# An Evaluation of Mechanisms for Adopting Climate Smart Agriculture to Ensure Sustainable Livelihoods in Zimbabwe

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## Abstract

Agriculture remains the main livelihood in sub-Saharan Africa where climate variability and change continue to impact negatively on food security. This study evaluated prevailing mechanisms within the agriculture sector that influence the adoption of Climate-smart agriculture (CSA) to ensure sustainable livelihoods in Zimbabwe. The paper applied information gathered from 266 households through questionnaire surveys, interviews with key informants, and observations. Participants were selected using convenience sampling, based on geographical proximity, accessibility, availability at a given time, and willingness to participate while interview respondents were chosen purposively based on their experience and knowledge of delivering extension services. The questionnaire focussed on CSA mechanisms, and locally-specific factors that have a bearing on the adoption of CSA. Respondents were expected to indicate from a dichotomous "yes or no" to a given set of CSA mechanisms. Locally-specific factors that were evaluated included socio-economic, environmental, climatic, technical, and institutional. Descriptive statistics were applied to summarize locally-specific factors that were examined in contrast with CSA adoption mechanisms. An overwhelming majority of respondents (93%) indicated "yes" to practicing mixed farming. Smallholder farmers pointed out that they benefit from look-and-learn field tours and experimental learning practices that are communicated in their vernacular language. Rural-urban migration was highlighted as the main factor that reduces the labour force in rural communities and invariably reduces agricultural productivity. The study underscored the significance of understanding mechanisms for adopting CSA to improve resilience in rural and urban communities. It is envisaged that the results will contribute to the information bank for stakeholders and researchers who seek to undertake further research on sustainable livelihoods.

**Keywords**: climate-smart agriculture, livelihoods, agricultural, productivity, vulnerability

## 1. Introduction

Although climate variability and change continue to have adverse effects on food security in Africa, agriculture remains the predominant source of livelihood for the majority of the population (Akinnagbe & Irohibe, 2014; Buhaug, Benjaminsen, Sjaastad, & Theisen, 2015). The vulnerability of the agriculture sector requires transformative strategies that reduce the impacts of extreme weather events (Hellin & Fisher, 2019). CSA is hailed as an appropriate approach to developing policy, technologies, and enabling conditions that result in improved resilience of the agriculture production system that ensures food security and poverty reduction (Collier & Dercon, 2014; Sullivan, Mwamakamba, Mumba, Hachigonta, & Sibanda, 2012). Researchers further contend that CSA represents the reorientation of agriculture production systems through policy development and institutional support that efficiently address climate-related challenges and strengthen the livelihoods of smallholder farmers through the adoption of suitable mechanisms (Senyolo, Long, Blok, & Omta, 2018; Williams et al., 2015). CSA implementation requires that countries put in place the necessary policy, financial and technical mechanisms to mainstream climate variability and change adaptation and mitigation in agriculture sectors (Zougmoré et al., 2016). Policies provide an enabling environment to ensure that stakeholders create the necessary infrastructure that provides appropriate mechanisms for smallholder farmers to adopt CSA (Palombi & Sessa, 2013).

CSA mechanisms reduce vulnerability to climate-induced change and achieve sustainable agricultural development goals under changing climatic conditions (Williams et al., 2015). Consequently, CSA mechanisms need to be grounded in the comprehension of how vulnerable rural and urban communities achieve and sustain their livelihoods. In Zimbabwe, CSA is promoted at the national and local levels to achieve food security, reduce poverty, and mitigate greenhouse gas emissions (Huyer & Nyasimi, 2017). The application of CSA mechanisms at the local level benefits smallholder farmers and provides stakeholders with information for identifying context-specific mechanisms that ameliorate impacts of climate variability and change (Muzorewa & Chitakira, 2020). Households' eligibility for mechanisms support is based on asset endowment coupled with the interaction between capital assets (natural, financial, human, social) and the prevailing enabling socioeconomic, environmental, institutional, and policy interventions (Hellin & Fisher, 2019).

