urged to adopt CSA techniques that lessen climate-induced hardships due to the negative effects of global climate change and the combination of increased agricultural production requirements. The effects of climate change fluctuate from nation to nation and from one geographical area to another geographical area because vulnerable people, particularly those in emerging nations, are more or less sensitive to the effects of the climate (First, 2019). Research in this field is necessary because, for example, the negative effects of climate change in developing nations manifest in more ambiguous terms (Scholes, Scholes and Lucas, 2021). According to studies conducted in Southern Africa, there is still a great deal of climate variability in Africa, characterised by frequent floods and droughts that may get worse in the future (Zengeya, Murwira and de Garine-Wichatitsky, 2021).

Climatic projections indicate that conditions will worsen and the effects of climate change on agricultural productivity have left a sizable part of households' food and nutrition insecure and forced to rely on food aid. Globally, there is increasing pressure to accelerate climate action by expanding both adaptation and mitigation measures. The sustainability aspect of food security may be threatened by climate change, which might further strain the Sub-Saharan region's already delicate ecosystems. Fraser (2003) investigated how vulnerable African food systems are to climate change and made the case that three aspects are particularly noteworthy in this regard. These include households with limited options for earning a living outside of farming; specialised agro-ecosystems; and circumstances in which formal

institutions fail to offer sufficient safety nets to safeguard individuals. Africa's food systems are characterised by a number of factors, including poverty, illiteracy, a lack of skills, weak institutions, inadequate infrastructure, a lack of technology and information, low primary education levels, inadequate health care, armed conflicts, restricted access to resources, poor governance, overexploitation of land and population growth and land degradation. These factors all work together to threaten the continent's agricultural systems. The data unequivocally demonstrate that food insecurity brought on by climate change is most severe in Africa.

The term 'climate-smart agriculture' refers to a conglomeration of methods that have been applied historically in the domains of agriculture, environmental ecology, conservation and climate change. FAO defines CSA as farming that lowers and/or eliminates GHGs), improves the resilience of livelihoods and ecosystems, boosts productivity in a sustainable manner and advances the attainment of national food security and development objectives. CSA encompasses tried-and-true, useful methods like crop rotation, mulching, intercropping, conservation agriculture, agroforestry, integrated crop-livestock management, enhanced grazing and better water management. The implementation of cutting-edge techniques like more accurate weather forecasting, early warning systems and climate risk insurance is also part of it. The goal of further combining agricultural development and climate responsiveness is reflected in the idea of CSA. The idea seeks to accomplish both food security and more general development objectives in light of the changing climate and rising demand for food. According to Vermeulen *et al.* (2012), greater planning is essential in addressing

trade-offs and synergies among the three pillars of productivity, adaptation and mitigation. Climate-smart agriculture represents an approach to transforming and re-orienting agricultural development in response to such climate change pressures (*Climate-Smart Agriculture Manual for Zimbabwe*, 2017). The dual nature of the agricultural sector is the fact that agricultural systems simultaneously contribute significantly to global anthropogenic GHG emissions and are susceptible to shocks and strains brought about by climate change meaning the relationship between agriculture and climate change is, nevertheless, poorly understood.

The study, therefore, seeks to investigate the adoption of CSCA in improving food security and how climate change has affected the food security of the Marondera (Zimbabwe) rural households. The study further investigates their coping strategies as they strive to sustain their livelihoods. It is against this background that there is a need to recognise the interlinkages between agriculture, food security and climate change at the ministerial level and that integrated policies are needed for CSA with reference to Marondera Rural District in Mashonaland East Zimbabwe.

CONCEPTUAL FRAMEWORK

Climate change encompasses prolonged alterations in temperature, precipitation and other climatic parameters, exerting considerable pressure on diverse sectors worldwide, notably agriculture and livelihoods (Smith *et al.*, 2018). According to UN (1992), climate change means a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is, in addition to natural climate variability, observed over comparable periods. The United

Nations defines climate change as long-term shifts in temperatures and weather patterns, accelerated by human activities such as burning fossil fuels, mainly coal, oil and gas, industry, transport, building, agriculture and land use (Matinez, 2022). Climate change represents a profound challenge to the livelihoods of women, as it has negatively affected their sources of income and means of production that enable them to provide for their families. This is because women in a patriarchal nation such as Zimbabwe, which celebrates male dominance, evidenced particularly by land ownership, have limited adaptive capacity (Chiname *et al.*, 2014). The way that climate-smart conservation agriculture methods are adopted is greatly influenced by induced innovation. It improves the sustainability and resilience of agricultural systems by encouraging a culture of innovation in response to economic and environmental difficulties, which eventually leads to better environmental health and food security. Gaining an understanding of this idea can help stakeholders advocate for successful CSCA adoption and implementation techniques.