Increased understanding of mechanisms for adopting CSA is fundamental for coping strategies in rural and urban communities in Zimbabwe. The clarity will open up opportunities for improved comprehension of overall vulnerability through the stimulation of multidisciplinary debate that incorporates awareness of socioeconomic and political factors which function as complex processes through which transformation is underpinned. With this background, the fundamental aim of this study is to appraise mechanisms within the prevailing agriculture sector that influence the adoption of CSA to ensure sustainable livelihoods. It is envisaged that the results will contribute to the data bank for use by stakeholders seeking to promote sustainable livelihoods, including practitioners and researchers.

## 2 Literature review of CSA mechanisms opportunities

### 2.1 Adaptation

Adaptation entails the application of a variety of measures and initiatives to alleviate the negative impacts of climatic shocks and stressors while taking advantage of new opportunities arising from climate variability and change (Parry, 2007). The measures and initiatives include building capacity, knowledge, information, and organizational technologies that enhance livelihood outcomes through increased agriculture productivity (Mujeyi, Mudhara, & Mutenje, 2021; Muzari, Nyamushamba, & Soropa, 2016; Zhu, Clements, Quezada, Torres, & Haggar, 2011). Smallholder farmers adapt to the challenges of climate variability and change through risk reduction behavioural change, mixed farming, planting suitable crops, early planting, use of pesticides under the integrated pest management (IPM) programme, and manure application. These mechanisms are considered fundamental for promoting local-based individual or community-based strategies that mitigate current adverse effects and reduce exposure to the risks of future climatic shocks and stressors (Fust, 2021).

### 2.2 Extension services

Agriculture extension services are a mechanism for disseminating information, knowledge, and skills that enhance farmers' food security and sustainable natural resources management (Baloch & Thapa, 2018; Zwane, Groenewald, & Van Niekerk, 2014). Extension services are vital for improving the lives of smallholder farmers through advisory services on current and new agriculture production technologies. Agriculture is a major activity in rural communities; as such, the timely dissemination of information is paramount for achieving desired livelihood outcomes (Emmanuel, 2013). Extension services provide smallholder farmers with practical knowledge in the use of adaptation mechanisms that include drought-tolerant and disease-free maize seeds, improved market linkages, mulching for moisture retention, and improved methods of harvesting and storage. It is vital to ensure extension services that are relevant to farmers' needs to help them make informed adaptation decisions.

### 2.3 Technological integration

Technology in agriculture has the potential to address climate-related challenges and invariably enable smallholder farmers to improve productivity and enhance livelihood outcomes (Brand, 2015; Senyolo et al., 2018). The development of new technology is important for the resilience of smallholder farmers in sub-Saharan Africa (McIntyre, Herren, Wakhungu, & Watson, 2009; Thornton et al., 2017). Access to new technology is critical for farming activities to successfully address development and sustainability challenges (Dhrifi, 2014). According to Atsriku (2020). Again, ensuring the availability of technologies to smallholder farmers is important for enhancing the growth of rural communities. Technological practices that include the use of solar, precision irrigation, and greenhouses have the potential to enhance the adoption of CSA in rural communities. Greenhouse technology has been alluded to as a production system that boosts yields through the regulation of climate conditions such as humidity, light, and temperature (Achour, Ouammi, & Zejli, 2021)

### 2.4 Access to weather information

Accessing weather information is vital for forecasting rainfall distribution patterns and temperature variations which are important for improving the adaptive capacity of smallholder farmers (Giorgi, Jones, & Asrar, 2009). Weather information entails the production, translation, and delivery of appropriate information for vulnerable farmers' adaptation and mitigation against climate variability and change (Asrar, Ryabinin, & Detemmerman, 2012; Vaughan, Buja, Kruczkiewicz, & Goddard, 2016). Information disseminated timeously is critical for enhancing smallholder farmers' resilience to variations in seasonal weather (Tall et al., 2012). Weather information has the potential of opening new markets and creating new income-generating ventures for vulnerable people (Egbe & Mutanga, 2016). Radio, mobile phones, and extension services have been singled out as effective channels for information dissemination (Churi, Mlozi, Tumbo, & Casmir, 2012)