Climate change can also be defined as a major shift in climatic variables such as temperature, wind and rainfall over a lengthy period, such as years or decades. It might take hundreds of years to build in the long term. According to Ngoh *et al.* (2013), 'climatic change' refers to long-term patterns in climate averages, such as global warming, as well as long-term changes in variability. Increasing sea levels, such as those in the Maldives Islands, have shown that global temperatures are rising, seas are warming and ice sheets are melting, leading to floods and ocean acidification (Woyesa and Kumar, 2021). The global climate is currently changing as a consequence of a combination of natural and man-made effects. On the same wavelength, Akudugu and Alhassan

(2013) point out that climate change may be defined as the gradual change in weather patterns of the world over a long period, mainly as a result of human activities concerning the environment. From the above definitions, climate change can be defined as a change in weather patterns from extremely hot to extremely cold or vice versa, which has been necessitated by human activities in the natural environment. Climate change can also refer to long-term changes in temperature and weather patterns, not just extreme shifts between hot and cold. It is arguably the most persistent threat to global environmental stability (Egyir *et al.*, 2015). This is supported by Chikodzi *et al.* (2012) who argue that climate change has become a threat to rain-fed agriculture and yet rain-fed agriculture is an important economic activity in the developing world. According to Lacombe *et al.* (2012) and Owusu and Waylen (2012), communities in the transition and coastal savannah zones are facing climatic changes as a result of the lengthening of the growing season and the major and minor rainy seasons. This has led to a decrease in the ability of farmers to plant multiple crops in most areas.

Assessing the effects of implementing CSCA methods on food security and agricultural sustainability is the main goal of this study. Climate change affects food production, which is crucial for human beings. These impacts urge humans to adopt specific measures to address the damages created and possible future risks. Food self-sufficiency for rural households depends more on the prevailing weather conditions than on any other variable. The impact of climate change on rural livelihoods in developing countries is a growing concern, particularly in sub-Saharan Africa where the majority of the population relies on agriculture for their food and income security. Climate change adaptation is an

important measure to tackle damages caused by the changing climate by adjusting nature utilisation and human systems to moderate harm and exploit beneficial opportunities (Obayelu *et al.*, 2014). Since the beginning of time, climate change has presented challenges, particularly for smallholder farmers. This is because small-scale farmers depend on rainfall, which has historically fluctuated due to climatic variations, resulting in low yields. The research aims to understand and improve the climate change adaptation strategies of smallholder farmers in Zimbabwe by examining CSA practices. It assesses strategies and decision-making processes of smallholder farmers in developing their environment and livelihood through CSA. Therefore, the goal of the study is to investigate the alternative strategies used by the farmers in Marondera District to increase their food security. This research is guided by the following objective: To explore farmers' understanding of climate smart conservation, to access the success and challenges using CSCA in improving food security and to identify ways of improving challenges associated with CSCA.

THEORETICAL FRAMEWORK

The research was guided by the Induced Innovation Theory (Hicks, 1932).

THE INDUCED INNOVATION THEORY

This theory can be applied in the area of climate change, as discussed by Netra *et al.* (2004). The concept of induced innovation, first put forth by economist John Hicks in 1932, is particularly pertinent to the adoption of climate-smart conservation agriculture practices because it suggests that technological innovations and advancements are frequently motivated by the need to address particular problems, especially

in response to shifts in economic conditions or resource availability. This theory helps examine how farmers' perceptions of climate change drive innovation and adaptation in Marondera Rural District. Induced innovation helps create adaptable techniques that improve food security by encouraging creative farming methods. CSCA techniques can boost biodiversity, enhance soil health and raise yields, all of which are essential for sustainable food production. The fundamental of induced innovation is that investment in innovation is a function of change which enters the farm's production function. Innovations in agriculture do not evolve climatic variables by non-climatic factors only. For example, political and economic environments have a noteworthy implication for innovation and adaptation to new agricultural practices.

The theory analyses the effects of climate change and how the perceptions each individual farmer has on this change trigger the farmer to be innovative in adapting. This theory assumes that when farmers experience some changes due to climate, they are likely to look for other means that can help them overcome constraints that arise. Therefore, these changes act as a catalyst in adaptation responses, in this case, farmers adjust crop management, land uses and farm management strategies so as to offset the adverse effects of climate change. It is thus assumed that perceptions of the variability in climate prompt the adaptation process among the households so as to cope with the negative impacts of climate change in the farm (Ndambiri *et al.*, 2015). The study observes that climate change in the Marondera Rural District is an important limitation towards the productive capacity of smallholder farmers and that adaptive responses would minimise farming risks stemming from climate change. It can also

be noted that when pressure to grow food from climatic stressed environment, the marginal cost of production goes up. Eventually, the farmer gets to a point where adaptation becomes the only means to enhance farm incomes. This may entail the creation and use of knowledge that accommodates climate change through a combination of land use and farm management practices such as water harvesting, irrigation or through the adoption of area specific crop varieties and livestock. Therefore, undertaking this study in Marondera Rural District provided important insights into the relationships between peasant farmer's adaptations to climate change, which would safeguard the local people, against the adverse effects of climate change. Therefore, CSA aims to meet the growing demand for food, fibre and fuel, despite the changing climate and fewer opportunities for agricultural expansion onto additional lands (Kumar, 2017). It also contributes to economic development, poverty reduction and food security, maintaining and enhancing productivity and resilience of natural and agricultural ecosystem functions, thus building natural capital and developing adaptation and mitigation approaches.

METHODOLOGY

This research employs a qualitative methodology to explore the adoption of CSCA practices and their impact on food security and agricultural sustainability. The qualitative approach was chosen to gain deeper insights into the experiences, perceptions and motivations of farmers and stakeholders involved in CSCA. According to Jankowicz (1995), research methodology is described as an analysis of, and the rationale for, the particular method or methods used in a given study and in that type of study in general. The section provides the description and arguments for the research design and the techniques and methods used in

collecting data. When carrying out research, one has to recognise a problem or an area one is interested in. A case study design was utilised to provide a comprehensive understanding of CSCA adoption in selected regions. Multiple case studies were conducted to capture diverse contexts, including variations in socio-economic conditions, environmental challenges and agricultural practices.