### 2.5 Farmer-field-schools (FFS)

Farmer-to-farmer collaboration through FFS is a platform through which smallholder farmers encourage hands-on interactive education with each other by sharing information that includes current and new technologies, market networking, and communal pooling of resources to cut crafty middlemen (Lukuyu, Place, Franzel, & Kiptot, 2012; Omulo & Kumeh, 2020; Ssemakula & Mutimba, 2011). The farmer associations are characterized by discovery through experimental learning, fields as learning platforms, learner-generated learning materials, and regular interactive group meetings which empower farmers, to understand the ecology of their farming activities (Anandajayasekeram, Davis, & Workneh, 2007; Rogers, Singhal, & Quinlan, 2014). FFS focus on empowering the farmers to use their initiatives and experiment with technologies (Gadzirayi & Mafuse, 2014). Farmer-to-farmer interactive associations have been renowned for reducing the over-use of pesticides through the IPM programme (Waddington & White, 2014). FFS are unique to particular farmers' conditions and this makes them effective for spreading information among farmers (Kiptot & Franzel, 2014)

### 2.6 Agricultural financial support

Agricultural financial support is vital for assisting vulnerable smallholder farmers to adapt to the challenges of climate variability and change (Aniah, Kaunza-Nu-Dem, &

Ayembilla, 2019). Financial support is argued to be a moral obligation of the main atmospheric polluter toward those who suffer the most from the impacts of climate change (Gore, 2010). In sub-Saharan Africa, financial donors and NGOs contract private sector suppliers to deliver extension services in specific project areas (Machila, Lyne, & Nuthall, 2015). However, most donors and NGOs prefer group formations as a prerequisite for accessing funding arguing that costs to them are lower and resources can be distributed much quicker (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009). The importance of financial support necessitates the need for enabling policy and institutions to devise innovative approaches that favour vulnerable smallholder farmers in remote communities (Siedenburg, Martin, & McGuire, 2012).

## 2. Materials and methods

### 2.1 The Study area

The study was undertaken in the Mutare District of Manicaland Province of Zimbabwe. The district is about 265km east of Harare, the capital city of Zimbabwe, and is surrounded by Chimanimani, Buhera, Makoni, and Mutasa districts and shares a border with Mozambique to the east as shown in Figure 1. Mutare district includes rural and urban communities of which Mutare urban is located near Vumba Mountain and Murahwa Hill and is accessed through the Christmas pass tunnel. The latitude is18°58'0" and the longitude is 32°40'0". The Sakubva River and its tributary Nyaphumbi pass through Mutare urban. The topography of Mutare rural is characterized by mountains, hills, steep valleys, and a network of rivers and tributaries. Zimbabwe is categorized into five agro-ecological regions based on soil quality, vegetation, and rainfall regime (Mugandani, Wuta, Makarau, & Chipindu, 2012; Ndebele-Murisa & Mubaya, 2015). Mutare district is located in ecological regions I and II which are suitable for intensive crop and livestock production (Nyamadzawo, Wuta, Nyamangara, & Gumbo, 2013). Intensive crop farming produces tea, coffee, sorghum, beans, maize, cotton, millet, sunflowers, fruits, and vegetables among others while animal farming involves both small and large livestock (Rusinga, Chapungu, Moyo, & Stigter, 2014).

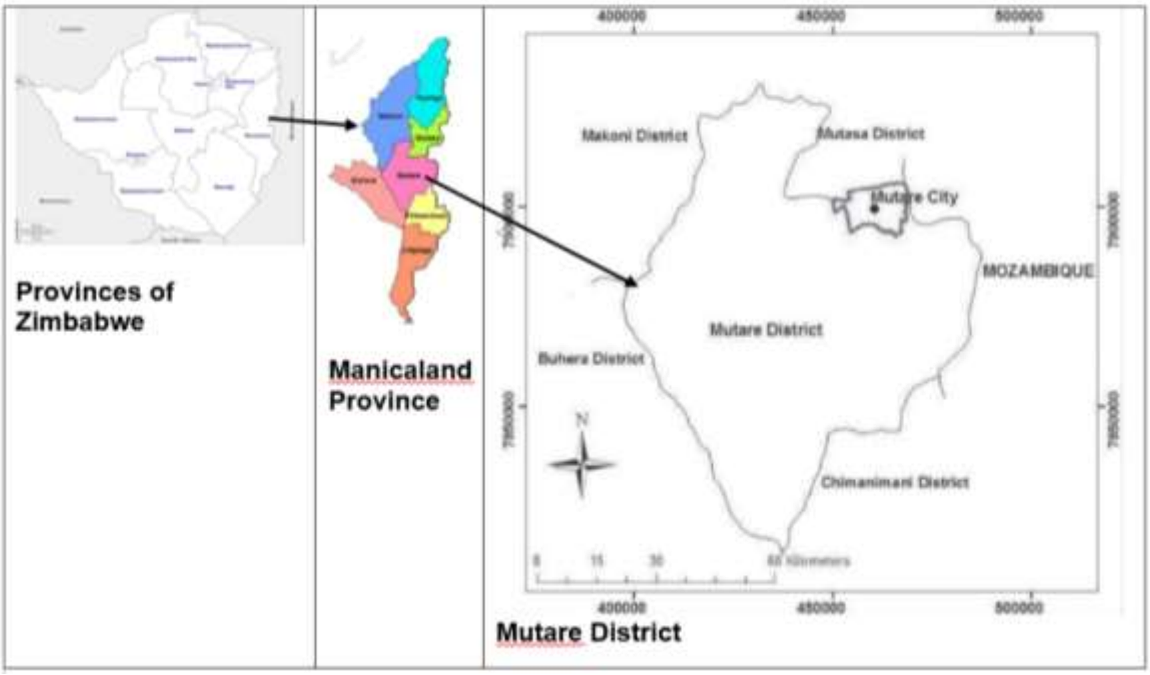


Figure 1: Geographical Situation of Mutare District and Mutare City, Zimbabwe: (Muzorewa & Chitakira, 2022)

## 2.2 Strategy of Inquiry

The data collection method involved a sample size of 266 household representatives, key informants, and field observations. The household representatives were asked to complete a semi-structured questionnaire while semi-structured interviews were held with key informants. The selection of respondents was based on purposive sampling where they met practical criteria that included geographical proximity, accessibility, availability at a given time, and willingness to participate (Etikan, Musa, & Alkassim, 2016). The semi-structured questionnaire focused on gathering information on demographic characteristics, CSA mechanisms, and context-specific factors that have bearing on the adoption of CSA. Key information interview respondents were chosen purposively based on their experience and knowledge of delivering extension services in the study area. The researchers stopped the interviews when data saturation was reached during which the collection of more data was yielding minimal relevant information. Field observations were undertaken to collect information that was used to verify data collected from questionnaires and interviews.

### 2.3 Data analysis

Descriptive statistics was the analytical tool used to interpret the results. Demographic statistics were explained using frequency and percentage counts. Regarding CSA mechanisms, respondents were requested to choose "yes or no" to a given selection of variables which were explained using percentage counts. Concerning locally-specific factors that influence the adoption of CSA, respondents were requested to demonstrate the level of their concurrence with given factors that were based on the following themes: socio-economic, environmental, climatic, technical, and institutional**.** These specific variables were calculated to produce the general value of the above themes which were examined using mean and standard deviation.