The qualitative research method was used. It has a lesser chance of limiting the scope of the research for it provides a detailed description and analysis of the research topic. The research uses the qualitative research methodology for it allows the research to assess the adaptive strategies used by peasant farmers in Marondera Rural District. The study adopted the use of focus group discussions (FDGs) and in-depth interviews for collecting data. Key informants interviews (KIIs) were done which consisted of farmers who have adopted CSCA practices, agricultural extension officers and local agricultural experts and were identified through purposive sampling. A sample of fifty (50) participants were purposively selected and each FDG consisted of a minimum of five (5) and a maximum of ten (10) people.

The research made sure the discussions lasted between sixty (60) to ninety (90) minutes. The methodology allowed probing further and gave a close interaction between the research and the participants. Gary, (2011) points out that the qualitative research method allows respondents to provide genuine responses, especially when they are in an environment they consider normal. Qualitative research, according to Flick (2014), is any type of research that produces findings not arrived at by statistical procedures or other means of quantification. It can refer to

research about persons' lives, lived experiences, behaviours, emotions and feelings. The qualitative research approach lends itself well to developing new ideas that can be used to promote progress since it focuses on daily life and people's experiences (Kroeze, 2012). Qualitative data were instrumental in getting an understanding of the perceptions and the reality of smallholder farmers on the impact of climate change on productivity, output and livelihood security. Qualitative research provides an understanding and description of people's personal experiences of a phenomenon, thus the emic or insider's viewpoint (Luttrell, (2010:75). Participants will naturally share their views and experiences. Since coping strategies are dynamic, the qualitative paradigm offers an opportunity to thoroughly investigate dynamic processes (Zakiya, 2008:86).

The data analysis for this qualitative research focus on systematically interpreting and extracting meaningful insights from the collected data regarding the adoption of CSCA practices. Data was analyzed thematically. The analysis focused on identifying core themes that emerge from the data, such as motivations for adoption, barriers to adoption and perceived benefits of CSCA to mention a few.

Conducting qualitative research on the adoption of CSCA practices involves various ethical considerations to ensure the integrity of the research process and the protection of participants. Participation was entirely voluntary and individuals had the right to refuse or withdraw from the study at any time without any negative consequences. Participants' identities and responses were kept confidential and efforts were made to empower participants

by valuing their knowledge and experiences, ensuring their voices were heard in the research findings.

LITERATURE REVIEW

The focus of the review is on examining climate change and its influence on food security. In order to draw comparisons as well as getting insight from other researchers, the work of other academics is recognised. The literature review explores adaptation options, theoretical underpinnings, climate change and food security. It is a review of literature on the research area and the theoretical frameworks guiding this research study. The section covers the conceptualisation of climate change and food security and the adaptive and coping strategies thereof. The primary goal of this literature review is to demonstrate how prior research has addressed the topic of climate change and its influence on food security. It also aims to offer empirical information for the aim of addressing the research goals, giving arguments and discovering gaps. Furthermore, being a survey of scholarly sources, the literature review also provides an overview of current knowledge, and allows the identification of relevant theories which the research draws from (Babbie, 2012). This section also discusses theories with regards to how they could guide discourse in this research.

CLIMATE-SMART AGRICULTURE

Climate-smart agriculture (CSA) is rooted in sustainable agriculture and rural development objectives which, if reached, would contribute to achieving the UN Sustainable Development Goals (SDGs) of reducing hunger and improving environmental management. More productive and resilient agriculture is built on the sound management of natural resources, including land,

water, soil and biodiversity. Conservation agriculture, agroforestry, improved livestock and water management, integrated pest management and ecosystem approaches to fisheries and aquaculture, can all make important contributions in this area.

Key elements of climate-smart conservation include understanding the implications of climate change and how human responses might create new environmental threats. It also involves developing and implementing no-regret actions that address current threats, preserve future adaptation options and avoid contributing to GHG emissions (Kumar, 2017). Also, take an integrated approach to adaptation, contributing to nature conservation and fair, equitable and sustainable development, active learning to build capacity and work collaboratively to plan and respond to increasing change and uncertainty and bringing about changes in policy that create an enabling environment across scales (local to international) for adaptive governance.

CLIMATE SMART AGRICULTURE

Climate-Smart Agriculture is an approach that focuses on the farmer, fisher and herder. It seeks ways to improve the farmer's productivity and income Hesselberg and Yaro (2006). It is an approach that helps farmers adapt to a changing climate and contributes to the mitigation of GHG emissions (Lima, 2014). CSA practices, appropriate for enabling farmers to effectively adapt to climate change, range from the use of techniques and mechanisms suited for farm-level operations to international policy and finance mechanisms. Examples of such technologies and techniques include agro-forestry, mulching, minimum tillage, crop rotation, water conservation, methane reducing rice systems and soil cover