## 3. Presentation of Results

### 3.1 Descriptive statistics of socio-demographic survey

**Table 1: Demographic characteristics**

| **Variables** | **Number of respondents** | **Percentage of respondents** |
|---|---|---|
| | | |
| **Age range (in years)** | | |
| 18 - 20 | 16 | 6 |
| 22 - 25 | 22 | 8 |
| 26 -29 | 25 | 9 |
| 30 - 33 | 31 | 12 |
| 34 - 37 | 37 | 14 |
| 38 - 41 | 52 | 20 |
| 42 and above | 83 | 31 |
| | | |
| **Gender** | | |
| Female | 146 | 55 |
| Male | 120 | 45 |
| | | |
| **Family size** | | |
| 1 – 2 | 43 | 16 |
| 3 – 4 | 72 | 27 |

| | | |
|---|---|---|
| 5 – 6 | 60 | 23 |
| 7 – 8 | 48 | 18 |
| 9 – 10 | 38 | 14 |
| 11 plus | 5 | 16 |
| | | |
| **Head of household** | | |
| Women | 136 | 51 |
| Men | 114 | 43 |
| Child | 16 | 6 |
| | | |
| **Highest level of school education** | | |
| No education | 32 | 12 |
| Primary education | 117 | 44 |
| Secondary education | 82 | 31 |
| Tertiary education | 35 | 13 |
| | | |
| **Formal education in farming** | | |
| Yes | 72 | 27 |
| No | 194 | 73 |
| | | |
| **Length of time as a farmer** | | |
| 0 – 4 | 40 | 15 |
| 5 – 9 | 43 | 16 |
| 10 – 14 | 52 | 20 |
| 15 –19 | 44 | 16 |
| 20 plus | 87 | 33 |
| | | |

Household representatives above the age of 42 years constituted the highest number of respondents (33%) and most of them were females (55%) as shown in Table 1. The most common family size was 3 - 4 members. Women headed most households (51%) in contrast to men (43%). Primary education was the highest level of education (44%) and an overwhelming 73% of respondents indicated that they have no formal education in farming but most (33%) had more than 20 years of experience in farming.

### 3.3 Specific CSA mechanisms adopted by farmers

**Table 2: Descriptive statistics results of CSA mechanisms adopted by farmers**

| Dependent variables | Yes (%) | No(%) |
|---|---|---|

| | | |
|---|---|---|
| **Adaptation** | | |
| Practice fisheries and forestry | 64 | 36 |
| Manure application (manure-intensive husbandry) | 83 | 17 |
| Practise animal and crop farming (mixed farming) | 93 | 7 |
| Early planting to take advantage of the first rains of the season | 72 | 28 |
| Stop planting the same crops on the same fields every year (monoculture practice) | 95 | 5 |
| Enhance forestry by planting trees around fields | 11 | 89 |
| **Extension services (Knowledge sharing)** | | |
| Participate in farmer field schools (look-and-learn field tours) | 88 | 12 |
| Participate in experimental learning activities | 62 | 38 |
| Replace traditional farming methods | 77 | 23 |
| Solve own agriculture production-related challenges | 81 | 19 |
| Enabling pooling of resources | 56 | 44 |
| Participate in livestock disease surveillance | 59 | 41 |
| **Technology integration (smart agriculture)** | | |
| Reduce the use of fuel-powered machine | 76 | 24 |
| Make use of solar technology | 53 | 47 |
| Apply drip irrigation (precision irrigation) | 51 | 49 |
| Apply the correct amount of fertilizer (precision fertilizer) | 79 | 21 |
| Practice horticulture | 44 | 56 |