maintenance (Barnard et al., 2015). The main benefit of implementing improved cropland management practices is expected to be higher and more stable yields, increased system resilience and, therefore, enhanced livelihoods and food security and reduced production risk (Vallis et al., 1996; Pan et al., 2006; Woodfine, 2009; Thomas, 2008; Conant, 2010). Climate-smart agriculture offers a promising pathway to achieve sustainable food systems and address the challenges of climate change. By embracing CSA, we can create a more resilient and equitable food future for all. A few technologies and methods that are often employed in several African nations are listed by (Lima, 2014). The conservation approach to agriculture is helping Zimbabwean farmers. Farmers are trained in the usage of small plots, which retain water readily and require less maintenance than bigger plots, through the *Pfumvudza* programme, which is known throughout the nation. *Pfumvudza* is a Shona word meaning "to gather together" or "to concentrate". Bringing food security to Zimbabwean families is the aim of this research so as to ensure food security in the country. The farmers' burden is significantly reduced by conservation agriculture, which also makes it even more bearable by limiting the size of plots.

CLIMATE CHANGE AND FOOD SECURITY

Food security's foundational elements are impacted by climate change. Food availability, food accessibility, food usage and food system stability are the four aspects of food security that are impacted. It affects purchasing power and market movements, food production and distribution routes, livelihood assets, human health and more (Maviza and Ahmed, 2020). The impacts of climate change on food security are both short-term, resulting from more frequent and more intense extreme weather events and

long-term, caused by changing temperatures and precipitation patterns (Millennium Ecosystem Assessment, 2020). The effects of climate change on agricultural systems and production, food security and the income of smallholder farmers have been widely documented (Laderach *et al.*, 2009; Esham and Garforth, 2013; Harvey *et al.*, 2018). The world is at a critical juncture: it is very different from where it was six years ago when it committed to the goal of ending hunger, food insecurity and all forms of malnutrition by 2030 (FAO, 2019). The number of people in the world affected by hunger continues to increase. Of the total number of undernourished people in 2020 (768 million), more than half (418 million) live in Asia and more than one-third (282 million) in Africa, while Latin America and the Caribbean account for about 8% (60 million) (Fuglie *et al.*, 2020). Compared with 2019, 46 million more people in Africa, almost 57 million more in Asia and about 14 million more in Latin America and the Caribbean were affected by hunger in 2020 (Rockström *et al.*, 2020). Moderate or severe food insecurity (based on the Food Insecurity Experience Scale) at the global level has been slowly on the rise, from 22.6% in 2014 to 26.6% in 2019 (*ibid.*). Food security occurs when members of a family have an insufficient diet for part or all of the year or face the prospect of an insufficient diet in the future (Ilaboya *et al.*, 2012). According to the Republic of South Africa (2013), there are four pillars of food and nutrition security, namely, availability, accessibility, utilisation and stability of supply of food.

Food availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).

Food access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command, given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).

Utilisation: Utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security.

Stability: To be food secure, a population, household, or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can, therefore refer to both the availability and access dimensions of food security (FAO, 2021).

According to FAO (*ibid.*), climate change-related disasters do not only have dire effects on economic development, but also have deleterious consequences for food security and nutrition. Reduced crop yields, pest and disease proliferation, shifts in growing seasons, reduced water availability and competition for water resources are some of the effects. Furthermore, studies on the impact of climate change in Africa reveal that, generally, smallholder agricultural production is significantly constrained by high temperatures and low rainfall. Climate change has compounded African peasant farmers' vulnerability to drought, hence food insecurity and poverty (Kawamoto and Kanie, 2020).

In developing countries in Africa, food insecurity is due to factors such as extensive reliance on rainfall for crop production, high seasonal variability, recurrent droughts and floods that affect both crops and livestock (Boko *et al.*, 2007). Climate change affects food production in several ways, ranging from direct effects on crop production such as changes in rainfall, leading to drought or flooding, or warmer or cooler temperatures leading to changes in the length of the growing season, as well as changes in markets, food prices and supply chain infrastructure (IPCC, 2014).

STRATEGIES TO IMPROVE FOOD SECURITY

Food security is a complex issue with no single solution. Crop rotation, intercropping and conservation agriculture are examples of sustainable farming practices that can improve soil health, decrease pest infestations and increase yields. According to Deguine, *et al.* (2021) (as cited in Sharma, Sharma and Thakur, 2024), adopting any of the three conservation agriculture principles has positive impacts on soil organic carbon (SOC), as has been shown globally. Conservation agriculture enhances the physical, chemical and biological qualities of soil, essential for preserving soil condition and health. Other strategies to improve food security include using sensors, drones and data analytics to optimise resource usage (water, fertilizer and pesticides) and customising farming practices to particular field conditions; biotechnology, which uses genetically modified crops (GMOs) to increase pest resistance and drought tolerance; and growing crops in stacked layers within controlled environments, maximising space and minimising environmental impact. These methods offer alternative food sources and can be implemented in areas where traditional farming is challenging. It is important to remember that the most effective approach to improving food security will vary

depending on the specific context and challenges faced by a particular region or community.

A combination of these methods, tailored to local needs, is likely to be most successful. At the proxy-impact level, household food access depends on a combination of families' own food production, income, food prices and household buffers (money, food storage capacity) to bridge food shortage periods, for example between harvests. Food availability, at the local or national level, is a condition but no guarantee for food access, as households may not be able to afford or access needed food. At the national level, food availability is the sum of domestic food production, food imports, food stocks and international food aid, minus food exports (Faramarzi *et al.*, 2013). Export earnings allow food imports. Natural resource management, land tenure security and financial services also support households to maintain their productive capital. To address all dimensions of food security, international partners and governments use a variety of approaches.

Activities range from funding research on disease-resistant crops to developing markets for farm products or educating families on good feeding practices for young children (*ibid.*). For this systematic review, the study first identified different ways of supporting food security and described each intervention's impact pathway. The interventions were ranked using the hierarchy of food security described by the United Nations Food and Agriculture Organisation (2020) and grouped into 11 broad categories of food security work. This review focused on four of these intervention areas: increasing production, developing value chains, reforming markets and improving land security.

SMART CONSERVATION AND FOOD SECURITY

Smart conservation plays a crucial role in enhancing food security by ensuring sustainable and resilient food production systems. Globally, CSA adoption is still being promoted, but few efforts have been made to solve the sustainability issues that many impoverished smallholder farmers face in doing so. Preventing the hazards of widespread environmental degradation and striking a balance between resource usage and productivity, are two particularly urgent challenges. This is crucial for assisting in the accomplishment of Agenda 2030's SDG 6 (*ibid.*). Building smallholder farmers' technical capacity is necessary in many nations in order to help them create and carry out wise policies and fortify local, regional and national governance frameworks. To address the impending risks of climate unpredictability and change in agriculture, CSA can be a potent instrument that opens up new development possibilities and presents alluring prospects. Conservation agriculture, which is characterised by little soil disturbance, crop rotation and diversification, agroforestry, ecological agriculture, regenerative agriculture and low soil disturbance are examples of CSA practice variations.

Pfumvudza is a climate-smart agriculture approach that has gained significant traction in Zimbabwe. *Pfumvudza* is a Shona word meaning "to gather together" or "to concentrate." It reflects the core principle of the method, concentrating inputs and efforts on a smaller, more manageable plot of land. The method involves preparing raised beds, applying compost and manure, planting in rows and using drought-tolerant crop varieties. Ideally, the concept was developed by the Foundation of Farming, a local NGO to meet cereal needs for an average household of six members over one year from a small piece of land. It is based on

three core underlying principles, namely minimum soil disturbance or tillage; digging holes for planting only, permanent soil cover by using organic mulch; crop rotations and intercropping cover crops with main crops. Household food security is expected to be realised when activities are done on time, at standard, without wastage, to the expected precision and with joy (Oldreive, 2006; 2011). Overall, *Pfumvudza* is a valuable example of a climate-smart agricultural approach that can contribute to sustainable food production in Zimbabwe. By integrating technology and promoting best practices, it has the potential to further enhance its effectiveness and contribute to a more resilient and productive agricultural sector.

It is important to note in this context, besides the above-discussed key components, that improving smallholder agricultural systems is central to achieving CSA and the local institutions and their role in facilitating CSA strategies. It requires changes in farming households' behaviour and strategies. The institutions that are operating locally have to produce and share information and help farmers translate this information into knowledge. They have to support the poor farmers lacking access to credit and regulated markets and also the people who are unable to adopt these techniques. Proper arrangements for access to agricultural markets, financial institutions and insurance schemes go a long way toward achieving CSA. Above all, public sector institutions have to play a crucial and leading role in the enforcement of related agricultural policies, proper distribution of agricultural subsidies, provision of research and extension services and collection of necessary and useful data relating to region/district-specific agricultural practices and should propagate how CSA can be implemented. NGOs, universities and research institutions

have to play their own academic and research roles actively in providing social services, pre-training and service training for extension workers. The faculties in the universities and related departments have to conduct research of their own to strengthen the CSA initiatives. It is hoped that all these efforts propel the climate-smart agricultural strategy and become instrumental in providing nutritious food and guaranteeing food security to all people around the globe.

RESULTS/FINDINGS

From the research, one of the interviewed farmers managed to define climate-smart conservation as a new way of thinking about protecting the environment, one that plans for how a changing climate affects conservation efforts. A farmer said,

“Climate-smart conservation is all about developing and implementing solutions that are effective under a range of potential futures.”

To ensure food security, one Agritex officer defined and explained climate-smart agriculture, also known as climate resilient agriculture, as an integrated approach to managing landscapes to help adapt agricultural practices, livestock and crops to the effects of climate change and, where possible, counteract it by reducing GHG emissions from agriculture. He emphasized the programme as a novel approach to putting an end to local food shortages and the majority of farmers agreed with his remarks.

When asked about the effects of climate change on food security, people indicated that extension officers in the Marondera Rural District confirmed that hunger and malnutrition were issues of both quantity and quality. Climate change affects both. Therefore,

there is need to take into consideration the issue of CSA seriously if it is to ensure food security in the country. Another participant said,

“Unpredictable rainfall patterns brought on by climate change may result in both droughts and floods. Water supply for drinking and irrigation, which are essential for food production, is impacted by this unpredictability.”