| | | |
|---|---|---|
| Convert harvest residue into animal feed and compost | 91 | 9 |
| **Access to weather information** | | |
| Use of radio/TV to access weather information | 95 | 5 |
| Use of the internet to access weather information | 7 | 93 |
| Access information through agriculture extension services | 82 | 18 |
| Acting upon the medium to long-range forecasts | 5 | 95 |
| Application of own experience of weather events | 53 | 47 |
| Use of Eco-farmer platform to acquire weather information (mobile phones farming platform) | 83 | 17 |
| **Farmer-field-schools (Knowledge sharing)** | | |
| Improve market linkages and networks | 86 | 14 |
| Communal pooling of resources to cut crafty middlemen | 58 | 42 |
| Sharing information on the importance of behavioural change (change of self-doubts to self-confidence) | 90 | 10 |
| Encourage hands-on, interactive education with each other | 53 | 47 |
| Benefits of communicating in the local language | 98 | 2 |
| **Financial support** | | |
| Land tenure security is critical (collateral security on land) | 74 | 26 |
| Need for low-interest rate bank lending to farmers | 61 | 39 |
| Training farmers in agri-business and risk management | 55 | 45 |
| Know where and how to obtain agriculture finance | 61 | 39 |
| Raise own income to reduce poverty and create jobs | 27 | 73 |

| | | |
|---|---|---|
| Infrastructure development (roads/bridges/clinics/transport) | 94 | 6 |

An overwhelming 95% of respondents revealed that they do not practice monoculture farming as demonstrated in Figure 2 whilst 93% indicated "yes" to the adoption of mixed farming that involves crop production and animal husbandry. Respondents (88%) reported "yes" to benefiting from participation in look-and-learn field tours under the FFS programme while 81% stated that extension services enable them to formulate their context-specific decisions related to farming practices. Regarding technology integration, 91% of the respondents pointed out that they convert harvest residue into livestock feed and compost. Precision fertilizer (79%) which is the application of the correct amount of fertilizer was revealed as a common smart agriculture mechanism. Contrary to the efforts of policy and institutional drive to promote technology integration into smallholder farming, respondents regretted that they are forced to reduce the use of fuel-powered machines (76%) because of the high operating costs and the erratic fuel supplies. The use of television and radio to access weather information (95%) coupled with the use of mobile phone network groups (83%) such as the Eco-farmer were indicated as popular mechanisms for accessing weather information. It is worth pointing out that a large number of farmers (93%) stated 'no' to the use of the internet to access weather information because of the lack of electricity in rural communities which makes it impossible for them to utilize computer technology. An overwhelming 98% of respondents signified that they benefit from practices that are communicated in their vernacular language whilst 90% emphasized the importance of behavioural change from self-doubts to self-confidence which is important for decision making. The provision of infrastructure (94%) was highlighted as critical for agricultural development while land tenure security (74%) was pointed out as critical for collateral security. Several respondents (94%) highlighted the need for infrastructure development which they argued to be either poorly maintained or non-existent.

## 3.4 Locally-specific factors that influence the adoption of CSA

Factors that were considered as the dependent variables included socioeconomic characteristics; environmental constraints; climatic shocks and stressors; agricultural technologies; and enabling institutional arrangements. During the questionnaire surveys, the respondents were asked to demonstrate the level of their agreement with given variables based on a scale 1= firmly agree, 2 = agree, 3 = neither agree nor disagree, 4 = disagree, and 5 = firmly disagree. The responses were inputted into Microsoft Excel to calculate the mean, standard deviation (Std Dev), and standard error of the mean (SE) to produce results shown in Table 3

**Table 3: Descriptive results of locally-specific factors**

| Dependent variables | Mean | Std. Dev | S.E |
|---|---|---|---|
| **Socio-economic** | | | |
| Agriculture activities are affected by the high cost of inputs | 2.09 | 1.18 | 0.07 |
| Rural-urban migration reduces the availability of farm labour | 3.51 | 1.44 | 0.09 |
| Nutrients for livestock are important but expensive | 2.33 | 1.28 | 0.08 |
| It is difficult to access insurance for agriculture | 2.09 | 1.11 | 0.07 |
| **Environmental** | | | |
| Poor soil requires large inputs of fertilizers | 2.05 | 1.03 | 0.06 |
| The removal of forests for agriculture impacts sustainable forestry | 2.13 | 1.11 | 0.07 |
| The use of machinery on sloppy, rough, and hilly terrain has a negative environmental impact | 2.53 | 1.31 | 0.08 |
| Irrigation causes the depletion of underground water which is important for the environment | 2.47 | 1.30 | 0.08 |
| **Climatic** | | | |
| The onset of rainfall is very difficult to predict these days | 2.41 | 1.31 | 0.08 |
| Availability of water for irrigation doubles farm yields | 2.11 | 1.10 | 0.07 |