Climate change generates considerable uncertainty about future water availability in many regions as witnessed by Marondera Rural District farmers during the interview. It affects precipitation, runoff and snow/ice melt, with effects on hydrological systems, water quality and water temperature, as well as on groundwater recharge. In many regions of the world, including the Marondera Rural District, increased water scarcity under climate change presents a major challenge for climate adaptation. Sea-level rise affects the salinity of surface and groundwater in coastal areas. Climate change is likely to affect the frequency and intensity of extreme events. The magnitude of the impacts of extreme events on agriculture is already high. Overall, the analysis of the data shows that changes in weather patterns, such as increased rainfall, prolonged droughts and extreme temperatures, have noticeable impacts on agriculture. Additionally, decreased crop yields, increased variability and pest/disease incidence have major concerns for farmers. These findings suggests the need for adaptation strategies and interventions to mitigate the negative effects of these factors on agricultural productivity.

STRATEGIES THAT CAN BE USED TO IMPROVE FOOD SECURITY

It is generally agreed that, smallholder farmers in developing countries are among the most vulnerable groups toward climate

change due to their limited skills and capabilities (Cacho *et al.*, 2020). Findings from this study reveal that CSA adaptation would increase the chances of the sampled farming households' food security in communities under investigation. This observation agrees with the Wekesa *et al.* (2018) study of CSA practices and food security in smallholder production systems in Kenya, which reveals that farmers who adopted CSA practices were at a better level of food security than non-adopters. Dooley and Chapman (2014) note that a farm household would be better off with CSA adoption primarily because CSA integrates adaptation benefits, food security and mitigation benefits.

Results from all communities suggest that mainstreaming CSA would impact the livelihood and food security status of small-scale farming households in the Marondera Rural District.

One of the Agricultural Extension Officers lamented that,

"The issue of climate change needs to be taken seriously from all walks of life. It is not a one-man band, but rather an inclusive issue which needs cooperation from all four corners of the world."

The findings support the aim of CSA as presented by FAO (2013) and Lipper *et al.* (2014), which is the alleviation of food insecurity by enhancing resilient and sustainable systems to increase food production.

Pfumvudza, crop rotation, integrated crop-livestock management and planting of drought and heat-tolerant crops were among the highly accepted CSA practices by the sampled farmers. However, findings reveal that the larger the household and the more exposure to extension and advisory services, the higher the preference for crop rotation as a CSA practice to be adopted.

One farmer argued that,

“It is high time to desist from traditional ways of farming since the seasons have shifted. There is need to improvise and be able to learn more from new technological advancements.”

Extension and advisory services expose farmers to adequate information needed for the successful adoption of relevant agricultural practices. The findings on the influence of the nature of agricultural production on the preference for crop rotation suggest that crop farmers would embrace crop rotation more than their counterparts who were into mixed farming.

Results further suggest that the more the sampled farmers were educated and exposed to extension and advisory services, the more their preference for integrated crop-livestock management. One of the interviewed farmers argued that,

“It is imperative to practise diversification of crops and livestock. This will go a long way as I won’t rely on crop production alone, there is need to include animal production so as to complement challenges being experienced due to climate change.”

This is expected, as an agricultural practice that is as technical as integrated crop-livestock management would require a level of technical know-how that requires a reasonable level of training or exposure to information. These findings agree with Onyeneke *et al.*, (2018) that education positively affects climate change adaptation.

The results reveal that smallholder farmers in the Marondera Rural District of Zimbabwe implement beneficial CSA practices to adapt to climate change. They tend to choose adaptation strategies

that bring short-term economic benefits, rather than long-term effects on natural resources.

A farmer argued that,

“It is now known by every famer that the climate is changing, hence it means as famers, we need to be innovative as well. Failure to do so it means you are going to run a loss each and every year, hence farming becomes unprofitable. As of my case, use strategies like: diversification of crops, implementing diverse cropping systems can enhance soil health, reduce pest pressures and increase resilience to climate variability. This approach often leads to improved yields and reduced input costs.”

On the same note, a key informant (KII) from Agricultural Extension Office said that,

“Adopting Climate-Smart Conservation Agriculture (CSCA) practices involves implementing adaptation strategies that not only address the impacts of climate change. but also provide immediate economic benefits while ensuring the sustainable use of natural resources.”

Adopting CSA is thought to be a practical way of guaranteeing food security and successfully manage climate threats. The adoption of CSA has highly benefited farmers in Zimbabwe to increase food production. Additionally, policies such as agricultural subsidies and organisational support may also play a role. Thus, governments should give more attention and priority to improve the awareness and lessen the vulnerabilities of smallholder farmers in the village to address the impacts of climate change. The government should be more concerned regarding the subsidies allocation for supporting fertilizers to smallholder farmers. For example, small-scale farmers in Zimbabwe are subsidised by the government through schemes like *Pfumvunza* and command agriculture. Problems with

administration like delays affect distribution processes. The price of unsubsidised fertilizers is two times higher. Hence, they are not affordable for farmers. As a result, farmers cannot apply the fertilizer properly at the planting time during rainy seasons and it affects their products.

POSSIBLE MEASURES TO IMPROVE FOOD SECURITY THROUGH SMART CONSERVATION

Education is expected to increase the capacity of farmers to obtain process and utilise information relevant to the adoption and management of agricultural practices (Onyeneke *et al.*, 2018). Wekesa *et al.* (2018) argue that educated farmers would opt out of a CSA package if it does not offer risk reduction measures that protect their investment against the risks of climate change. Agricultural extension services serve as a crucial source of information on climate change, climate change adaptation and resilience, as well as agricultural management practices (Onyeneke *et al.*, 2018).

Results also show that farmers with large expanses of land would embrace integrated crop-livestock management more than their counterparts with smaller portions of land. It is further shown that farmers with higher exposure to extension and advisory services and larger expanses of land will likely embrace the planting of drought and heat-tolerant crops when compared with their counterparts with lower exposure to extension and advisory services and smaller expanses of land. It is expected that frequent contact with extension agents would brighten the chances of awareness of climate change and CSA practices that can be adopted to adapt to climate variability and shocks. Besides,

farmers, through extension services, can learn climate change mitigation measures and strategies that can enhance resilience.

The household size of the sampled households in the district significantly and negatively influenced food security in the area. The more populated the household is, the higher the chances of being food insecure. This result concurs with Huluka *et al.*, (2019) who state that household dietary diversity decreases with a big household size. A similar pattern obtains for the dependency ratio of the households. This is expected, as a high dependency ratio in a household means more household members are not working than those working. Although the present study cannot attribute the number of non-working individuals in a household to unemployment, there is a high correlation between unemployment and a high dependency ratio. Ngema *et al.* (2018) show a positive correlation between employment and food security. Huluka *et al.* (2019) also assert that an increase in daily working hours would boost the chances of a household falling under a high dietary diversity category. Invariably, the more there are non-working individuals in a household, either due to unemployment or other reasons, the lower the chances of such households being food secure.

The flow of income from farming engagements or non-farming sources significantly affected the communities' food security status. The result suggests that an increase in farm income and income from off-farm sources would increase the sampled farming households' chances of being food secure. This result corroborates the findings of Jones *et al.* (2014) and Harris-Fry *et al.* (2015), who report that households who supplement their income with non-farm income are more likely to diversify their diets, thereby

boosting their HDDS. It also agrees with Mark *et al.*, (2014) who assert that an increase in the income of a household would boost the chances of such household to be food secure. It is expected that an increased flow of income will increase the means or ability to purchase food, thereby strengthening households in battling food insecurity. However, the result is in contrast with Ngema *et al.* (2018) who report a lesser likelihood of households being food secure with increased household income.

Results from all communities show that household members' involvement in farming activities has a significant effect influence on the food security status of the households. This suggests that households with sufficient labour resources are more likely to be food secure. The probable explanation is that sufficient labour would help in the timely conduct of farming activities, resulting in high yields. This finding concurs with the submissions of Bogale and Shimelis (2009) and Mango *et al.* (2014). The household head's farming experience also has a significant effect on its food security status in both municipalities. The explanation for this could be that productivity is expected to improve with an increase in years of experience, thereby enhancing the food security status of the household.

DISCUSSION

The goal of this study was to analyze the effectiveness of the adoption of climate-smart conservation agriculture in improving food security in Marondera District, Mashonaland East Province, Zimbabwe. The adoption of CSCA in Zimbabwe holds significant potential for improving food security. By enhancing agricultural productivity, resilience to climate change and soil health, CSCA can help mitigate the impacts of climate variability on farming.

However, overcoming the challenges of awareness, costs and cultural resistance is crucial for successful implementation. From the above results, it can be noted that climate change is increasingly becoming a major issue for agriculture globally. Smallholder farmers in Mashonaland East Province implement rain-fed agriculture and currently, they experience drought, reduced crop quality and pest and disease outbreaks. The changing climate makes these problems worse. In this regard, farmers implement adaptation strategies through CSA practices such as soil management, utilisation of decomposed manure and agroforestry and intercropping systems.

According to IPCC (2019) (as cited in Mizik, 2021), special attention should be paid to climate change, especially to the reduction of GHG emissions. Its atmospheric concentration is projected to double by 2030, causing a significant increase in global temperature. This has serious implications for the agricultural sector all over the world. These initiatives interrelate in CSA, which, on one hand, uses the latest technological achievements, while on the other hand, aims to mitigate climate change. There is need for local small-scale farmers and the general populace in Zimbabwe to join hands and complement government's effort in fighting against implications of climate change. Climate-smart agriculture sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation) and enhances achievement of national food security and development goals. Sustainable agricultural practices consider sustainability's environmental, economic and social aspects, thereby preserving environmental health and supporting economic viability and social well-being. A transformation is needed in agricultural production to satisfy the growing

population-based increased food demands and to overcome food safety challenges while supporting human health and the preservation of natural resources. Improving sustainable agricultural practices is essential for developing a long-term and resilient economy (Boros *et al.*, 2025). The integrative assessment suggests that adopting novel, innovative practices can achieve the most significant progress toward agricultural sustainability. At the same time, a broad range of limitations and challenges is listed, which widely hinder the penetration of sustainability initiatives. Climate-smart agriculture is compromising food insecurity in sub-Saharan Africa. In 2022, at a minimum, 123 million people (12% of SSA's population) were projected to be acutely food insecure-suffering from high malnutrition and unable to meet minimum food consumption needs (WFP, 2022).