| | | | |
|---|---|---|---|
| The seasons are becoming hotter | 2.41 | 1.28 | 0.08 |
| Extreme weather events are affecting crop yields | 2.26 | 1.19 | 0.07 |
| **Technical** | | | |
| Market availability is significant for the adoption of technology | 2.15 | 1.10 | 0.07 |
| Technical assistance enhances my farming knowledge | 2.24 | 1.19 | 0.07 |
| Early detection of diseases in dairy animals is important | 2.32 | 1.33 | 0.08 |
| There is a need to shift to growing treated small grains | 2.58 | 1.33 | 0.08 |
| **Institutional** | | | |
| Agriculture reform laws are essential for improving yields | 2.76 | 1.29 | 0.08 |
| There is a need for private sector CSA funding | 1.92 | 1.04 | 0.06 |
| There are no government subsidies that I know of | 1.67 | 0.77 | 0.05 |
| Producer prices are an incentive to farmers to produce more | 2.33 | 1.19 | 0.07 |

The results of the socioeconomic characteristics in Table 3 indicate that rural-urban migration mean (3.51) reduces the labour force in rural communities and invariably reduces agriculture productivity. Although the respondents alluded to the importance of nutrient management for boosting livestock production, they deplored the prohibitive costs involved with an intensive farming mean (2.33). The challenge of using agriculture machinery on sloppy, rough, and hilly terrain, mean (2.53) was highlighted as a factor that hinders the sustainable increase in agriculture productivity. In addition, irrigation was pointed out as a contributing factor that causes the depletion of underground water which is important for the environment mean (2.47). Respondents revealed that the onset of rainfall which is increasingly becoming difficult to predict and the seasons which are becoming hotter, mean (2.41) are the leading climatic factors that are retarding farmers' adoption of climate-smart livelihood strategies. The farming practice of shifting to growing treated small grains mean (2.58) was alluded to as the main technical consideration that boosts climate resilience in rural communities. Agriculture reform laws, mean (2.76), on leasehold, and communal land were highlighted as essential institutional changes required to enhance the adoption of CSA.

## 4. Discussion

Smallholder farmers employ a variety of adaptation packages for the uptake of CSA. One of the most common strategies is the practice where farmers have moved from continually growing the same crops on the same field (monoculture) to crop rotation which is a system of planting different crops in recurrent succession (Sumner, 2018). Smallholder farmers practice crop-livestock management, an example of a package that utilizes resources to boost agriculture productivity while promoting natural resource management (Lemaire, Franzluebbers, de Faccio Carvalho, & Dedieu, 2014). The crop component of the integrated farming practice involves the production of maize, sorghum, groundnuts, cowpeas, vegetables, fruits, and sugar beans as staple crops whilst tea, coffee, sunflower, cotton, soya beans, and paprika are grown as cash crops (Rusinga, Chapungu, Moyo, & Stigter, 2014).

A common practice among smallholder farmers is to feed straw to livestock to increase the quality of meat and milk (Valbuena et al., 2012). The farmers supplement livestock nutrients with straw because most cannot afford the prohibitive prices of commercial animal feeds. Livestock farming in practice includes cattle, chickens, rabbits, ducks, pigs, and goats. Apart from providing beef, milk, and manure, cattle are a source of draught power and transport while small livestock is easily disposed of for cash (Chipunza, Mutibvu, Kashangura, & Mbiriri, 2013).