Responsive governments should come up with preventative measures to ensure food security. Collaborative efforts among government, NGOs and local communities will be vital in promoting and sustaining these practices for the benefit of Zimbabwean farmers and food security. Agricultural productivity has decreased and biodiversity has been lost as a result of climate change, endangering food security. Water supply has also been impacted, which has had a terrible impact on small-scale farmers who depend on the environment for their lives (Durodola and Mourad 2020). CSCA is an innovative farming approach that aims to increase agricultural productivity while enhancing resilience to climate change and reducing GHG emissions. In Zimbabwe, where food security is a pressing issue due to various environmental and socio-economic challenges, the adoption of CSCA presents a viable solution. Therefore, it is against this background that CSA is a useful strategy to address these

problems by emphasizing resilience, boosting agricultural output and cutting GHG emissions. Precision farming, often known as smart agriculture, is a quickly developing multidisciplinary field that includes expertise from a variety of fields, including environmental science, data science, technology and agriculture. It presents a major obstacle for worldwide farming, impacting both the growth and delivery of crops. Therefore, numerous governments are investing significant funds into research for advanced agricultural practices and Zimbabwe is also among them. There is need for researchers to invest in looking for practices that use the latest technological achievements and aim to reduce GHG emissions and water use while helping farmers adapt to and relieve the effects of climate change. Thus, these methods (e.g., cover cropping and nutrient recycling) promote the resistance of the sector to changing environmental conditions.

The negative effects of climate change on small-scale farmers can be reduced at the individual and larger levels by putting CSA practices and technology into place. The low rainfall in dry seasons makes the smallholder farmers more vulnerable. Additional irrigation systems should be available and accessible to increase productivity during the prolonged periods of drought, especially to those small-scale farmers close to dams like Wenimbe, Rufaro, Nyambuya and Chikwama in Marondera District. Therefore, providing piping systems from villages with water resources can help provide better irrigation systems to alleviate the possibility of crop failure in other villages. Climate change directly impacts the whole agricultural sector, which can be either positive (e.g., agricultural production zones expand) or negative (e.g., more frequent natural disasters such as heat stress). Developing countries are particularly affected due to the higher

share of agriculture in their national gross domestic product (Mizik, 2021). The outcomes of this strategy demonstrate a number of advantages, such as improved crop yields, harmonious germination, improved financial returns and more efficient use of resources overall, hence increasing food security in the country.

The general observation of the research was that, CSA is a proper adaptation strategy for farmers to deal with climate change impacts. CSA improves agricultural production and conserves natural resources through land and water management and this is also supported by Olawuyi (2020). For instance, land management enhances the soil's organic content to improve the land capacity and hold more water, which positively impacts crop growth. Therefore, promoting farming methods and techniques that support the sustainability of farmers and resources is one way that sustainable agriculture helps.

CONCLUSION

The research, therefore, concludes that climate-smart agriculture aims to transform agriculture, particularly in low- and middle-income countries, into sustainable, food secure and climate-resilient systems by the achievement of its three principles: increasing of sustainable productivity and food security, building climate resilience and reducing GHG (GHG) emissions. CSA is the way to turn around the situation to more resilience and higher agricultural productivity, leading to improved food security status. Long-term climate change resilience and adaptation interventions by national governments, farmers' associations and development partners need to be implemented in the context of broad-based frameworks that address the socioeconomic conditions of farmers. Climate change is a great threat to

agriculture and, as such, there is need to tackle this adverse impact by adopting new innovative techniques in CSA. This research has dealt with some of the CSA techniques that can help reduce the impacts of climate change on agriculture and increase food crop production. To achieve food security and agriculture development goals, adaptation to climate change will be required to lower emission intensities per output. Thus, improving food protection by moderate climate change, sustainable use of natural resources and using all products more competently, have less inconsistency and greater constancy in their outputs. More fruitful and more flexible agriculture requires a paramount change in the usage of resources such as land, water, soil nutrients and genetic resources management by CSA approaches. In addition, indigenous knowledge should be considered and documented for positive application and that a range of strategies that are not money-consuming should be considered to ensure sustainable livelihoods especially for underprivileged rural farmers as effects of climate change are expected to continue to worsen in the coming years.

RECOMMENDATIONS

Agriculture plays a vital role in the economic growth. Therefore, introducing climate-smart agriculture to rural regions will greatly benefit the farming sector. Therefore, this research recommends that policy design and implementation be driven toward encouraging and helping small-scale farmers engage in multiple CSA practices to improve their agricultural production. By this, farmers can fortify themselves against climate-change-related risks and enhance their households' food security level. Secondly, given the positive influence of the involvement of the members of the sampled households on the food security status of the households, governments and organisations interested in agricultural

development and other stakeholders should embark on projects that will make agriculture more attractive, particularly at the small-scale level. There is need to do more in rebranding agriculture as a lucrative venture and not as a vocation for those without options. This intervention is essential for enhancing food security and poverty alleviation as well as agricultural and rural development in South Africa and many other African countries.

Based on the positive influence of farming experience on food security, this study also suggests that national and local institutions should be strengthened to support farmers by providing them with access to information and resources. Policymakers should use extension services for information dissemination in more attractive and productive ways, particularly concerning using evidence to adapt practices to local conditions. Also, there is a need for policies and regulations for increased coordination of agricultural, environmental and food systems. An enabling policy environment facilitated by collaborations across relevant units is needed to enhance the synergy that could usher in the desired outcome.

This research recommends extending the research to other areas in Zimbabwe. This will support effective decision-making and make evidence widely accessible to decision-makers at the national and local levels. An extended scope into similar research will also help address technical challenges associated with the up-scaling of recommendations and models that will be needed for more appropriate decision-making. Researches can also exploit synergies from global, national and local studies for more robust and integrated findings.

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