Access to extension services is an important factor that enhances the adoption of CSA through information dissemination and capacity building. Agriculture extension services have promoted the use of drought–tolerant, heat stress, and disease-free maize to safeguard against multiple stressors that result in the loss of crop production. As such, smallholder farmers have benefitted from the maize seed varieties which have been successfully tested and have performed better than other hybrid seeds (Ngara, 2017). The choice of seed varieties that include ZM309, ZM401, PAN3M-41, and SC301 has better results when used in combination with approved agriculture practices. In addition, the Seed Services Institution developed high-yielding sorghum varieties (DC75 and NS511) (Ngara, 2017).

Extension services encourage smallholder farmers to participate in FFS and master farmer training that transfers specialist knowledge and skills that empower them to decide on farming practices that are specific to their areas (Gadzirayi & Mafuse, 2015). The initial focus of FFS in Zimbabwe was to promote the adoption of IPM (Braun & Duveskog, 2011) but the current focus is for farmers to meet regularly and share ideas on issues that include natural resources protection, soil management, crop management, animal husbandry, entrepreneurship, and innovation. The groups participate in look-and-learn field tours during which instructors and the farmers exchange information and knowledge on current and new production systems, and discuss experiences and opinions useful for profitable farming. Farmers benefit the most when discussions are held in their vernacular language.

Technological integration into farming is essential for increasing productivity and reducing environmental degradation. However, smallholder farmers are resource-poor to afford precision irrigation, solar, and greenhouse technologies. Lack of resources forces farmers to desist from using fuel-powered machinery because apart from the capital outlay, fuel is expensive and the supply is erratic. Besides, the challenge of using fuel-powered machinery such as tractors is exacerbated by sloppy, rough, and hilly terrain because farm topography plays an important role. In Zimbabwe, smallholder farmers access weather information through the Department of Agriculture, Research and Extension (AREX), radio, newspapers, and television (Rusinga et al., 2014). A mobile farming platform launched in 2013 by the largest mobile phone provider in Zimbabwe, Econet, provide daily weather information, farming tips, information on when and where to sell, and the best price for their produce (Moyo, Van Rooyen, Moyo, Chivenge, & Bjornlund, 2017). Besides technological integration, smallholder farmers are faced with the challenges of security of tenure or title deeds on two of the four land tenure systems in Zimbabwe (leasehold, and communal) for use as collateral security which is important for accessing agricultural insurance and finance. Further challenges that beset smallholder farmers include the provision of agriculture infrastructure which is an important determinant of productivity (Gajigo & Lukoma, 2011). Agriculture infrastructure includes equipment, transport, roads, bridges, clinics, other basic services, and institutions that support on-farm production (Warner, Kahan, & Lehel, 2008).

## 5. Conclusion

The study emphasized the significance of understanding mechanisms for adopting CSA to cope with climate variability and change. Respondents alluded to the adoption of CSA through the implementation of a variety of strategies that include adaptation, extension services, access to weather information, and participation in FFS. These were underlined as an important mechanism that promotes the adaptability of the entire agriculture production system. Accordingly, many households practice integrated farming that involves crops and animal husbandry to maximize productivity. Extension services were praised for their important role in impacting the knowledge and technical skills needed for achieving desired livelihood outcomes. In the rural context, the study revealed that smallholder farmers benefit from practices that are communicated in their vernacular language. The study highlighted the challenges rural communities face, including rural-urban migration that reduces their communities' labour force and invariably reduces agriculture productivity. Technological integration such as the use of computers and machinery remains the biggest challenge to sustainable development in remote rural communities due to poor infrastructure. There is therefore a need to support technological intervention which is an essential mechanism for supporting context-specific strategies that increase productivity and reduce environmental degradation.

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## Conflict of Interest

The research project did not receive financial support from any institutions. The authors declare no known competing financial or personal interests that could have influenced the collection, analysis, and interpretation of data and in the writing of the manuscript.

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